**REPUBLIC OF CYPRUS**
**Ministry of Communications and Works**

# "THE NICOSIA INTEGRATED MOBILITY MASTER PLAN"

# FINAL REPORT

# APPENDICES

**DENCO S.A. - CERTH/HIT - CTL – POLYTIA ARMOS**

**August 2010**

*Republic of Cyprus*

*European Union*

*Structural Fund*

## APPENDICES

# APPENDIX Chapter 1

# Notes on the Process of the Preparation of the IMMP

The present Appendix gives some basic information on the process of the preparation and of the up to now presentations of the project “Integrated Mobility Master Plan” (IMMP) for the Greater Nicosia Urban Area.

## 1. Preceding Reports

### Inception Report

- Scope and brief description of the study.
- Methodology to be followed, work allocation and time plan.
- First results of the collection and review of data.
- Proposal of possible “early winners” projects.

### Interim Report 1

Tasks completed as they are described in Component 1 of the Terms of Reference:

- Collection and review of socioeconomic and transportation data and projections for the target year 2020.
- Assessment of the current mobility in the Greater Nicosia Area based on the analysis of the results of the transport demand surveys, the traffic counts and other information and data collected.
- Calibration of the VISUM Transportation Model and preparation for the application for the target year 2020.
- Review of stated objectives for the Nicosia Public Transport Enhancement Projects and specific targets for their achievement, including the feasibility for the creation of a Transport Management Authority.
- Basic concepts of an integrated Parking Policy for on-street and off-street parking.
- Definition of the “early winners” projects as proposed in the Inception Report.

## Interim Report 2

Tasks completed, as they are described in Component 2 of the terms of reference. They mainly refer to the formulation, analysis and evaluation of alternative scenarios for the development of the Nicosia Greater Area by the year 2020 and the selection and presentation of the best scenario proposed.

- Sum-up of the current situation and trends and of the Urban Planning and Transport Planning principles considered in the Integrated Mobility Development Strategy.

- Formulation, analysis and evaluation of the three alternative scenarios, the model used and the results obtained for each scenario examined, concluding with proposals on the scenario to be accepted and a presentation of this scenario.

- Formulation of a Marketing Policy. Development and proposed means, size and content of the Communication Strategy.

## Interim Report 3

Elaboration and evaluation of the preferred scenario No 2 as well as two alternative scenarios concerning Public Transport (Multi-centre vs Radial) and one concerning road system (more one-way roads and pedestrianizations). Evaluation of the above four scenarios and selection of a preferred scenario. (Multi-centre PT and extended one-way roads and pedestrianization).

The preferred scenario, as elaborated in Phase 3, was complemented with a complete set of proposals that include the road, public transport, pedestrian and cyclist networks, together with a costed implementation timetable.

Also presented in this report are proposals for the organisational structure for the management of the transport infrastructure and services within the Greater Nicosia Area, the results of the pre-feasibility study carried out for the introduction of a tramway system in Nicosia and a Marketing plan for the successful implementation of the plan.

The plan was presented to the Steering Committee of the Programme for the Enhancement of Public Transport on May 31, 2010. The Steering Committee adopted the plan, with the additional requirement that, prior to implementation, detailed studies be conducted to ensure the following:

- Access to the affected areas and important developments is facilitated.
- The impact on sensitive areas (residential areas, schools) and on the secondary road network is considered.

- A detailed assessment of the traffic impact on the major junctions and primary roads is carried out.
- The impact on road safety is assessed.
- The impact on the adjacent commercial developments is assessed.

There was also a public presentation of the Plan for the citizens of Nicosia on June 22, 2010. The presentation was advertised in advance and was well attended. In the discussion that followed, most of the comments were positive, although some concerns were also echoed, mostly regarding individual elements of the plan.

In general, the plan was praised as well thought out and people expressed the feeling that, for the first time, something serious is going on. It was, furthermore, stated, that the implementation of the various schemes, particularly the introduction of one-way systems, must be speeded and that it must be demonstrated to the citizens that there will be reliability in the implementation of plan. The proposal for the tram was also well received, with even suggestions to extend the network considered to include other major destinations, such as the University of Cyprus.

There were concerns regarding the necessity of implementing specific schemes of the plan. It was also cited that there needs to be better coordination between the various government departments and that the link between town planning and transport planning must be stronger.

An issue that a few people addressed is the illegal parking of vehicles, particularly on pedestrian footways. Some people also mentioned that current planning does not sufficiently take into account the needs of pedestrians.

## 2. Involvement of Related Bodies

### 2.1 Steering Committee

The progress of work and the intermediate results of the project were presented to and discussed with a Steering Committee composed of the following members:

1. Permanent Secretary Ministry of Communications and Works (Chairman)
2. Mayor of Nicosia
3. Permanent Secretary of the Planning Bureau
4. Permanent Secretary Ministry of Interior
5. Director of Public Works Department
6. Director of Road Transport Department
7. Director of Town Planning Department

8. President of Union of Municipalities
9. President of Union of Communities
10. *Observer :* Director of Control of Ministry of Communications and Works
11. *Sitting in :* Programme Manager Public Transport Enhancement Programme

## 2.2 Project Management Unit (PMU) of the Ministry of Communications and Works (MCW)

The supervision of the project was carried out by the PMU of the Ministry under the direction of M. Lambrinos and the participation of the Senior Productivity Officer D. Kathijotis and the executive engineers D. Demosthenous and A. Savvas. W. Brouwer of the ARUP was a permanent advisor to the PMU while Messrs J.F. Biros from JASPERS and J. Ojeil from ARUP were also advising the PMU.

## 2.3 Departments of other related Ministries:

**a. Public Works Dept. of the MCW**

**b. Town Planning Dept. of the Ministry of Interior**

**c. Road Transport Dept. of the MCW**

Numerous contacts were made with the above Departments to collect information and coordinate the IMMP with their programs and the under way revision of the Nicosia Local Plan.

## 2.4 Municipalities and Public Consultations

Several contacts were made with the Municipalities of the study area, to collect information and coordinate their efforts with the IMMP. A Public Consultation was made on February 2 where the progress and proposals of the IMMP were presented and discussed with the Municipalities and the Public.

## 2.5 Other related bodies

Collection of information and discussions were made with various other related bodies e.g. Bus Operators, Consultants, etc.

# APPENDIX Section 3.1

# Applied Methodology and Models. Results

# 1. REVIEW OF TRANSPORTATION MODELING ACTIVITIES FOR THE NICOSIA IMMP STUDY

The activities during the IMMP study, that involved the design, implementation and validation of transportation modelling tools have included all the issues related to the transportation planning procedures commonly referred to as 'four-step transportation planning'. Concise overviews of these activities per step are discussed below.

## 1.1 Trip Generation

Production and attraction models have been developed based on the telephone surveys results.

*Productions*

Productions are mainly calculated as trips of residents. This has also been validated by the telephone survey results, which showed that most of the trips are home-based trips.

*Attractions*

An attraction model has been developed based on the attractions of each zone (ENORIA) correlated to the number of employees per zone.

Production and attraction models have been used in order to calculate the 2020 forecasts, based on the forecasts of the population increase indexes of the Statistics Bureau and the mobility ratio, which has been forecasted as 2,7 for the year 2020 (2,4 in the year 2010) based on the economical growth indexes of the Statistics Bureau.

## 1.2 Trip Distribution

For the year 2010, Origin-Destination matrices have been produced, based on the results of the telephone survey, extrapolated to the entire population of the study area. The 2010 O-D together with the attraction-production model have provided the necessary input for the estimation of the parameters of a gravity model, which has then been used for the trip distribution of the year 2020. This resulted to a balanced O-D matrix for the year 2020.

## 1.3 Modal Split

A logit-type model has been selected for the modal split calculations, based on an extensive literature review. The model used, takes into account the adjusted income of the users per zone, the difference of access time between auto and transit including parking and walking time (from parking and bus stop to final destinations) and waiting time at bus stops (access time of auto – access time of bus – waiting time at bus stops), the difference of inline travel time between auto

and transit mode (travel time by auto – travel time by bus) and finally the cost difference between the auto and transit modes (cost of auto – cost of a bus). The O-D matrices and datasets of the year 2020 have been used for the forecast of the modal split between auto and transit modes (transit included bus and tram systems) for the year 2020.

## 1.4 Assignment

Two types of traffic assignment models have been developed and used for the purposes of the IMMP study: A Static traffic assignment and a Dynamic traffic assignment model.

*Static traffic assignment model*

The initial traffic assignment model used in the study, has been VISUM, which is a static traffic assignment model. Static refers to the nature of algorithms and underlying assumptions used by this specific model, in terms of the way that route choice is calculated.

The supply side of the model has been fed with datasets comprised by the existing road network (links and nodes with respective information related to the free flow speed, the capacity, the effective capacity, length, link hierarchy, turn restrictions and other), traffic analysis zones, connectors and the public transport system related characteristics (lines, line routes, timetables etc).

The demand side of the model has been fed with datasets comprised by the Origin-Destination matrices for the peak morning period and for a typical twenty-four hour (daily) period.

In terms of scenarios and forecasts, an initial model has been created for the year 2010, which served as the base case scenario. The base case scenario has been validated with actual traffic count measurements within specific locations of the study area, which took place during the initial phase of the study period. The model validation process resulted to a model which could represent the actual traffic characteristics of the Nicosia network and on which future proposals and scenarios could be developed, assessed and evaluated. The outputs of the static models developed with VISUM included system-wide characteristics, such as total kilometers travelled and total vehicle hours and also link-specific characteristics, such as traffic volumes, travel times and volume-to-capacity ratios.

*Dynamic traffic assignment model*

A dynamic traffic assignment model has then been developed, based on the finally selected proposal of the study. VISTA, the simulation model used for this purpose, had as input the supply and the demand data mentioned previously and provided useful insights of traffic related dynamics, in a more detailed way, taking into account the dynamic spatiotemporal characteristics of each individual vehicle with the use of time-dependent shortest paths as an input for the final route choice of the users.

### 1.5 Micro-simulation

The time dependent shortest paths and volumes of VISTA for selected road sections – focusing on centrally located areas of Nicosia - have been provided to the SYNCHRO microscopic simulation model. The SYNCHRO simulation model provided detailed datasets for delays at selected intersections, queues and queue lengths and Levels-of-Service for these as well.

## 2. RESULTS

### 2.1 Results from VISTA Analysis on Selected Scenario (Scenario 2, Variation D)

The total demand used in VISTA for obtaining detailed results for the peak period (7:30 to 9:30 AM) is 133.214 vehicles. It includes a 15-minute warm up and a 15-minute cooling period for the simulator (the final analysis time period is from 7:15 to 9:45AM). Table 1 shows the demand and network characteristics.

**Table 1. Final Scenario Network Characteristics**

| Item | Counts in Final Scenario | |
|---|---|---|
| **Nodes** | 1.328 | |
| **Links** | 3.482 | |
| **Signalized Intersections** | 141 | |
| **V1 Demand(7:15-9:45am)** | 135.386 | vehicles |
| **Bus Demand(7:15-9:45am)** | 390 | buses |
| **Total Demand(7:15-9:45am)** | 135.776 | vehicles |
| **Bus Routes** | 71 | |
| **Assignment Length (s)** | 10.800 | seconds |
| **Assignment Interval (s)** | 900 | seconds |

The assignment interval is the corresponding Dynamic Traffic Assignment (DTA) interval that is taken into consideration by the model to reach Dynamic User Equilibrium (DUE) – the corresponding paths for each Origin-Destination pair and each 15-minute time interval when the model reaches DUE they should be approximately the same. Table 2 shows the characteristics and results of the dynamic assignment.

**Table 2. Network-wide Traffic Flow Characteristics – Nicosia Final Scenario Network (7:15 – 9:45 am)**

| | Time Period (am) | Loaded Vehicles | Total Travel Time (H) | AVG (min) | VKmT (km) |
|---|---|---|---|---|---|
| **All Vehicles** | 7:15 – 9:45 | 135776 | 42875 | 18,95 | 1159305 |
| **Bus** | 7:15 – 9:45 | 390 | 164 | 25,55 | 166 |
| **Autos** | 7:15 – 9:45 | 135386 | 42712 | 18,93 | 1159139 |

Table 3 shows analytically the results of the dynamic assignment.

**Table 3. Final Scenario Network-wide Traffic Flow Characteristics per 15-minute time interval (7:15 – 9:45 am)**

| Assignment Interval | Start | End | No. Veh. | Total TT (H) | AVG (min) | VMT (km) |
|---|---|---|---|---|---|---|
| 4 | 0:00:00 | 0:15:00 | 35550 | 11192 | 18,89 | 297145 |
| *5* | *0:15:00* | *0:30:00* | 13537 | 5321 | 23,58 | 124501 |
| *6* | *0:30:00* | *0:45:00* | 13519 | 5137 | 22,80 | 121710 |
| *7* | *0:45:00* | *1:00:00* | 13527 | 5112 | 22,68 | 121626 |
| *8* | *1:00:00* | *1:15:00* | 13471 | 4993 | 22,24 | 120655 |
| *9* | *1:15:00* | *1:30:00* | 10054 | 3107 | 18,54 | 86227 |
| *10* | *1:30:00* | *1:45:00* | 10030 | 2702 | 16,16 | 84589 |
| *11* | *1:45:00* | *2:00:00* | 9977 | 2306 | 13,87 | 82875 |
| *12* | *2:00:00* | *2:15:00* | 9999 | 2023 | 12,14 | 81407 |
| 13 | 2:15:00 | 2:30:00 | 6106 | 983 | 9,66 | 42285 |
| **Total** | 0:00:00 | 2:30:00 | 135770 | 42875 | 18,95 | 1163022 |

## 2.2 Results from SYNCHRO Analysis on Selected Scenario (Scenario 2, Variation D)

In order to carry out the analysis using the SYNCHRO software, the VISTA results were aggregated into 15-minute time intervals. Given the 15-minute VISTA results the peak 15-minute time period was identified to be from 7:45 to 8:00AM, the following arterials were modelled using SYNCHRO:

- Griva Digeni Ave. - Spyrou Kyprianou Ave. arterial from Prodromou Ave. to Makariou III.
- Kallipoleos Ave. from Evgenias and Antoniou Theodotou to Aglantzias Ave.
- Omirou Ave. – Stasinou – Salaminos from Mouseiou to Roikou.

The following tables provide a summary of the main results at the arterial level. The main parameters of interest include the delay at each approach, the travel time and the corresponding Level Of Service (LOS).

**Griva Digeni – Spyrou Kyprianou Arterial (Table 4)**

Table 4 presents the arterial operational analysis for the Griva Digeni-Spyrou Kyrpianou arterial from Prodromou Ave. to Makariou III Ave.

*Note: It is noted that the WB S. KYPRIANOU in table 4 refers to the D. AKRITA Ave.*

The main arterial links that fall into LOS F are the following:

From Vyronos to Severi Ave. This is influenced by the high left turning movement from G. Digeni (EB) to Severi (NB) towards the City center.

- A potential remedy could be the elimination during the peak hours of the right turn from G. Digeni (WB) to Severi (NB) towards the City center that would result in a two phase operation. However, it will force travellers to choose residential streets which may not be desirable.
- Make Vyronos as a two-way street to allow more vehicles to move north towards the City center and near the governmental buildings in a distributed way.
- Rethink the Prodromou-Vyronos as a one-way system North of Griva Digeni. Prodromou could become one-way South at its North leg only while Vyronos could become one-way North all the way. This will force vehicles to use Chilonos to exit from downtown and reduce the volume from Vyronos into Griva Digeni. This mitigation plan may be introduced in conjunction with the plans for the new governmental buildings such that they can gain access via Vyronos.

The Griva Digeni west of Prodromou also falls under LOS F however since this is an entry link the LOS is misleading (the corresponding approach LOS is E based on the detailed intersection report) as it is influenced by the length of the entry link.

The remaining links of the arterial operate at rather acceptable LOS for this time period of the day.

Arterial Level of Service

3/29/2010

Arterial Level of Service: EB G.DIGENI

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| PRODROMOU | III | 48 | 17.0 | 76.0 | 93.0 | 0.19 | 7.5 | F |
| VYRONOS | III | 48 | 18.8 | 2.0 | 20.8 | 0.23 | 39.1 | B |
| D. SEVERI | III | 48 | 20.4 | 154.3 | 174.7 | 0.25 | 5.1 | F |
| T. DERVI | III | 48 | 34.7 | 4.3 | 39.0 | 0.44 | 40.6 | B |
| Total | III | | 90.9 | 236.6 | 327.5 | 1.10 | 12.1 | F |

Arterial Level of Service: WB G.DIGENI

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| T. DERVI | III | 48 | 39.9 | 4.7 | 44.6 | 0.51 | 40.9 | B |
| D. SEVERI | III | 48 | 34.7 | 5.2 | 39.9 | 0.44 | 39.7 | B |
| A. OMOLOGITON | III | 48 | 20.4 | 6.1 | 26.5 | 0.25 | 33.3 | C |
| PRODROMOU | III | 48 | 18.8 | 11.9 | 30.7 | 0.23 | 26.5 | D |
| Total | III | | 113.8 | 27.9 | 141.7 | 1.42 | 36.0 | C |

Arterial Level of Service: EB S. KYPRIANOU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| MAKARIOU III | III | 48 | 39.9 | 15.9 | 55.8 | 0.51 | 32.7 | C |
| Total | III | | 39.9 | 15.9 | 55.8 | 0.51 | 32.7 | C |

Arterial Level of Service: WB S. KYPRIANOU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| MAKARIOU III | III | 48 | 20.2 | 12.6 | 32.8 | 0.24 | 26.6 | D |
| Total | III | | 20.2 | 12.6 | 32.8 | 0.24 | 26.6 | D |

Baseline
Maser Consulting P.A.

Synchro 6 Report
Page 1

**Table 4. Griva Digeni – Spyrou Kyprianou Arterial Operational Analysis using SYNCHRO – Nicosia Variation D Network – 7:45-8:00 AM Peak**

## E&A Theodotou-Kallipoleos-Makariou III-Lemesou Arterial (Table 5)

This arterial corridor operates at rather acceptable LOS throughout from Theodotou to Lemesou.

The E&A Theodotou arterial operates at LOS E due to the heavy demand yet it is manageable.

- Additional remedies may include left turn and right turn bays at these intersections.

The only LOS F is observed at the SB arterial link of Makariou III at the junction with Aglantzias Ave. The Aglantzias (WB) to Makariou III (NB) right turn towards the City center and the through (WB) into Verenikis operate at LOS F. In correspondence the Lemesou (NB) approach operates at LOS B.

*Kallipoleos Ave. & Aglantzias Junction*

Potential mitigation plans at the Kallipoleos(Makariou III) -Lemesou/Aglantzias-Verenikis junction:

- Rebalance the signal timing to provide more green to the Aglantzias (WB) right turn and less to Lemesou (NB) through movement.

- Make the left turn from Kallipoleos into Aglantzias a free movement with an extra lane.

- Verenikis may become one way with two lanes (EB) and the San Sousi to serve as the WB with also two lanes. Since Statsinou is becoming a one-way street to the North then the junction with Verenikis will ne unsignalised. This solution will create extra capacity and it will not need any major changes at the junction with Ifigeneias.

Arterial Level of Service

3/29/2010

Arterial Level of Service: SW E&A THEODOTOU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| SALAMINOS | IV | 48 | 16.7 | 21.4 | 38.1 | 0.15 | 14.1 | E |
| ROIKOU | IV | 48 | 16.6 | 18.1 | 34.7 | 0.12 | 12.2 | E |
| D. AKRITA | IV | 48 | 20.5 | 28.1 | 48.6 | 0.18 | 13.6 | E |
| Total | IV | | 53.8 | 67.6 | 121.4 | 0.45 | 13.4 | E |

Arterial Level of Service: SB KALLIPOLEOS

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| YPATEIAS | IV | 48 | 15.1 | 10.2 | 25.3 | 0.11 | 15.2 | D |
| E Frouras | IV | 48 | 15.5 | 12.5 | 28.0 | 0.14 | 17.9 | D |
| Total | IV | | 30.6 | 22.7 | 53.3 | 0.25 | 16.6 | D |

Arterial Level of Service: NB LEMESOU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| Armenias | III | 48 | 23.8 | 42.4 | 66.2 | 0.30 | 16.4 | E |
| Verenikis | III | 48 | 27.6 | 17.3 | 44.9 | 0.35 | 28.1 | D |
| Total | III | | 51.4 | 59.7 | 111.1 | 0.65 | 21.1 | E |

Arterial Level of Service: SB LEMESOU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| Armenias | III | 48 | 27.6 | 0.8 | 28.4 | 0.35 | 44.4 | B |
| Total | III | | 27.6 | 0.8 | 28.4 | 0.35 | 44.4 | B |

Arterial Level of Service: NE MAKARIOU III

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| T. KENNEDY | III | 48 | 22.0 | 0.2 | 22.2 | 0.26 | 42.9 | B |
| E Frouras | III | 48 | 20.8 | 12.8 | 33.6 | 0.25 | 26.8 | D |
| Total | III | | 42.8 | 13.0 | 55.8 | 0.51 | 33.2 | C |

Arterial Level of Service: SB MAKARIOU III

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| AGLANTZIAS | IV | 48 | 14.0 | 49.3 | 63.3 | 0.10 | 5.6 | F |
| Total | IV | | 14.0 | 49.3 | 63.3 | 0.10 | 5.6 | F |

Baseline
Maser Consulting P.A.

Synchro 6 Report
Page 1

**Table 5. E&A Theodotou-Kallipoleos-Makariou III-Lemesou Arterial Operational Analysis using SYNCHRO – Nicosia Variation D Network – 7:45-8:00 AM Peak**

**Akrita-Nechrou-Omerou-Stasinou-Salaminos Arterial (Tables 6 and 7)**

The corresponding arterial analysis using SYNCHRO for the Louki Akrita (from Metohiou-Iroon) – Nechrou-Omerou-Stasinou is depicted in Table 6. The continuation of this arterial to the east Stasinou-Salaminos is depicted in Table 7.

The arterial LOS at the various sections of this arterial operate at better than LOS D. The corresponding travel times are rather reasonable for this time period of the day.

*Lloyd George Square mitigation plans*

The principal concern involves the Lloyd George Square junctions where the Omerou-K. Palama (WB) and the Omerou-Diagorou (EB) operate at LOS F. This is expected due to the rather many intersecting flows that are converging towards the same area.

- The complete reversal of Diagorou will ease substantially the conflicting movements and the traffic lights at the Lloyd George Square (only one traffic light will be needed). This is currently been modelled with the latest VISTA run among with the suggested new improvements.

- The bus routes could be eliminated from Diagorou and instead been rerouted through the Solomou-Omerou (WB). Omerou can be a two-way street from Solomou to the west with an exclusive bus lane.

*Metohiou-Iroon/L. Akrita Junction*

- The bridge along Pediaos near this junction could be widened to fit two lanes in each direction. This will improve the operation of this junction as there is substantial capacity at the east leg of the junction. Then the entire junction may be restructured accordingly.

- Given that bus routes are operating through this junction an exclusive bus lane may be considered in each direction as well.

*Omerou/Solomou Square Junction (main Downtown Bus Station)*

The junction and all movements operate at very good LOS (C and above) despite the large Left turn movement from Omerou into Omerou (1368 vehicles) as this is a two-phase operation). This now is the main entrance and exit into the Old City within the Venetian Walls.

- While the LOS is relatively good, the large volume may create conflict with the operation of the buses. A potential mitigation plan would be to allow vehicles to come in and out from the Paphos Gate through Rigainis) which may stay as is today (two-way). This will minimize the conflict between buses, pedestrians and private autos at perhaps. The Solomou Square would then be completely allocated to buses and pedestrians.

*Eleytheria Square/Omerou-Styasinou Junction*

All movements at this junction operate at good LOS levels (C and above) due to the rather low volumes from both Omerou and Stasinou into Evagorou. This is due to the roadway changes that mainly resulted into the redistribution of the flows through other roadways.

- A potential mitigation plan to extend the pedestrianization of Eleftheria Square could be to make Omerou a two-way street and restrict all movements into Evagorou for private vehicles. Then the vehicles can be rerouted through Diagorou to the South part of the downtown. This will create more delays for vehicle yet it will increase the walking space for pedestrians.

*Salaminos Ave./ Larnacos Ave. Junction*

The Left turn from Larnacos into Salaminos operates at LOS F due to the high LT volume.

- Resignalization to favour the Left turning movement from Larnacos may be considered if this is considered a priority over the other movements.

Similarly, the Right turn from Salaminos into Larnacos operates at LOS E as is the Salaminos WB through movement.

- Similarly, resignalization maybe considered to favor this movement instead of other movements based on what it is been considered a priority.

The remaining intersections operate at reasonable LOS (D and above) therefore no improvements are proposed based on the model results at the arterial level.

Arterial Level of Service

3/30/2010

Arterial Level of Service: NB AIGYPTOU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| OMIROU | III | 48 | 23.5 | 0.0 | 23.5 | 0.30 | 45.7 | B |
| Total | III | | 23.5 | 0.0 | 23.5 | 0.30 | 45.7 | B |

Arterial Level of Service: EB L. AKRITA

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| METOCHIOU | III | 48 | 23.1 | 34.6 | 57.7 | 0.28 | 17.3 | E |
| Total | III | | 23.1 | 34.6 | 57.7 | 0.28 | 17.3 | E |

Arterial Level of Service: WB L. AKRITA

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| IROON | IV | 48 | 13.8 | 5.4 | 19.2 | 0.10 | 18.4 | D |
| Total | IV | | 13.8 | 5.4 | 19.2 | 0.10 | 18.4 | D |

Arterial Level of Service: EB OMIROU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| DIAGOROU | IV | 48 | 7.6 | 17.7 | 25.3 | 0.05 | 7.7 | F |
| SOLOMOU | IV | 48 | 17.4 | 10.5 | 27.9 | 0.16 | 20.1 | D |
| ELEYTHERIAS | IV | 48 | 18.7 | 14.4 | 33.1 | 0.17 | 18.2 | D |
| Total | IV | | 43.7 | 42.6 | 86.3 | 0.38 | 15.7 | D |

Arterial Level of Service: WB OMIROU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| K. PALAMA | IV | 48 | 7.6 | 23.9 | 31.5 | 0.05 | 6.2 | F |
| VYRONOS | IV | 48 | 17.0 | 3.5 | 20.5 | 0.15 | 26.7 | C |
| Total | IV | | 24.6 | 27.4 | 52.0 | 0.21 | 14.3 | E |

Arterial Level of Service: WB SALAMINOS

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| LARNACOS | IV | 48 | 14.7 | 62.6 | 77.3 | 0.13 | 6.1 | F |
| | IV | 48 | 24.9 | 2.3 | 27.2 | 0.29 | 37.9 | B |
| E&A THEODOTOU | IV | 48 | 16.0 | 22.8 | 38.8 | 0.14 | 13.3 | E |
| Total | IV | | 55.6 | 87.7 | 143.3 | 0.56 | 14.1 | E |

5:00 pm Baseline
Maser Consulting P.A.

Synchro 6 Report
Page 1

**Table 6. L Akrita-Nechrou-Omerou-Stasinou-Salaminos Arterial Operational Analysis using SYNCHRO – Nicosia Variation D Network – 7:45-8:00 AM Peak**

Arterial Level of Service

3/30/2010

Arterial Level of Service: WB SALAMINOS

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| LARNACOS | IV | 48 | 14.7 | 62.6 | 77.3 | 0.13 | 6.1 | F |
| | IV | 48 | 24.9 | 2.3 | 27.2 | 0.29 | 37.9 | B |
| E&A THEODOTOU | IV | 48 | 16.0 | 22.8 | 38.8 | 0.14 | 13.3 | E |
| Total | IV | | 55.6 | 87.7 | 143.3 | 0.56 | 14.1 | E |

Arterial Level of Service: SE SALAMINOS

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| | III | 48 | 12.5 | 9.0 | 21.5 | 0.14 | 24.0 | D |
| LARNACOS | III | 48 | 22.6 | 1.1 | 23.7 | 0.29 | 43.4 | B |
| Total | III | | 35.1 | 10.1 | 45.2 | 0.43 | 34.2 | C |

Arterial Level of Service: EB STASINOU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| D. LOIZOU | III | 48 | 33.7 | 9.4 | 43.1 | 0.43 | 35.7 | C |
| A. MAKARIOU II | III | 48 | 39.4 | 24.4 | 63.8 | 0.50 | 28.2 | D |
| Total | III | | 73.1 | 33.8 | 106.9 | 0.93 | 31.2 | C |

Arterial Level of Service: WB STASINOU

| Cross Street | Arterial Class | Flow Speed | Running Time | Signal Delay | Travel Time (s) | Dist (km) | Arterial Speed | Arterial LOS |
|---|---|---|---|---|---|---|---|---|
| BOUMBOULINAS | III | 48 | 39.4 | 9.2 | 48.6 | 0.50 | 37.0 | C |
| EVAGOROU | III | 48 | 33.7 | 22.8 | 56.5 | 0.43 | 27.2 | D |
| Total | III | | 73.1 | 32.0 | 105.1 | 0.93 | 31.8 | C |

5:00 pm Baseline Synchro 6 Report
Maser Consulting P.A. Page 1

**Table 7. L Stasinou-Salaminos Arterial Operational Analysis using SYNCHRO – Nicosia Variation D Network – 7:45-8:00 AM Peak**

# APPENDIX Section 4.5

# Evaluation of the Impact on the Atmospheric and the Acoustic Environment with Respect to the Development of the Public Transport System

# 1. Atmospheric Environment

## 1.1 Methodology

In the evaluation of all alternative scenarios for the development of a transportation system for Nicosia, as far as the impact on the atmospheric environment is concerned, particular attention was given to the problematic existing situation in the centre of the town, in order to determine any improvement in the traffic flow, the capacity of the network as well as in the quality of life of the residents, workers and visitors. The contribution of public transportation is important not only for the better service for the passengers but also for the improvement in the quality of the atmosphere that they achieve.

The emissions of Carbon Monoxide (CO) were calculated based on the vehicle kilometres and the corresponding factors of emissions in terms of transported passenger.

The definition of *emission factor* is the quantity of pollutant that is produced per unit of consumed fuel or per unit of produced work. It is expressed in mass of pollutant per unit of fuel or per unit of produced good or per unit of produced work. More specifically, when the source of pollutants is the car, the emission factor is expressed in mass (grams) of produced pollutant for the covered distance of one kilometre. Its values are differentiated depending on the speed of movement, the quality of consumed fuel and the type of engine. The values of emission factors (based on COPERT II, Methodology and Emission Factors, 2nd Edition - November 1997) are also determined by the quantitative and qualitative composition of fleet of cars that will use the studied influenced road segments.

The criteria cued mean values of emission factors per category and per type of engine are calculated for various values of speed based on the composition of the traffic that circulates in the wider region of Nicosia, which are then criteria cued with the rate of composition of general categories of vehicles in the fleet forecasted to use the studied road segments, taking also into account the rate of replacement of private cars with new vehicles of catalytic technology.

The emission factors of air pollutants that were used are presented analytically in the tables below. For the determination of the total emitted polluting load from road circulation, the estimate of the following elements, from the circulation model are required for all of the alternative scenarios:

- Vehicle speed per road segment in the study area
- Vehicle composition,
- Traffic volume,
- Road segment being travelled/ used.

The Emitted Polluting Load (E.P.L.) is calculated using the following formula:

**E.P.L (grams) = L * R * Q** where:

L (Km) = length of travelled road segment
R (gr/km) = emission factor of vehicles
Q (vehicles) = volume for the studied period of time.

## 1.2 Emitted Polluting Loads and Pollutants Per Passenger From Road Segments Affected by the Studied Mobility Master Plan

The emitted polluting loads have been estimated for the affected road network for the all scenarios considered.

The Base Case scenario (existing situation) is not evaluated here because a comparison between years 2009 and 2020 has no meaning in selecting the proper scenario. The best approach for comparing scenarios for this study is to compare all scenarios considered with the "Do Nothing" scenario as the base scenario for the future (2020).

For each scenario, the polluting loads of CO were calculated for the morning two-hour peak (2-hour peak as it has been estimated in the circulatory model) based on the corresponding emission factors. Then, based on the total number of transported passengers, the pollutant per transported passenger is calculated, for all alternative scenarios aiming at estimating the contribution of various road segments in the final configuration of pollutant emissions and the estimation of probable relative improvement or aggravation, due to the implementation of the development plan.

The circulatory data that has been taken into account (volume 2-hr peak, number of buses, speed, etc.) for every road segment as well as the estimated pollutants per transported passenger for all above scenarios are given in the table below. The assumption of 100% catalytic cars in the future scenarios has been made.

The estimates presented here focus on the calculation of emissions of the main pollutant CO coming from road traffic in the wider region of study on the different scenarios, based on the above approach parameters.

The table below is indicative to show the kind of data used and the results obtained, for the evaluation of pollutants per passenger (part of the table concerning scenario 1). All tables and results for all scenarios are included in electronic form in the available CD.

Comparing the alternative scenarios considered, it is realised that the reduction in the pollutants per transported passenger fluctuates from 20% (individual segments in scenario 1) and reaches up to 99% (road segments in scenarios 2 and 3) specifically in central roads (e.g. Omirou, Griva Digeni, John Kennedy, Nikis, etc.) but also in avenues with increased traffic (e.g. Athalassas, Strovolou, Limasol, etc).

## Table 1
## Table of data used to estimate pollutant per passenger (Indicatively for scenario 1)

| Number of Link | Street name | Length | Length | Traffic flow (vehicles) | | | Speed (km/hr) | Emission Factor CO | Polluting load | Passenger transport | Pollutant per passenger |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (m) | (km) | | CARS | BUSES | 2-hour peak | gr/km | kg | | g / pass.transp. |
| 886 | A1_1 (Lemesou Av.) | 240,78 | 0,24 | 3.680 | 3.650 | 30 | 14 | 10,59 | 9,38 | 6.975 | 1,35 |
| 200958 | A1_10 (L. Lemesou) | 1647,37 | 1,65 | 5.405 | 5.405 | 0 | 36 | 10,59 | 94,29 | 8.108 | 11,63 |
| 200957 | A1_11 (Lemesou Av.) | 2605,33 | 2,61 | 2.916 | 2.916 | 0 | 87 | 10,03 | 76,20 | 4.374 | 17,42 |
| 200956 | A1_12 (Lemesou Av.) | 2660,73 | 2,66 | 4.790 | 4.790 | 0 | 48 | 10,03 | 127,83 | 7.185 | 17,79 |
| 200955 | A1_13 (Lemesou Av.) | 1532,52 | 1,53 | 4.790 | 4.790 | 0 | 48 | 11,56 | 84,86 | 7.185 | 11,81 |
| 200954 | A1_14 (Lemesou Av.) | 119,11 | 0,12 | 2.463 | 2.463 | 0 | 93 | 9,05 | 2,65 | 3.695 | 0,72 |
| 200951 | A1_15 (Lemesou Av.) | 1513,44 | 1,51 | 2.668 | 2.668 | 0 | 90 | 10,87 | 43,89 | 4.002 | 10,97 |
| 200947 | A1_16 (Lemesou Av.) | 1987,82 | 1,99 | 4.790 | 4.790 | 0 | 48 | 9,39 | 89,41 | 7.185 | 12,44 |
| 200948 | A1_17 (Lemesou Av.) | 1949,82 | 1,95 | 2.668 | 2.668 | 0 | 90 | 9,39 | 48,85 | 4.002 | 12,21 |
| 200943 | A1_18 (Lemesou Av.) | 1609,84 | 1,61 | 5.428 | 5.428 | 0 | 36 | 9,39 | 82,05 | 8.142 | 10,08 |
| 200944 | A1_19 (Lemesou Av.) | 1634,02 | 1,63 | 3.900 | 3.900 | 0 | 67 | 9,39 | 59,84 | 5.850 | 10,23 |
| 944 | A1_2 (Lemesou Av.) | 310,45 | 0,31 | 3.466 | 3.466 | 0 | 94 | 9,39 | 10,10 | 5.199 | 1,94 |
| 200945 | A1_20 (Lemesou Av.) | 263,08 | 0,26 | 4.341 | 4.341 | 0 | 57 | 9,39 | 10,72 | 6.512 | 1,65 |
| 885 | A1_3 (Lemesou Av.) | 710,39 | 0,71 | 3.121 | 3.121 | 0 | 83 | 9,49 | 21,04 | 4.682 | 4,49 |
| 202573 | A1_4 (Lemesou Av.) | 1170,03 | 1,17 | 6.294 | 6.294 | 0 | 23 | 9,27 | 68,27 | 9.441 | 7,23 |
| 207 | A1_5 (Lemesou Av.) | 419,98 | 0,42 | 4.435 | 4.435 | 0 | 55 | 9,05 | 16,86 | 6.653 | 2,53 |
| 209 | A1_6 (Lemesou Av.) | 457,44 | 0,46 | 3.466 | 3.466 | 0 | 77 | 9,05 | 14,35 | 5.199 | 2,76 |
| 200961 | A1_7 (Lemesou Av.) | 536,67 | 0,54 | 5.405 | 5.405 | 0 | 36 | 9,39 | 27,24 | 8.108 | 3,36 |
| 200960 | A1_8 ( Lemesou Av.) | 535,70 | 0,54 | 3.466 | 3.466 | 0 | 77 | 9,39 | 17,43 | 5.199 | 3,35 |
| 200959 | A1_9 (Λ. Λεμεσού) | 1640,79 | 1,64 | 3.466 | 3.466 | 0 | 77 | 9,39 | 53,40 | 5.199 | 10,27 |

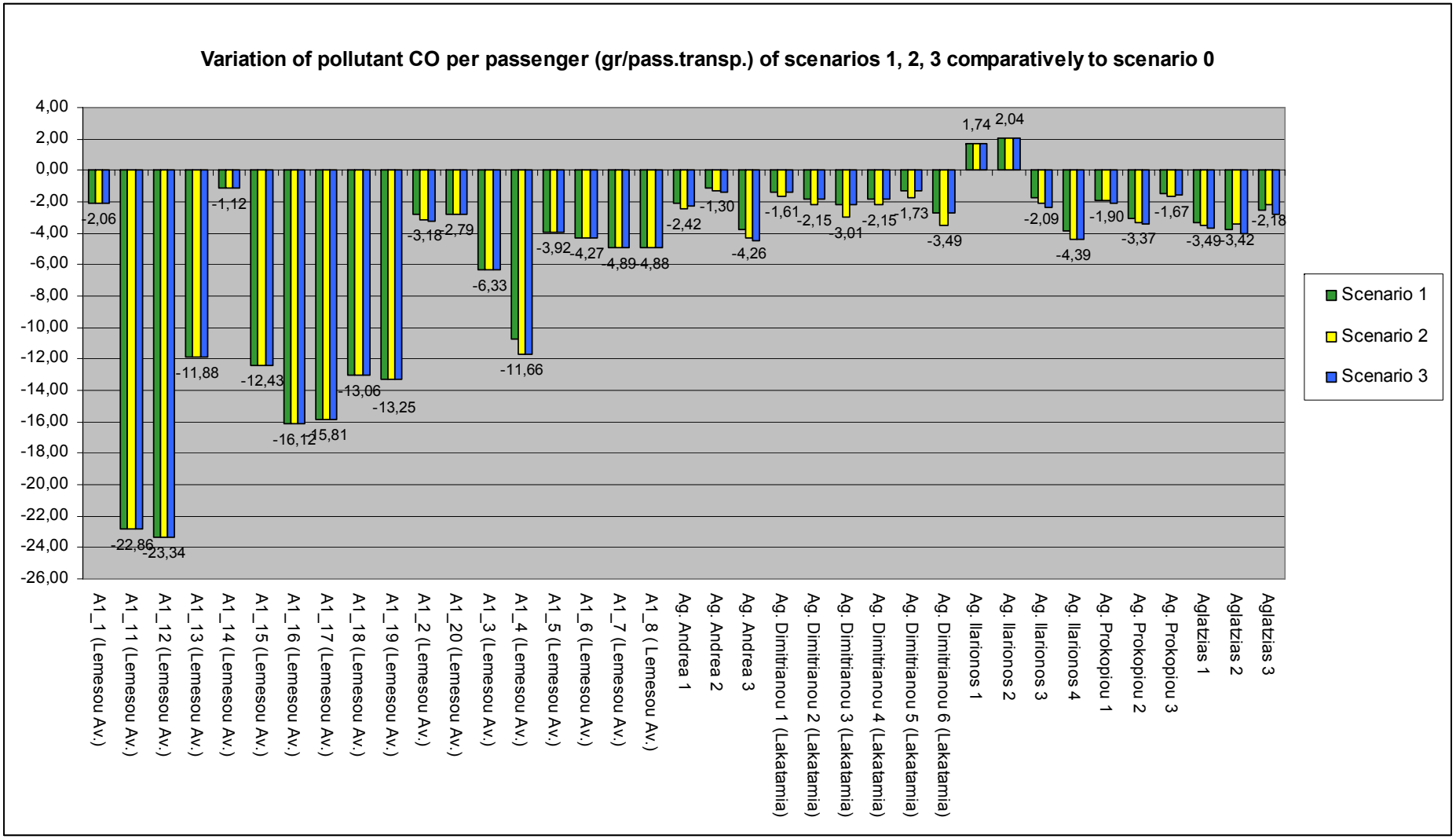
| Number of Link | Street name | Length | Length | Traffic flow (vehicles) | | Speed (km/hr) | | Emission Factor CO | Polluting load | Passenger transport | Pollutant per passenger |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (m) | (km) | | CARS | BUSES | 2-hour peak | gr/km | kg | | g / pass.transp. |
| 131 | Ag. Andrea 1 | 297,95 | 0,30 | 935 | 929 | 6 | 49 | 8,61 | 2,40 | 1.694 | 1,42 |
| 202596 | Ag. Andrea 2 | 208,33 | 0,21 | 1.844 | 1.826 | 18 | 42 | 8,55 | 3,28 | 3.639 | 0,90 |
| 202598 | Ag. Andrea 3 | 647,55 | 0,65 | 1.835 | 1.823 | 12 | 44 | 8,32 | 9,89 | 3.335 | 2,96 |
| 200431 | Ag. Dimitrianou 1 (Lakatamia) | 199,85 | 0,20 | 3.256 | 3.256 | 0 | 12 | 8,34 | 5,43 | 4.884 | 1,11 |
| 200429 | Ag. Dimitrianou 2 (Lakatamia) | 264,43 | 0,26 | 3.256 | 3.256 | 0 | 12 | 8,43 | 7,26 | 4.884 | 1,49 |
| 201400 | Ag. Dimitrianou 3 (Lakatamia) | 356,65 | 0,36 | 1.584 | 1.584 | 0 | 45 | 8,26 | 4,67 | 2.376 | 1,96 |
| 200443 | Ag. Dimitrianou 4 (Lakatamia) | 289,93 | 0,29 | 3.632 | 3.632 | 0 | 43 | 8,38 | 8,82 | 5.448 | 1,62 |
| 201002 | Ag. Dimitrianou 5 (Lakatamia) | 209,59 | 0,21 | 1.963 | 1.963 | 0 | 49 | 9,49 | 3,90 | 2.945 | 1,33 |
| 201594 | Ag. Dimitrianou 6 (Lakatamia) | 437,78 | 0,44 | 2.643 | 2.643 | 0 | 30 | 9,27 | 10,73 | 3.965 | 2,71 |
| 201735 | Ag. Ilarionos 1 | 373,44 | 0,37 | 14 | 14 | 0 | 50 | 9,05 | 0,05 | 21 | 2,25 |
| 202030 | Ag. Ilarionos 2 | 505,54 | 0,51 | 26 | 26 | 0 | 50 | 9,05 | 0,12 | 39 | 3,05 |
| 308 | Ag. Ilarionos 3 | 380,59 | 0,38 | 120 | 114 | 6 | 50 | 9,66 | 0,44 | 471 | 0,94 |
| 2060 | Ag. Ilarionos 4 | 685,22 | 0,69 | 508 | 502 | 6 | 50 | 10,59 | 3,69 | 1.053 | 3,50 |
| 30 | Ag. Prokopiou 1 | 325,23 | 0,33 | 2.198 | 2.186 | 12 | 48 | 8,57 | 6,13 | 3.879 | 1,58 |
| 43 | Ag. Prokopiou 2 | 584,24 | 0,58 | 2.960 | 2.940 | 20 | 45 | 10,03 | 17,35 | 5.410 | 3,21 |
| 90 | Ag. Prokopiou 3 | 306,42 | 0,31 | 6.337 | 6.333 | 4 | 22 | 9,70 | 18,84 | 9.700 | 1,94 |
| 161 | Aglatzias 1 | 637,01 | 0,64 | 4.882 | 4.870 | 12 | 22 | 11,56 | 35,95 | 7.905 | 4,55 |
| 201102 | Aglatzias 2 | 568,01 | 0,57 | 1.666 | 1.660 | 6 | 44 | 9,05 | 8,56 | 2.790 | 3,07 |
| 289 | Aglatzias 3 | 329,04 | 0,33 | 1.143 | 1.137 | 6 | 49 | 10,87 | 4,09 | 2.006 | 2,04 |

The table below, as well as the diagram, are indicative to show the comparison between scenarios of the results obtained, (part of the table) while the table as a whole is included in electronic form in the available CD.

**Table 2**

| | Street name | Variation of CO values | | |
|---|---|---|---|---|
| | | Comparison of scenarios 1 & 0 | Comparison of scenarios 2 & 0 | Comparison of scenarios 3 & 0 |
| | | | | |
| 1 | A1_1 (Lemesou Av.) | -2,09 | -2,06 | -2,09 |
| 2 | A1_11 (Lemesou Av.) | -22,86 | -22,86 | -22,86 |
| 3 | A1_12 (Lemesou Av.) | -23,34 | -23,34 | -23,34 |
| 4 | A1_13 (Lemesou Av.) | -11,88 | -11,88 | -11,88 |
| 5 | A1_14 (Lemesou Av.) | -1,12 | -1,12 | -1,12 |
| 6 | A1_15 (Lemesou Av.) | -12,43 | -12,43 | -12,43 |
| 7 | A1_16 (Lemesou Av.) | -16,12 | -16,12 | -16,12 |
| 8 | A1_17 (Lemesou Av.) | -15,81 | -15,81 | -15,81 |
| 9 | A1_18 (Lemesou Av.) | -13,06 | -13,06 | -13,06 |
| 10 | A1_19 (Lemesou Av.) | -13,25 | -13,25 | -13,25 |
| 11 | A1_2 (Lemesou Av.) | -2,79 | -3,18 | -3,23 |
| 12 | A1_20 (Lemesou Av.) | -2,79 | -2,79 | -2,79 |
| 13 | A1_3 (Lemesou Av.) | -6,33 | -6,33 | -6,33 |
| 14 | A1_4 (Lemesou Av.) | -10,75 | -11,66 | -11,70 |
| 15 | A1_5 (Lemesou Av.) | -3,92 | -3,92 | -3,92 |
| 16 | A1_6 (Lemesou Av.) | -4,27 | -4,27 | -4,27 |
| 17 | A1_7 (Lemesou Av.) | -4,89 | -4,89 | -4,89 |
| 18 | A1_8 ( Lemesou Av.) | -4,88 | -4,88 | -4,88 |
| 19 | Ag. Andrea 1 | -2,12 | -2,42 | -2,28 |
| 20 | Ag. Andrea 2 | -1,12 | -1,30 | -1,38 |
| 21 | Ag. Andrea 3 | -3,79 | -4,26 | -4,46 |
| 22 | Ag. Dimitrianou 1 (Lakatamia) | -1,35 | -1,61 | -1,35 |
| 23 | Ag. Dimitrianou 2 (Lakatamia) | -1,79 | -2,15 | -1,79 |
| 24 | Ag. Dimitrianou 3 (Lakatamia) | -2,20 | -3,01 | -2,20 |
| 25 | Ag. Dimitrianou 4 (Lakatamia) | -1,79 | -2,15 | -1,79 |
| 26 | Ag. Dimitrianou 5 (Lakatamia) | -1,28 | -1,73 | -1,28 |
| 27 | Ag. Dimitrianou 6 (Lakatamia) | -2,73 | -3,49 | -2,73 |
| 28 | Ag. Ilarionos 1 | 1,74 | 1,74 | 1,74 |
| 29 | Ag. Ilarionos 2 | 2,04 | 2,04 | 2,04 |
| 30 | Ag. Ilarionos 3 | -1,71 | -2,09 | -2,36 |
| 31 | Ag. Ilarionos 4 | -3,81 | -4,39 | -4,34 |
| 32 | Ag. Prokopiou 1 | -1,94 | -1,90 | -2,10 |
| 33 | Ag. Prokopiou 2 | -3,06 | -3,37 | -3,40 |
| 34 | Ag. Prokopiou 3 | -1,51 | -1,67 | -1,54 |
| 35 | Aglatzias 1 | -3,32 | -3,49 | -3,65 |
| 36 | Aglatzias 2 | -3,77 | -3,42 | -4,04 |
| 37 | Aglatzias 3 | -2,53 | -2,18 | -2,80 |

**Diagram 1**


Variation of pollutant CO per passenger (gr/pass.transp.) of scenarios 1, 2, 3 comparatively to scenario 0
4,00
2,00
0,00
-2,00
-4,00
-6,00
-8,00
-10,00
-12,00
-14,00
-16,00
-18,00
-20,00
-22,00
-24,00
-26,00
-2,06
-22,86
-23,34
-11,88
-1,12
-12,43
-16,12
-15,81
-13,06
-13,25
-3,18
-2,79
-6,33
-11,66
-3,92
-4,27
-4,89
-4,88
-2,42
-1,30
-4,26
-1,61
-2,15
-3,01
-2,15
-1,73
-3,49
1,74
2,04
-2,09
-4,39
-1,90
-3,37
-1,67
-3,49
-3,42
-2,18
A1_1 (Lemesou Av.)
A1_11 (Lemesou Av.)
A1_12 (Lemesou Av.)
A1_13 (Lemesou Av.)
A1_14 (Lemesou Av.)
A1_15 (Lemesou Av.)
A1_16 (Lemesou Av.)
A1_17 (Lemesou Av.)
A1_18 (Lemesou Av.)
A1_19 (Lemesou Av.)
A1_2 (Lemesou Av.)
A1_20 (Lemesou Av.)
A1_3 (Lemesou Av.)
A1_4 (Lemesou Av.)
A1_5 (Lemesou Av.)
A1_6 (Lemesou Av.)
A1_7 (Lemesou Av.)
A1_8 ( Lemesou Av.)
Ag. Andrea 1
Ag. Andrea 2
Ag. Andrea 3
Ag. Dimitrianou 1 (Lakatamia)
Ag. Dimitrianou 2 (Lakatamia)
Ag. Dimitrianou 3 (Lakatamia)
Ag. Dimitrianou 4 (Lakatamia)
Ag. Dimitrianou 5 (Lakatamia)
Ag. Dimitrianou 6 (Lakatamia)
Ag. Ilarionos 1
Ag. Ilarionos 2
Ag. Ilarionos 3
Ag. Ilarionos 4
Ag. Prokopiou 1
Ag. Prokopiou 2
Ag. Prokopiou 3
Aglatzias 1
Aglatzias 2
Aglatzias 3
Scenario 1
Scenario 2
Scenario 3

In the comparison of the selected scenario **with and without the tramway**, a similar approach is taken as the above analysis. It must be noted that the total number of passengers for the Scenario Without Tramway takes into account only the passengers of private cars and buses, while the Scenario With Tramway takes into account the passengers of both means of transport mentioned above plus tram passengers. Motorcycles have not been considered.

The emitted polluting loads have been estimated for the affected road network for the following future scenarios:

- ⇒ Selected alternative Scenario Without Tramway
- ⇒ Selected alternative Scenario With Tramway

For the two scenarios, the polluting loads of CO were calculated for the morning hour peak (2-hour peak as it has been estimated in the circulatory model) based on the corresponding emission factors. Then, based on the total of transported passengers, the pollutants per transported passenger were calculated, aiming at estimating the contribution of various road segments in the final configuration of pollutant emissions and the estimation of probable relative improvement or aggravation due to the implementation of the development plan.

The data that have been taken into account (volume 2-hr peak, number of buses, speed, etc.) for every road segment (road segments selected to be the main network of the city) as well as the estimated pollutants per transported passenger for the above scenarios are given in the tables below. The assumption of 100% catalytic cars in the future scenarios has been made.

The tables below are indicative to show the kind of data used and the results obtained, for the evaluation of pollutant per passenger concerning the selected alternative scenario **Without Tramway** and the same scenario **With Tramway**. More analytical information is included in electronic form in the available CD.

## Table 3
## Table of data used to estimate pollutant per passenger for the Scenario Without Tramway (Indicative data)

| Number of Link | Street name | Length | Length | Traffic flow (vehicles) | | | Speed (km/hr) | Emission Factor CO | Polluting load | Passenger transport | Pollutant per passenger |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (m) | (km) | | CARS | BUSES | 2-hour peak | gr/km | kg | | g / pass.transp. |
| 886 | A1_1 (Lemesou Av.) | 240,78 | 0,24 | 3.722 | 3.722 | 0 | 13 | 10,59 | 9,49 | 5.583 | 1,70 |
| 200958 | A1_10 (L. Lemesou) | 1647,37 | 1,65 | 5.337 | 5.337 | 0 | 37 | 10,59 | 93,11 | 8.006 | 11,63 |
| 200957 | A1_11 (Lemesou Av.) | 2605,33 | 2,61 | 2.907 | 2.907 | 0 | 87 | 10,03 | 75,96 | 4.361 | 17,42 |
| 200956 | A1_12 (Lemesou Av.) | 2660,73 | 2,66 | 4.749 | 4.749 | 0 | 49 | 10,03 | 126,74 | 7.124 | 17,79 |
| 200955 | A1_13 (Lemesou Av.) | 1532,52 | 1,53 | 4.749 | 4.749 | 0 | 49 | 11,56 | 84,13 | 7.124 | 11,81 |
| 200954 | A1_14 (Lemesou Av.) | 119,11 | 0,12 | 2.462 | 2.462 | 0 | 93 | 9,05 | 2,65 | 3.693 | 0,72 |
| 200951 | A1_15 (Lemesou Av.) | 1513,44 | 1,51 | 2.671 | 2.671 | 0 | 90 | 10,87 | 43,94 | 4.007 | 10,97 |
| 200947 | A1_16 (Lemesou Av.) | 1987,82 | 1,99 | 4.749 | 4.749 | 0 | 49 | 9,39 | 88,64 | 7.124 | 12,44 |
| 200948 | A1_17 (Lemesou Av.) | 1949,82 | 1,95 | 2.671 | 2.671 | 0 | 90 | 9,39 | 48,90 | 4.007 | 12,21 |
| 200943 | A1_18 (Lemesou Av.) | 1609,84 | 1,61 | 5.400 | 5.400 | 0 | 36 | 9,39 | 81,63 | 8.100 | 10,08 |
| 200944 | A1_19 (Lemesou Av.) | 1634,02 | 1,63 | 3.956 | 3.956 | 0 | 66 | 9,39 | 60,70 | 5.934 | 10,23 |
| 944 | A1_2 (Lemesou Av.) | 310,45 | 0,31 | 4.501 | 4.501 | 0 | 86 | 9,39 | 13,12 | 6.752 | 1,94 |
| 200945 | A1_20 (Lemesou Av.) | 263,08 | 0,26 | 4.305 | 4.305 | 0 | 58 | 9,39 | 10,63 | 6.458 | 1,65 |
| 885 | A1_3 (Lemesou Av.) | 710,39 | 0,71 | 4.221 | 4.221 | 0 | 60 | 9,49 | 28,46 | 6.332 | 4,49 |
| 202573 | A1_4 (Lemesou Av.) | 1170,03 | 1,17 | 6.371 | 6.371 | 0 | 23 | 9,27 | 69,10 | 9.557 | 7,23 |
| 207 | A1_5 (Lemesou Av.) | 419,98 | 0,42 | 4.255 | 4.255 | 0 | 59 | 9,05 | 16,17 | 6.383 | 2,53 |
| 209 | A1_6 (Lemesou Av.) | 457,44 | 0,46 | 3.475 | 3.475 | 0 | 77 | 9,05 | 14,39 | 5.213 | 2,76 |
| 200961 | A1_7 (Lemesou Av.) | 536,67 | 0,54 | 5.337 | 5.337 | 0 | 37 | 9,39 | 26,90 | 8.006 | 3,36 |
| 200960 | A1_8 ( Lemesou Av.) | 535,70 | 0,54 | 3.475 | 3.475 | 0 | 77 | 9,39 | 17,48 | 5.213 | 3,35 |
| 200959 | A1_9 (Lemesou Av.) | 1640,79 | 1,64 | 3.475 | 3.475 | 0 | 77 | 9,39 | 53,54 | 5.213 | 10,27 |

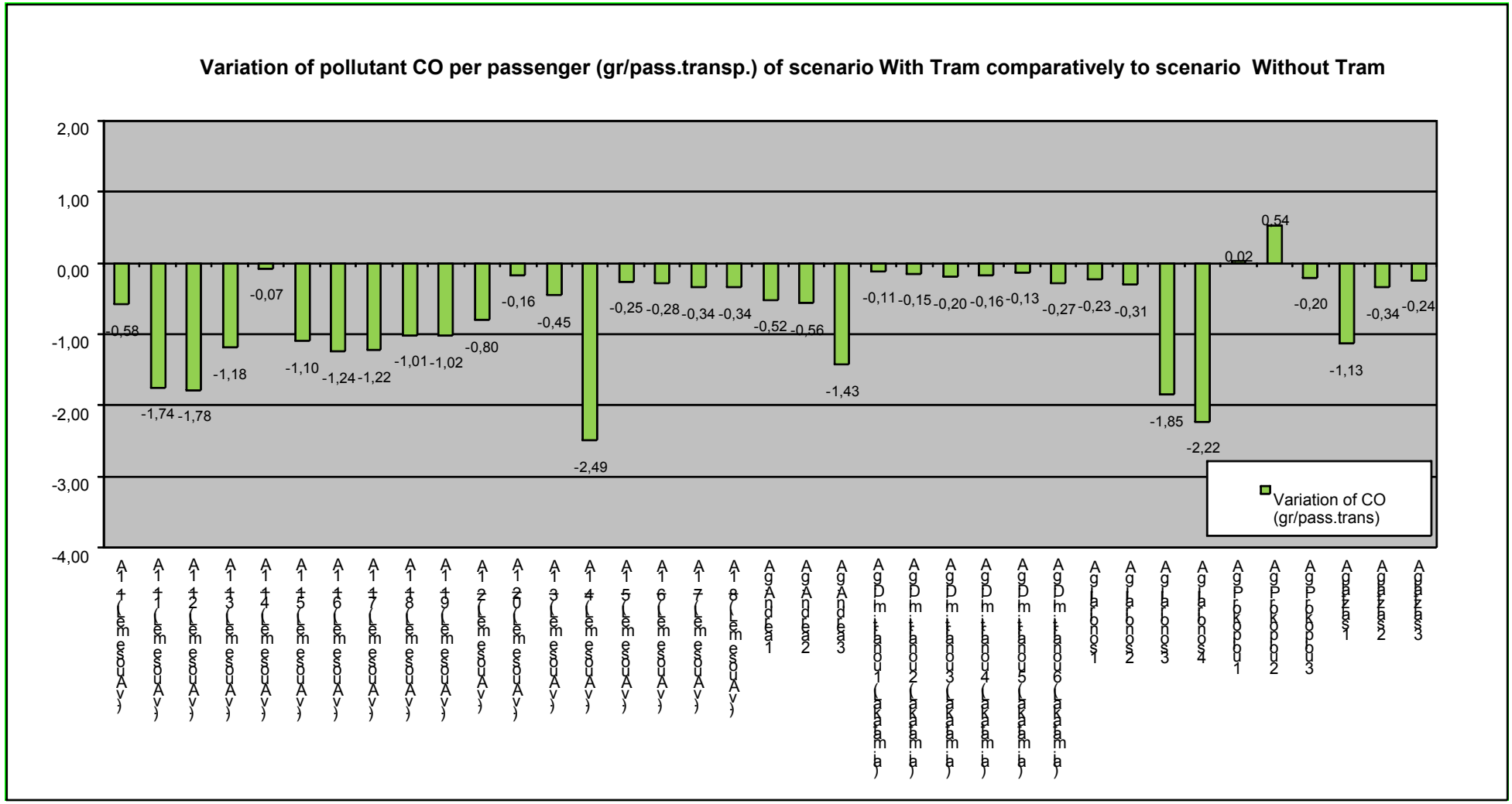
## Table 3
## Table of data used to estimate pollutant per passenger for the Scenario With Tramway (Indicative data)

| Number of Link | Street name | Length | Length | Traffic flow (vehicles) | | | | Speed (km/hr) | Emission Factor CO | Polluting load | Passenger transport | Pollutant per passenger |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (m) | (km) | | CARS | BUSES | TRAM | 2-hour peak | gr/km | kg | | g / pass.transp. |
| | | | | | | | | | | | | |
| 886 | A1_1 (Lemesou Av.) | 240,78 | 0,24 | 3.667 | 3.656 | 11 | 13 | 14 | 9,53 | 8,42 | 7.484 | 1,12 |
| 200958 | A1_10 (L. Lemesou) | 1647,37 | 1,65 | 5.247 | 5.247 | 0 | 0 | 39 | 9,53 | 82,38 | 7.871 | 10,47 |
| 200957 | A1_11 (Lemesou Av.) | 2605,33 | 2,61 | 2.947 | 2.947 | 0 | 0 | 86 | 9,03 | 69,31 | 4.421 | 15,68 |
| 200956 | A1_12 (Lemesou Av.) | 2660,73 | 2,66 | 4.720 | 4.720 | 0 | 0 | 49 | 9,03 | 113,37 | 7.080 | 16,01 |
| 200955 | A1_13 (Lemesou Av.) | 1532,52 | 1,53 | 4.720 | 4.720 | 0 | 0 | 49 | 10,40 | 75,26 | 7.080 | 10,63 |
| 200954 | A1_14 (Lemesou Av.) | 119,11 | 0,12 | 2.494 | 2.494 | 0 | 0 | 93 | 8,15 | 2,42 | 3.741 | 0,65 |
| 200951 | A1_15 (Lemesou Av.) | 1513,44 | 1,51 | 2.697 | 2.697 | 0 | 0 | 90 | 9,78 | 39,93 | 4.046 | 9,87 |
| 200947 | A1_16 (Lemesou Av.) | 1987,82 | 1,99 | 4.720 | 4.720 | 0 | 0 | 49 | 8,45 | 79,29 | 7.080 | 11,20 |
| 200948 | A1_17 (Lemesou Av.) | 1949,82 | 1,95 | 2.697 | 2.697 | 0 | 0 | 90 | 8,45 | 44,44 | 4.046 | 10,99 |
| 200943 | A1_18 (Lemesou Av.) | 1609,84 | 1,61 | 5.400 | 5.400 | 0 | 0 | 36 | 8,45 | 73,47 | 8.100 | 9,07 |
| 200944 | A1_19 (Lemesou Av.) | 1634,02 | 1,63 | 3.956 | 3.956 | 0 | 0 | 66 | 8,45 | 54,63 | 5.934 | 9,21 |
| 944 | A1_2 (Lemesou Av.) | 310,45 | 0,31 | 4.496 | 4.485 | 11 | 26 | 86 | 8,45 | 11,80 | 10.288 | 1,15 |
| 200945 | A1_20 (Lemesou Av.) | 263,08 | 0,26 | 4.307 | 4.307 | 0 | 0 | 58 | 8,45 | 9,58 | 6.461 | 1,48 |
| 885 | A1_3 (Lemesou Av.) | 710,39 | 0,71 | 4.234 | 4.234 | 0 | 0 | 60 | 8,54 | 25,69 | 6.351 | 4,04 |
| 202573 | A1_4 (Lemesou Av.) | 1170,03 | 1,17 | 6.342 | 6.331 | 11 | 26 | 23 | 8,34 | 61,91 | 13.057 | 4,74 |
| 207 | A1_5 (Lemesou Av.) | 419,98 | 0,42 | 4.221 | 4.221 | 0 | 0 | 60 | 8,15 | 14,44 | 6.332 | 2,28 |
| 209 | A1_6 (Lemesou Av.) | 457,44 | 0,46 | 3.494 | 3.494 | 0 | 0 | 76 | 8,15 | 13,02 | 5.241 | 2,48 |
| 200961 | A1_7 (Lemesou Av.) | 536,67 | 0,54 | 5.247 | 5.247 | 0 | 0 | 39 | 8,45 | 23,80 | 7.871 | 3,02 |
| 200960 | A1_8 ( Lemesou Av.) | 535,70 | 0,54 | 3.494 | 3.494 | 0 | 0 | 76 | 8,45 | 15,82 | 5.241 | 3,02 |
| 200959 | A1_9 (Lemesou Av.) | 1640,79 | 1,64 | 3.494 | 3.494 | 0 | 0 | 76 | 8,45 | 48,45 | 5.241 | 9,24 |

The table below, as well as the diagram, are indicative to show the comparison between the two scenarios mentioned above of the results obtained. The comparison concerns the difference (increase or decrease) in the absolute values of pollutant per passenger per road segment in grams. All analytical calculations are included in electronic form in the available CD.

**Table 4**
**Variation of CO values (Indicative data)**

| Variation of CO values | |
|---|---|
| **Street name** | **Comparison of scenario With Tramway in relation with Scenario Without Tramway** |
| A1_1 (Lemesou Av.) | -0,58 |
| A1_11 (Lemesou Av.) | -1,74 |
| A1_12 (Lemesou Av.) | -1,78 |
| A1_13 (Lemesou Av.) | -1,18 |
| A1_14 (Lemesou Av.) | -0,07 |
| A1_15 (Lemesou Av.) | -1,10 |
| A1_16 (Lemesou Av.) | -1,24 |
| A1_17 (Lemesou Av.) | -1,22 |
| A1_18 (Lemesou Av.) | -1,01 |
| A1_19 (Lemesou Av.) | -1,02 |
| A1_2 (Lemesou Av.) | -0,80 |
| A1_20 (Lemesou Av.) | -0,16 |
| A1_3 (Lemesou Av.) | -0,45 |
| A1_4 (Lemesou Av.) | -2,49 |
| A1_5 (Lemesou Av.) | -0,25 |
| A1_6 (Lemesou Av.) | -0,28 |
| A1_7 (Lemesou Av.) | -0,34 |
| A1_8 ( Lemesou Av.) | -0,34 |


Variation of pollutant CO per passenger (gr/pass.transp.) of scenario With Tram comparatively to scenario Without Tram
2,00
1,00
0,00
-1,00
-2,00
-3,00
-4,00
-0,58
-1,74
-1,78
-1,18
-0,07
-1,10
-1,24
-1,22
-1,01
-1,02
-0,80
-0,16
-0,45
-2,49
-0,25
-0,28
-0,34
-0,34
-0,52
-0,56
-1,43
-0,11
-0,15
-0,20
-0,16
-0,13
-0,27
-0,23
-0,31
-1,85
-2,22
0,02
0,54
-0,20
-1,13
-0,34
-0,24
Variation of CO (gr/pass.trans)

Comparing the two scenarios, it is realised that **the reduction in the pollutants per transported passenger for the scenario with tramway,** fluctuates from 5-10% and reaches up to 90% specifically in central roads (e.g. Griva Digeni, John Kennedy, Larnakos, Archagellou, Ag. Prokopiou etc.) but also in avenues with increased traffic (e.g. Athalassas, Strovolou, Limasol, etc). It is obvious that the pollutants per transported passenger **significantly decrease in roads where an high number of bus lines are proposed or new tramway lines are introduced** since this increases the figurative faculty of the road.

## 2. Acoustic Environment

### 2.1 Methodology

It is a fact that traffic flow influences the acoustic environment (Road Traffic Noise), due to the volume of vehicles moving around the road network. Difficulties in the movement of vehicles due to their increased volume as well as the existence of illegally parked vehicles result in more frequent and more intense use of the horn which has as a consequence the degradation of the acoustic environment.

The implementation of the proposed development plan for the transportation system in the city of Nicosia is studied in relation to the problems in the circulation due to the increased usage of private cars and taxi, one of them being the relative acoustic nuisance (level of Road Traffic Noise) before and after the implementation of the development plan. The improvement in the traffic conditions, in combination with a necessary monitoring by local authorities, improve generally the acoustic environment due to the decrease, in some degree, of secondary sources of noise and generally uproar caused by conditions of circulatory congestion.

Road traffic noise level is shaped by many and complex parameters concerning on road circulation as well as characteristics of the study area. In order to have a more complete estimate of future noise level, traffic conditions during operation of each alternative scenario were analysed. More specifically, the British Method L10 (1hr) – CRTN was used. This method calculates L10 (peak hour) levels of noise in dB(A). The precision of this method has been ascertained repeatedly in various conditions of circulation and topography. The method is composed by the following main stages:

- Every road to be studied is separated in individual segments with the same characteristics (with regard to the geometry of road, the topography of region, possible obstacles on road, etc.)
- Basic noise level is calculated at a reference distance of 10 m from the nearest to the point of reception neatline of paving (for each individual segment of road) and for those road segments at a distance $\leq$200 m from the nearest residence or the edge of the urban area.

- Noise level is calculated for every road segment at the point of reception (taking into consideration the attenuation because of the distance or possible attenuation because of obstacles).
- Noise level at the point of reception is corrected by taking into consideration topographic and other data of the area (i.e. reflections by buildings, walls) as well as the size of the segment that is examined (that is to say the angle of view under which it seen from the point of reception).
- The contribution of each road segment concerning the calculated noise level in the point of reception is combined.

For each alternative scenario, the affected road segments with the highest traffic volumes were analyzed in order to evaluate possible impacts on the acoustic environment from the implementation of the alternative scenarios.

## 2.2 Impact on the Acoustic Environment by Implementing the Selected Plan

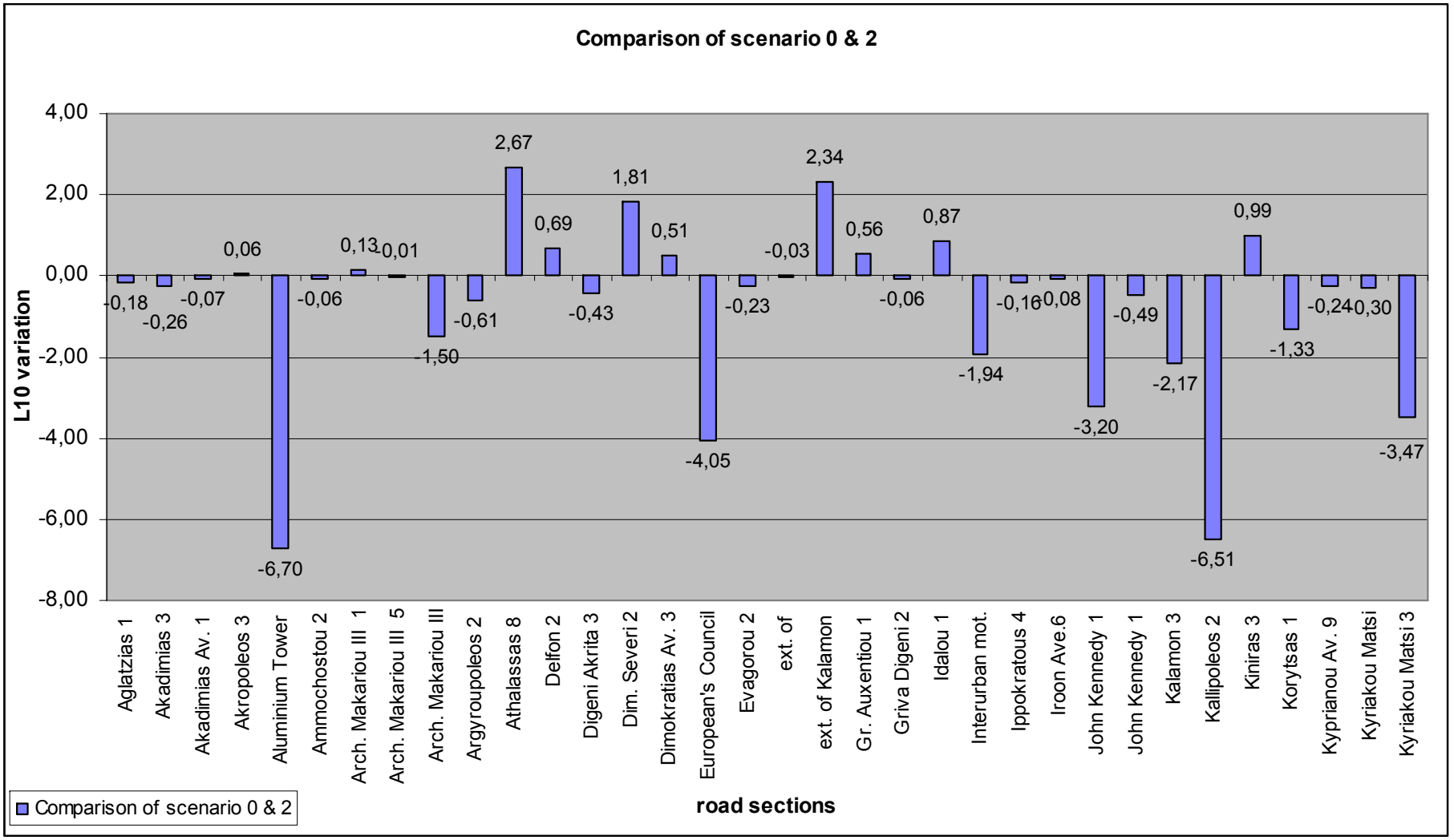
In the table below the variation of BNL10 level (peak hour) regarding road circulation, is presented as well as the relative diagram of fluctuation of BNL10 level.

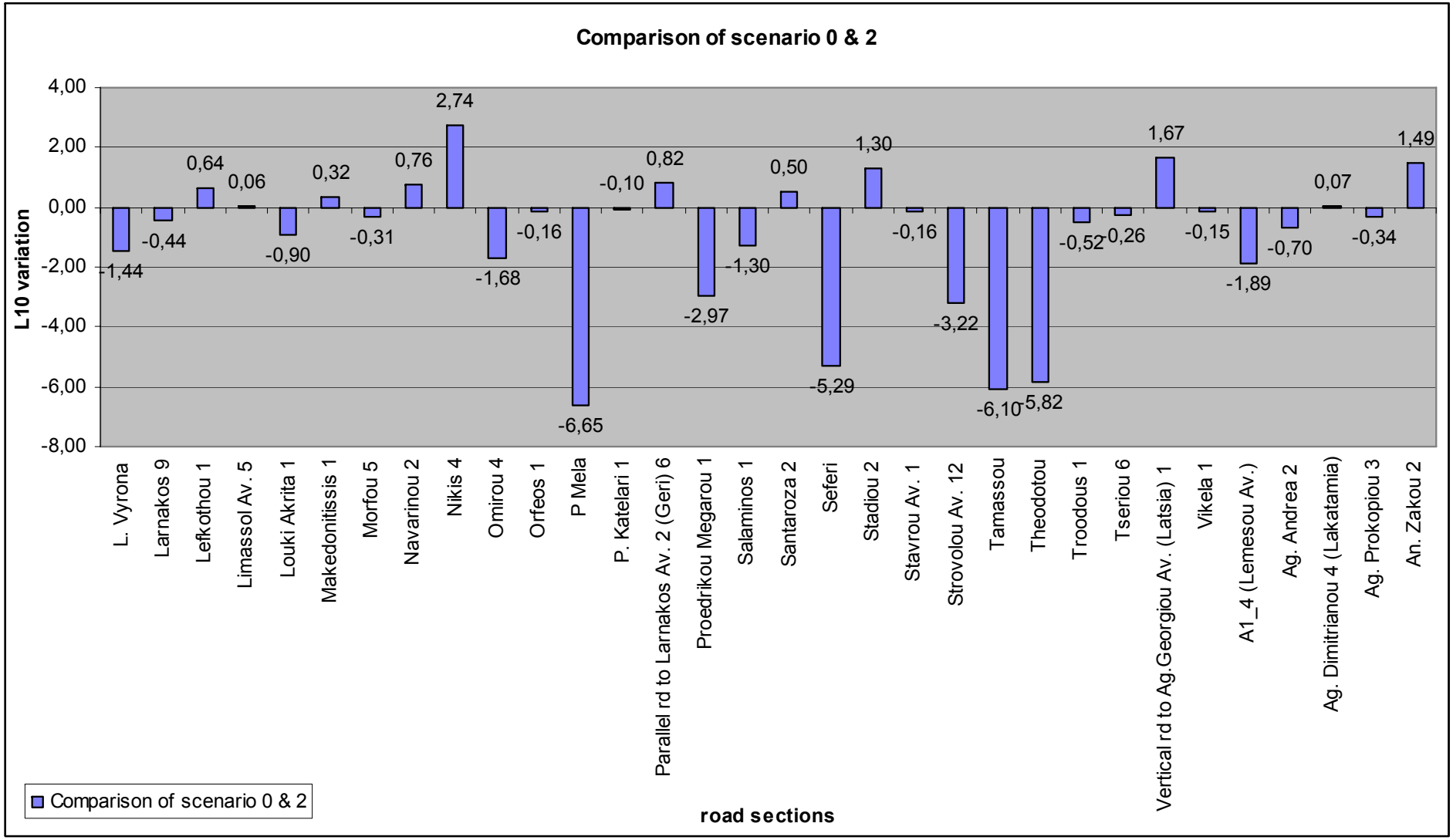
**Table 5**
**Variation of BNL10 level (peak hour) from road circulation scenarios 0 & 2– Year 2020**

| | Street name | Total traffic flow – Scen. 0 (peak hour) | Speed (km/hr) | Total traffic flow – Scen. 2 (peak hour) | Speed (km/hr) | L10 level Scenario 0 | L10 level Scenario 2 | Comparison of scenario 0 & 2 |
|---|---|---|---|---|---|---|---|---|
| 1 | Aglatzias 1 | 2.578 | 22 | 2.379 | 23 | 78,33 | 78,16 | -0,18 |
| 2 | Akadimias 3 | 1.370 | 43 | 1.385 | 41 | 79,07 | 78,81 | -0,26 |
| 3 | Akadimias Av. 1 | 2.326 | 24 | 2.032 | 27 | 78,23 | 78,16 | -0,07 |
| 4 | Akropoleos 3 | 3.134 | 26 | 2.511 | 32 | 79,85 | 79,91 | 0,06 |
| 5 | Aluminium Tower intersection branch | 1.088 | 98 | 896 | 49 | 84,85 | 78,15 | -6,70 |
| 6 | Ammochostou 2 | 966 | 37 | 1.027 | 35 | 76,64 | 76,57 | -0,06 |
| 7 | Arch. Makariou III 1 (Latsia) | 721 | 45 | 718 | 46 | 76,64 | 76,77 | 0,13 |
| 8 | Arch. Makariou III 5 (Archagelos) | 1.603 | 25 | 1.598 | 25 | 76,80 | 76,79 | -0,01 |
| 9 | Arch. Makariou III (centre) 4 | 1.930 | 30 | 2.812 | 8 | 78,45 | 76,95 | -1,50 |
| 10 | Argyroupoleos 2 | 2.596 | 35 | 2.431 | 33 | 80,55 | 79,94 | -0,61 |
| 11 | Athalassas 8 | 1.308 | 11 | 2.456 | 6 | 73,83 | 76,50 | 2,67 |
| 12 | Delfon 2 | 884 | 38 | 1.164 | 35 | 76,42 | 77,11 | 0,69 |
| 13 | Digeni Akrita 3 | 947 | 26 | 1.350 | 14 | 74,74 | 74,31 | -0,43 |
| 14 | Dim. Severi 2 | 2.062 | 41 | 2.822 | 44 | 80,51 | 82,33 | 1,81 |
| 15 | Dimokratias Av. 3 | 1.128 | 31 | 1.323 | 30 | 76,32 | 76,83 | 0,51 |
| 16 | European's Council str. 1 | 868 | 37 | 853 | 12 | 76,18 | 72,13 | -4,05 |
| 17 | Evagorou 2 | 1.322 | 12 | 1.129 | 4 | 73,98 | 73,74 | -0,23 |
| 18 | ext. of Argiroupoleos road (Latsia) 1 | 1.630 | 44 | 2.431 | 33 | 79,96 | 79,94 | -0,03 |
| 19 | ext. of Kalamon road (Latsia) 6 | 585 | 49 | 1.050 | 48 | 76,34 | 78,68 | 2,34 |
| 20 | Gr. Auxentiou 1 | 795 | 43 | 942 | 42 | 76,75 | 77,31 | 0,56 |
| 21 | Griva Digeni 2 | 3.988 | 12 | 4.024 | 11 | 78,70 | 78,64 | -0,06 |

| | Street name | Total traffic flow – Scen. 0 (peak hour) | Speed (km/hr) | Total traffic flow – Scen. 2 (peak hr) | Speed (km/hr) | L10 level Scenario 0 | L10 level Scenario 2 | Comparison of scenario 0 & 2 |
|---|---|---|---|---|---|---|---|---|
| 22 | Idalou 1 | 992 | 27 | 1.218 | 27 | 75,10 | 75,97 | 0,87 |
| 23 | Interurban mot. Nicosia_Paleochori 5 | 3.403 | 26 | 3.403 | 14 | 80,21 | 78,27 | -1,94 |
| 24 | Ippokratous 4 | 2.539 | 33 | 2.449 | 33 | 80,12 | 79,97 | -0,16 |
| 25 | Iroon Ave.6 | 1.578 | 23 | 1.610 | 22 | 76,40 | 76,31 | -0,08 |
| 26 | John Kennedy 1 (centre) | 938 | 37 | 928 | 18 | 76,51 | 73,32 | -3,20 |
| 27 | John Kennedy 1 (Pallouriotissa) | 1.170 | 37 | 1.083 | 36 | 77,45 | 76,96 | -0,49 |
| 28 | Kalamon 3 | 1.613 | 46 | 1.250 | 39 | 80,22 | 78,05 | -2,17 |
| 29 | Kallipoleos 2 | 1.320 | 46 | 656 | 24 | 79,36 | 72,85 | -6,51 |
| 30 | Kiniras 3 | 2.030 | 38 | 1.674 | 50 | 79,97 | 80,97 | 0,99 |
| 31 | Korytsas 1 | 1.994 | 30 | 1.075 | 38 | 78,59 | 77,25 | -1,33 |
| 32 | Kyprianou Av. 9 | 4.196 | 36 | 4.285 | 34 | 82,78 | 82,55 | -0,24 |
| 33 | Kyriakou Matsi (Engomi) 9 | 1.448 | 47 | 1.398 | 46 | 79,90 | 79,61 | -0,30 |
| 34 | Kyriakou Matsi 3 (centre) | 1.095 | 32 | 717 | 22 | 76,36 | 72,89 | -3,47 |
| 35 | L. Vyrona | 645 | 22 | 687 | 9 | 72,45 | 71,00 | -1,44 |
| 36 | Larnakos 9 | 1.837 | 25 | 1.723 | 24 | 77,39 | 76,94 | -0,44 |
| 37 | Lefkothou 1 | 699 | 50 | 812 | 50 | 77,24 | 77,88 | 0,64 |
| 38 | Limassol Av. 5 | 2.729 | 30 | 2.465 | 33 | 79,94 | 80,00 | 0,06 |
| 39 | Louki Akrita 1 | 1.346 | 34 | 1.009 | 36 | 77,57 | 76,66 | -0,90 |
| 40 | Makedonitissis 1 | 1.121 | 28 | 1.075 | 31 | 75,79 | 76,11 | 0,32 |
| 41 | Morfou 5 | 1.731 | 21 | 1.676 | 20 | 76,46 | 76,15 | -0,31 |
| 42 | Navarinou 2 | 785 | 42 | 938 | 42 | 76,54 | 77,30 | 0,76 |
| 43 | Nikis 4 | 1.332 | 10 | 1.911 | 3 | 73,83 | 76,57 | 2,74 |
| 44 | Omirou 4 | 2.067 | 35 | 1.247 | 38 | 79,57 | 77,88 | -1,68 |
| 45 | Orfeos 1 | 1.278 | 45 | 1.232 | 45 | 79,07 | 78,91 | -0,16 |
| 46 | P Mela | 2.524 | 30 | 1.096 | 9 | 79,60 | 72,95 | -6,65 |

| | Street name | Total traffic flow – Scen. 0 (peak hour) | Speed (km/hr) | Total traffic flow – Scen. 2 (peak hour) | Speed (km/hr) | L10 level Scenario 0 | L10 level Scenario 2 | Comparison of scenario 0 & 2 |
|---|---|---|---|---|---|---|---|---|
| 47 | P. Katelari 1 | 1.971 | 34 | 1.855 | 35 | 79,20 | 79,10 | -0,10 |
| 48 | Parallel rd to Larnakos Av. 2 (Geri) 6 | 1.928 | 34 | 1.865 | 40 | 79,11 | 79,93 | 0,82 |
| 49 | Proedrikou Megarou 1 | 3.186 | 21 | 1.789 | 18 | 79,08 | 76,11 | -2,97 |
| 50 | Salaminos 1 | 2.456 | 43 | 1.883 | 42 | 81,58 | 80,28 | -1,30 |
| 51 | Santaroza 2 | 3.442 | 18 | 3.319 | 22 | 78,92 | 79,42 | 0,50 |
| 52 | Seferi | 1.317 | 44 | 882 | 22 | 79,05 | 73,76 | -5,29 |
| 53 | Stadiou 2 | 1.029 | 7 | 1.041 | 3 | 72,70 | 74,01 | 1,30 |
| 54 | Stavrou Av. 1 | 1.906 | 14 | 1.834 | 14 | 75,78 | 75,62 | -0,16 |
| 55 | Strovolou Av. 12 | 2.995 | 44 | 2.907 | 25 | 82,58 | 79,36 | -3,22 |
| 56 | Tamassou | 3.000 | 44 | 697 | 45 | 82,59 | 76,49 | -6,10 |
| 57 | Theodotou | 1.024 | 48 | 667 | 23 | 78,57 | 72,75 | -5,82 |
| 58 | Troodous 1 | 4.176 | 39 | 4.136 | 36 | 83,24 | 82,72 | -0,52 |
| 59 | Tseriou 6 | 1.603 | 26 | 1.569 | 25 | 76,97 | 76,71 | -0,26 |
| 60 | Vertical rd to Ag.Georgiou Av. (Latsia) 1 | 1.093 | 43 | 1.615 | 43 | 78,10 | 79,77 | 1,67 |
| 61 | Vikela 1 | 1.645 | 20 | 1.590 | 20 | 76,07 | 75,93 | -0,15 |
| 62 | A1_4 (Lemesou Av.) | 3.294 | 23 | 3.137 | 12 | 79,56 | 77,67 | -1,89 |
| 63 | Ag. Andrea 2 | 1.082 | 42 | 884 | 43 | 77,90 | 77,20 | -0,70 |
| 64 | Ag. Dimitrianou 4 (Lakatamia) | 1.838 | 43 | 1.802 | 44 | 80,33 | 80,39 | 0,07 |
| 65 | Ag. Prokopiou 3 | 3.268 | 22 | 3.393 | 19 | 79,35 | 79,02 | -0,34 |
| 66 | An. Zakou 2 | 821 | 42 | 853 | 51 | 76,73 | 78,22 | 1,49 |


Comparison of scenario 0 & 2
L10 variation
4,00
2,00
0,00
-2,00
-4,00
-6,00
-8,00
-0,18
-0,26
-0,07
0,06
-6,70
-0,06
0,13
0,01
-1,50
-0,61
2,67
0,69
-0,43
1,81
0,51
-4,05
-0,23
-0,03
2,34
0,56
-0,06
0,87
-1,94
-0,16
0,08
-3,20
-0,49
-2,17
-6,51
0,99
-1,33
-0,24
-0,30
-3,47
Aglatzias 1
Akadimias 3
Akadimias Av. 1
Akropoleos 3
Aluminium Tower
Ammochostou 2
Arch. Makariou III 1
Arch. Makariou III 5
Arch. Makariou III
Argyroupoleos 2
Athalassas 8
Delfon 2
Digeni Akrita 3
Dim. Severi 2
Dimokratias Av. 3
European's Council
Evagorou 2
ext. of
ext. of Kalamon
Gr. Auxentiou 1
Griva Digeni 2
Idalou 1
Interurban mot.
Ippokratous 4
Iroon Ave.6
John Kennedy 1
John Kennedy 1
Kalamon 3
Kallipoleos 2
Kiniras 3
Korytsas 1
Kyprianou Av. 9
Kyriakou Matsi
Kyriakou Matsi 3
road sections
Comparison of scenario 0 & 2


Comparison of scenario 0 & 2
L10 variation
4,00
2,00
0,00
-2,00
-4,00
-6,00
-8,00
-1,44
-0,44
0,64
0,06
-0,90
0,32
-0,31
0,76
2,74
-1,68
-0,16
-6,65
-0,10
0,82
-2,97
-1,30
0,50
-5,29
1,30
-0,16
-3,22
-6,10
-5,82
-0,52
-0,26
1,67
-0,15
-1,89
-0,70
0,07
-0,34
1,49
L. Vyrona
Larnakos 9
Lefkothou 1
Limassol Av. 5
Louki Akrita 1
Makedonitissis 1
Morfou 5
Navarinou 2
Nikis 4
Omirou 4
Orfeos 1
P Mela
P. Katelari 1
Parallel rd to Larnakos Av. 2 (Geri) 6
Proedrikou Megarou 1
Salaminos 1
Santaroza 2
Seferi
Stadiou 2
Stavrou Av. 1
Strovolou Av. 12
Tamassou
Theodotou
Troodous 1
Tseriou 6
Vertical rd to Ag.Georgiou Av. (Latsia) 1
Vikela 1
A1_4 (Lemesou Av.)
Ag. Andrea 2
Ag. Dimitrianou 4 (Lakatamia)
Ag. Prokopiou 3
An. Zakou 2
road sections
Comparison of scenario 0 & 2

Taking into account the results presented in the above tables and diagrams it is noted that there is a difference between the selected scenario and the Do Nothing scenario in the levels of noise for L10. The fluctuation of the difference can be attributed to the increase and decrease of noise level depending on the traffic volume calculated for each road segment evaluated here and the corresponding forecasted speed. There is a fluctuation between -6,7 to + 2,74 dB(A) in the comparison of the two scenarios. More specifically, for the 66 road segments selected to be evaluated as described above, 21 of them showed an increase due to a traffic volume and/or speed increase, and the rest of them (45) showed a decrease in noise levels.

In the case of comparing the selected alternative scenario **with and without the tramway**, a similar approach was used as the above analysis.

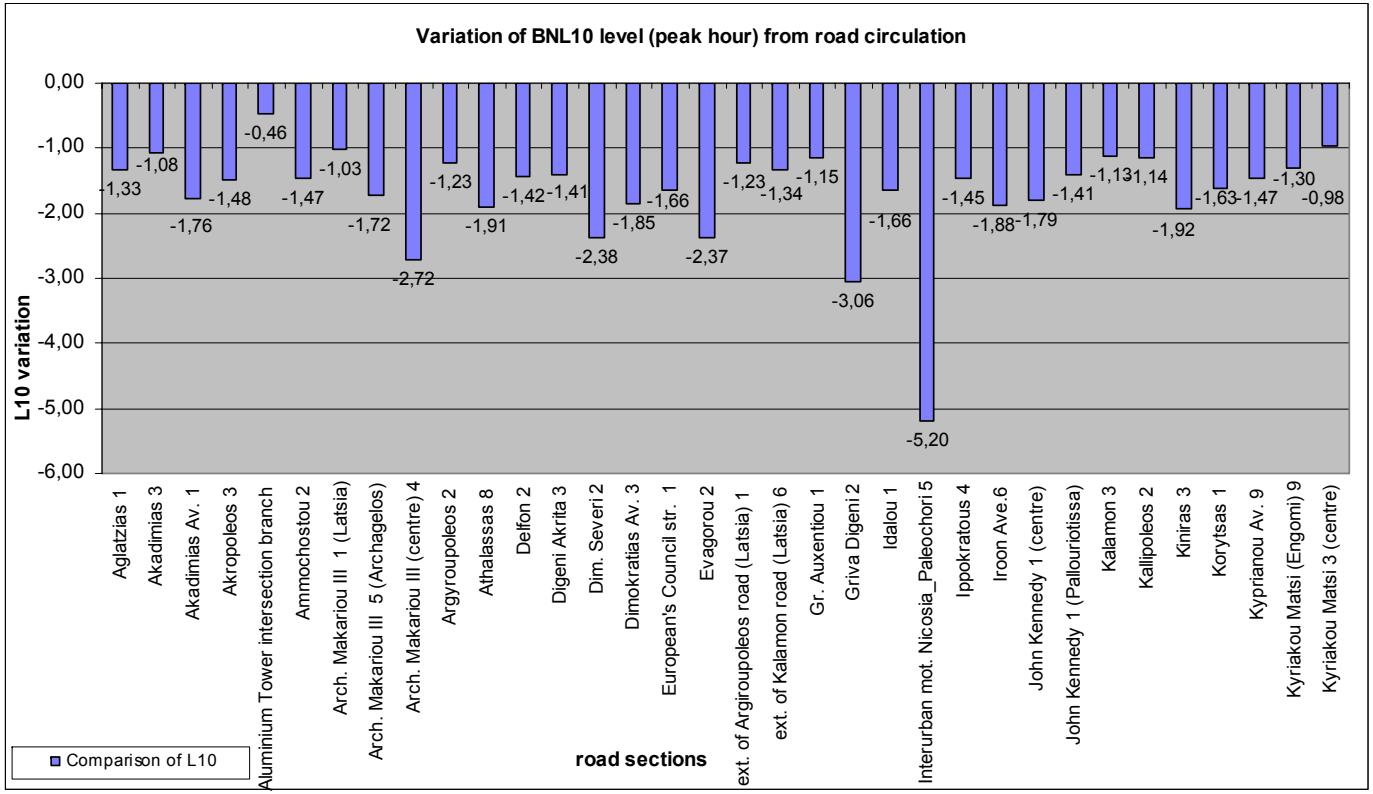
In the following table the variation of BNL10 level (peak hour) regarding traffic flow, is presented as well as the relative diagram of fluctuation of BNL10 level. More analytical information is included in electronic form in the available CD.

**Table 6**

Variation of BNL10 level (peak hour) from road circulation
Scenarios With and Without Tramway – Year 2020 (Indicative data)

| | Street name | Total traffic flow – Scen. Without Tram (peak hour) | Speed (km/hr) | Total traffic flow – Scen. With Tram (peak hour) | Speed (km/hr) | L10 level Scenario Without Tram | L10 level Scenario With Tram | Comparison of selected scenarios |
|---|---|---|---|---|---|---|---|---|
| 1 | Aglatzias 1 | 4393 | 27 | 4092 | 31 | 79,53 | 78,21 | -1,33 |
| 2 | Akadimias 3 | 2714 | 42 | 2740 | 43 | 79,64 | 78,56 | -1,08 |
| 3 | Akadimias Av. 1 | 4387 | 24 | 4266 | 25 | 79,03 | 77,26 | -1,76 |
| 4 | Akropoleos 3 | 5674 | 26 | 5485 | 28 | 80,49 | 79,01 | -1,48 |
| 5 | Aluminium Tower intersection branch | 1952 | 97 | 2013 | 97 | 84,67 | 84,21 | -0,46 |
| 6 | Ammochostou 2 | 2301 | 32 | 2259 | 33 | 77,50 | 76,03 | -1,47 |
| 7 | Arch. Makariou III 1 (Latsia) | 1399 | 46 | 1460 | 45 | 77,30 | 76,28 | -1,03 |
| 8 | Arch. Makariou III 5 (Archagelos) | 3220 | 24 | 3232 | 24 | 77,70 | 75,98 | -1,72 |
| 9 | Arch. Makariou III (centre) 4 | 5726 | 12 | 5534 | 13 | 78,90 | 76,18 | -2,72 |
| 10 | Argyroupoleos 2 | 4662 | 35 | 4557 | 36 | 80,88 | 79,65 | -1,23 |
| 11 | Athalassas 8 | 3431 | 18 | 3293 | 20 | 77,20 | 75,29 | -1,91 |
| 12 | Delfon 2 | 2433 | 33 | 2454 | 33 | 77,81 | 76,38 | -1,42 |
| 13 | Digeni Akrita 3 | 2461 | 32 | 2502 | 32 | 77,78 | 76,37 | -1,41 |
| 14 | Dim. Severi 2 | 5198 | 18 | 4960 | 18 | 79,03 | 76,65 | -2,38 |
| 15 | Dimokratias Av. 3 | 2841 | 29 | 2791 | 28 | 77,96 | 76,11 | -1,85 |
| 16 | European's Council str. 1 | 2225 | 29 | 2248 | 28 | 76,84 | 75,19 | -1,66 |
| 17 | Evagorou 2 | 1878 | 14 | 1784 | 16 | 74,29 | 71,92 | -2,37 |
| 18 | ext. of Argiroupoleos road (Latsia) 1 | 4662 | 35 | 4557 | 36 | 80,88 | 79,65 | -1,23 |
| 19 | ext. of Kalamon road (Latsia) 6 | 2712 | 45 | 2589 | 45 | 80,05 | 78,71 | -1,34 |
| 20 | Gr. Auxentiou 1 | 1880 | 42 | 1835 | 43 | 78,00 | 76,85 | -1,15 |
| 21 | Griva Digeni 2 | 8205 | 10 | 7981 | 11 | 80,40 | 77,35 | -3,06 |
| 22 | Idalou 1 | 2400 | 27 | 2408 | 27 | 76,95 | 75,29 | -1,66 |
| 23 | Interurban mot. Nicosia_Paleochori 5 | 6910 | 2 | 6910 | 2 | 83,79 | 78,60 | -5,20 |
| 24 | Ippokratous 4 | 5364 | 28 | 5131 | 30 | 80,54 | 79,09 | -1,45 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 25 | Iroon Ave.6 | 3299 | 21 | 3229 | 22 | 77,47 | 75,59 | -1,88 |
| 26 | John Kennedy 1 (centre) | 2273 | 26 | 2335 | 25 | 76,57 | 74,78 | -1,79 |
| 27 | John Kennedy 1 (Pallouriotissa) | 2357 | 34 | 2369 | 34 | 77,82 | 76,41 | -1,41 |
| 28 | Kalamon 3 | 2198 | 42 | 2194 | 43 | 78,74 | 77,61 | -1,13 |
| 29 | Kallipoleos 2 | 1792 | 43 | 1742 | 44 | 78,01 | 76,87 | -1,14 |
| 30 | Kiniras 3 | 3517 | 26 | 3445 | 25 | 78,36 | 76,44 | -1,92 |
| 31 | Korytsas 1 | 2931 | 25 | 2845 | 26 | 77,44 | 75,82 | -1,63 |
| 32 | Kyprianou Av. 9 | 9248 | 28 | 9033 | 29 | 82,81 | 81,34 | -1,47 |
| 33 | Kyriakou Matsi (Engomi) 9 | 3035 | 44 | 2784 | 45 | 80,33 | 79,03 | -1,30 |
| 34 | Kyriakou Matsi 3 (centre) | 952 | 49 | 972 | 49 | 76,16 | 75,18 | -0,98 |



Taking into account the results presented in the relative tables and diagrams, it is noted that there is a small difference between the scenario with tramway and the scenario without tramway in the levels of noise for index L10. The fluctuation of this difference can be attributed to the increase and decrease of noise level depending on the volume calculated for each road segment evaluated here and the relevant forecasted speed. There is a fluctuation of between 0,55 (which seems to be a decrease of minimum importance) to the significant decrease of 6,2 dB(A) in the comparison of the two scenarios. More specifically, for the 66 road segments selected to be evaluated as described above, 37 of them showed a slight decrease between 0,5 and 2,0 dB(A) (56,1%), 27 road segments showed a larger decrease between 2,0 and 4,0 dB(A) (40,9%) and the rest of them (2) showed an important decrease of more than 4,0 dB(A) (3%) in noise levels. There is not any increase in noise levels observed in the road segments.

# APPENDIX Section 4.6

# Pre-feasibility Study
# for the Operation of a Tramway in Nicosia

## Table of Contents

## List of Tables

## 1. Introduction

The project under study concerns the operation of a Tramway in the study area, and in particular the comparison of the selected scenario with and without a tramway, in order to provide public transportation, consistent with regional and local planning.

The project is a dynamic and multi-dimensional intervention, which is intended to remove the impact of constraints on transport and develop potentials of the area. In addition to its direct results, the project generally has wider impacts on the economy, environment, communities and institutions. As far as the analyst is concerned, the project involves combining resources, which are carefully defined and programmed over time (costs) to bring about an improvement in the well-being of society (benefits).

The aim of the financial and economic analysis is to determine and quantify, wherever possible, the costs and benefits of the project in order to facilitate the decision for its development as well as certain decisions which have to be made throughout the project cycle.

Financial analysis involves examining the activities and resource flows of entities concerned – the standpoint of the entities is adopted. Economic analysis involves examining the flows of resources among entities and their impact on society as a whole – the standpoint of society as a whole is adopted. Financial and economic analysis is used to produce standardized information in order to assess the project concerning:

- Effectiveness: by comparing the project results with its purpose;
- Efficiency: by comparing the results obtained with the resources used;
- Viability: by considering the extent to which the results (i.e. the benefits) will continue beyond the end of the project;
- Effects (impact): by identifying and measuring the consequences of the project for the national economy;
- Relevance: by comparing the project purpose, results and effects with the overall objectives and major constraints of the economic environment.

# 2. Methodology

## 2.1 The Project's Incremental Contribution

Not all flow of costs and benefits existing with the project area are due to the project; even without the project a certain level of service would have been achieved.

The project's incremental impact is the difference between the flows of costs and benefits in the with-project situation and those in the without-project situation. In general:

$$Project\ contribution = Flows_{with\ project} - Flows_{without\ project}$$

So:

$$Incremental\ benefits = Benefits_{with\ project} - Benefits_{without\ project}$$

And

$$Incremental\ costs = Costs_{with\ project} - Costs_{without\ project}$$

Care is taken not to confuse the without-project situation with the before-project situation. All economic activities are likely to change over time and estimation of the "without project" situation is taking this into account. The careful forecasting of the with-project and without-project situation is essential in estimating the project's real contribution.

### *2.1.1 Without Project*

The "without-project" situation is that which the project of tramway is not implemented. Only re-organization of the public transport system will take place as proposed included in the IMMP. The assumptions of costs and benefits of this solution will be derived by the demand analysis and technical papers.

### *2.1.2 With Project*

The "with-project" situation is that which will result from the implementation of the project of tramway. Again the assumptions of costs and benefits will be derived by the demand analysis and technical papers.

## 2.2 Taking Time into Account

Time is taken into account in project analysis since making an investment involves incurring costs in anticipation of future benefits. It is thus important to compare costs and benefits occurring at different times.

The value of money changes over time for three totally independent reasons:

- The general rise in prices (inflation) reduces the purchasing power of money. In order to take account of this, the analysis is conducted in constant prices 2009.
- The "preference for the present", which reduces the perceived value of future resources compared to present ones. Discounting is the computational technique that allows taking into account this preference for the present.
- The remunerative power of capital, which creates a "loss of earning". Any project involves the use of resources, which could be used elsewhere, or the opportunity cost of using the resource. The opportunity cost of any resource thus represents the highest net income that it could earn elsewhere in the economy.

The opportunity cost of capital invested in the project is normally measured in the form of a constant interest rate over time by:

- The average market rate of interest, for financial analysis;
- The social interest rate, which takes into account the future consumption, for the economic analysis.

Due to the recent financial unrest (crisis) and its effects on real economy, the above figures are neither good measures for the requirements of the current study nor relatively safe predictors for the future. In addition, the duration of the financial and economic crisis, the consequences and final equilibrium point are indeterminate (and not the point of the study). For that reason, an interest rate of 6% is used for the financial analysis and 5% for the economic analysis.

## 2.3 Financial Analysis

For each of the entities taking part in the project, financial analysis involves comparison of:

- Costs: the operating and investment expenses

- Benefits: the revenues resulting from the activity

The exact value of the flows paid out or received is taken into account. Financial analysis involves:

- Identifying and estimating all the flows of money, goods and services resulting from the activities in the with- and without-project situations, including investment costs, operating costs, and benefits earned from these activities;

- Calculating the return on invested capital;

The evaluation was performed on the difference between the with- and without-project situation.

## 2.4 Economic Analysis

Economic analysis assesses projects from the view of society as a whole (the national economy). The possible alternative to world markets provides the opportunity cost of the goods and services produced and used:

- Costs correspond to real consumption of economic resources, and are given the values they have on the international markets and not their local values (except if they cannot be traded on the international markets);

- Benefits are made up of the project outputs, which also are given the value they have on the international markets.

From this perspective, the costs and benefits are similar to those of the financial analysis; only the prices assigned to them differ.

A full economic analysis would involve:

- Calculating all the effects induced in the economy in shadow prices and determining the project's viability within the framework of the economy (shadow prices will be adopted by other relevant studies in Cyprus);

- Calculating the return on invested capital in socioeconomic terms;

- Examining the project's relevance.

The evaluation is performed on the difference between the with- and without-project situation, taking into account environmental impact, value of passengers' commuting time etc.

Unfortunately, given the very early stage of the project, at the time of the pre-feasibility study the most important element of the transportation projects, i.e. time savings, could not be even roughly estimated. Therefore the methodology and the scope of the economic appraisal varied from typical. Economic evaluation criteria, presented below, were kept to base (i.e. NPV = 0, IRR = discount rate and BC ratio = 1), and the economic model was solved for the time savings parameter. The economic appraisal answers to the question: Above which value of average time saving per trip for all modes, the project is economically viable. The result of the economic analysis is in average seconds of time savings per trip for all modes.

## 2.5 Evaluation Criteria

Evaluation criteria are indicators, which enable costs and benefits to be compared. Each criterion has a different meaning, which allows the assessment of the project from various standpoints. This improves the understanding of the stakes and risks involved in the project and guarantee a better decision. The most common criteria used are:

### *2.5.1 Net Present Value (NPV)*

The net present value, or total discounted profit, is equal to the sum of discounted flows throughout the life span of the project: the sum of gross annual discounted benefits less the sum of annual discounted costs. It is thus equal to the sum of discounted net benefits:

$$NPV = \sum_{t=0}^{N} \frac{(\text{Gross Benefits}_t - \text{Operating Costs}_t - \text{Investment Costs}_t)}{(1+i)^t}$$

where:

$i$ = discount rate

$t$ = year

$N$ = number of years

The project is acceptable as long as: NPV > 0.

In theory, this is the best indicator of the project's real value. The major constraint in the use of this criterion is that the discount rate $i$ must be fixed. The analysis to calculate this indicator was performed for 30 years, a period long enough not to underestimate the benefits.

### *2.5.2 Internal Rate of Return*

The internal rate of return is the rate, r, which reduces the net present value to zero:

$$0 = \sum_{t=0}^{N} \frac{(\text{Gross Benefits}_t - \text{Operating Costs}_t - \text{Investment Costs}_t)}{(1+r)^t}$$

where:

*r* = internal rate of return

*t* = year

*N* = number of years

The only correct way to use this indicator is to compare it to the value (or range of values) of discount rate *i*: the investment is acceptable if *r* > *i*.

The calculation of the internal rate of return does not require precise estimation of the discount rate. However, the order of magnitude of the discount rate must be known in order to appraise the value of IRR.

In financial analysis, the internal rate of return can be interpreted as being the highest interest rate the entity can bear while still balancing its accounts, assuming all its investments were covered by a loan. The IRR is a measure of the "return" on the capital invested. This data can be compared to the average rate of the financial market (if it is the discount rate chosen for the entity) in the case of the financial analysis of a "modern sector" entity, or to the opportunity cost of capital (it is the discount rate chosen for society as a whole) in the case of the economic analysis.

The major limitation of this indicator is that depending on the type of flow sequence, several IRR's may exist – or even none at all. However, any series of data initially negative then systematically positive allows only a single solution *r*.

The use of this indicator tends to reduce the attractiveness of those projects having a major initial investment, even if these projects have greater advantages over a long subsequent period (due to the discounting effect, which reduces the effect of remote income).

### *2.5.3 Discounted Benefit – Cost Ratios*

The ratio of the present value of net benefits and the present value of investments is widely used

$$R_{BC} = \frac{\sum_{t=0}^{N} \frac{\text{Gross Benefits}_t - \text{Operating Costs}_t}{(1+i)^t}}{\sum_{t=0}^{N} \frac{\text{Investment Costs}_t}{(1+i)^t}}$$

where:

*i* – discount rate

*t* = year

*N* = number of years

The project is acceptable as long as: $R_{BC} > 1$.

This indicator gives the current return on the unit of capital invested. It takes into account the financing constraint of investments.

In the current study, the following type of ratio using the present value of fixed and operating costs is calculated:

$$R_{bc} = \frac{\sum_{t=0}^{N} \frac{\text{Gross Benefits}_t}{(1+i)^t}}{\sum_{t=0}^{N} \frac{\text{Investment Costs}_t + \text{Operating Costs}_t}{(1+i)^t}}$$

The interpretation of this indicator depends on the situation in which it is calculated.

The major limitation is that the calculation of these criteria requires fixing a discount rate. In the usual sequence of flows, the higher the discount rate, the smaller the ratio.

## 2.6 Sensitivity Analysis

During project planning, the costs and benefits used are only estimates. The actual costs and benefits will diverge from these estimates, as the project is implemented, for various reasons. The assessment of how changes in project costs and benefits will affect the economic and financial viability of the project is done using sensitivity analysis.

In both financial and economic analysis, the analysis involves:

- Identifying the variables whose values are most uncertain;
- Estimating the likely range of these values;

- Evaluating how sensitive the results of the economic and financial analysis are to these, through computations based on a range of value;

Sensitivity analysis highlights those variables, which have the greatest potential impact on the economic and financial viability of the project, and gives a measure of the overall robustness of the economic and financial analysis.

## 3. Financial Analysis

In this chapter the financial analysis of the project is performed. In this ex-ante evaluation of the project, the following studies preceding the financial analysis are used: demand studies, which determine the "market" size, estimate of future demand (nature, quantities, growth, structure) etc; technical studies which determine selection of technology, scale of operation, location etc.

The aim of the financial analysis is to:

- Understand the project's operation by reviewing its physical and money flows;
- Assess the project's financial balance, and thus the viability of its operations;
- Assess the project's efficiency and estimate the likely financial return on investment.

### 3.1 Buses - Operating and Other Cost

Deriving data from the contract signed in December 2009 between the Ministry of Communications and Works and the company that will operate the bus PT system of the Lefkosia Province, the cost of the standard bus is 3,45 € per traveled-kilometer and 2,90 € per traveled-kilometer for the midi bus. This cost includes investment cost (price of the bus), operating cost and depreciation cost.

#### *3.1.1 Without the Project*

Taking into account that 45 standard buses and 73 midi buses will be required for the operation of the bus system, then the average cost of buses is 3,11 € per traveled kilometer.

As it was estimated above the total traveled-kilometers per year will be 10,11 million. Therefore, the annual total cost of the bus system is estimated to be 31,46 million €.

### *3.1.2 With the Project*

Taking into account that 33 standard buses and 62 midi buses will be required for the operation of the bus system, then the average cost of buses is 3,09 € per traveled kilometer.

As it was estimated above, the total traveled-kilometers for the buses only, will be 8,13 million per year. Therefore, the annual total cost of the bus system is estimated to be 25,12 million €.

## 3.2 Tram – Investment Cost

At this stage of the study, it is not possible to estimate the investment cost in detail, because the technical assessment is at a preliminary level. Unit costs are derived from the recent studies for the extension of the existing tramway system from Athens to Piraeus and from a study of a tramway system for the city of Patras. All values are without VAT, and they are in constant prices 2009.

### *3.2.1 Construction Cost*

For the requirements of the financial analysis, taking into consideration the characteristics of the tramway line, the following unit cost per kilometer is considered:

- 14 million € per kilometer of double tramway line on the same street
- 11 million € per kilometer of single tramway line

The brake down of the total construction cost into basic cost categories was as follows, based on the mentioned above recent relevant studies.

| Type of Cost € | Estimation - Cyprus tramway |
|---|---|
| *Network construction* | *76,00%* |
| Infrastructure works – tracks and catenary | 28,00% |
| Developments along the lines | 18,00% |
| Electromechanical works | 28,00% |
| Hydraulic works | 2,00% |
| *Contingencies* | *9,00%* |
| *Project management* | *8,00%* |
| *Relocation of public utility networks / archeology /land expropriations* | *7,00%* |
| **Total** | **100,00%** |

Estimated cost (million €):

| Type of line | Cost per kilometer | Kilometers | Total Cost |
|---|---|---|---|
| Double line | 14,00 | 14,52 | 203,24 |
| Single line | 11,00 | 3,89 | 42,71 |
| Total cost | | | 245,95 |

The cost for the construction of depot is expected to be 20% of the cost of infrastructure. Therefore, this cost is estimated to be 43,78[1] million €.

The cost per tram is approximately 2,25 million €. Therefore the cost for the 20 trams is 45,00 million €.

Summing up the above amounts, the total cost of the project is estimated to be in the order of magnitude of 334,73 million € without VAT in constant 2009 prices.

### *3.2.2 Residual Value and Replacement Cost*

As a result of wear and tear, and obsolescence, productive capital loses its value over time; therefore, it is replaced. It is considered, though, that assets have a market value (resale value) at the end of the project period, this is incorporated into the receipts of the final year (thus simulating a resale of the assets). This residual value is introduced into the final period.

For the calculation of the residual value and replacement cost, the economic life of the project is considered to be:

- For civil engineer's works..... 50 years
- Electromechanical works ..... 20 years
- Tram-wagons ..... 25 years
- Land expropriations ..... unlimited time

Therefore, the residual value of electromechanical works and tram-wagons is set to zero at the end of the analysis.

For the tram project, replacement cost appears as a major renewal and it is equal to 20% of construction cost (every 15 years for the civil engineer's

[1] Depot construction cost = 20% * 89% * 245.951,00 € = 43,78 million €

works, every 10 years for the electromechanical works and every 13 years for the tram-wagons).

## 3.3 Tram – Operating cost

### *3.3.1 Maintenance Cost*

The annual cost for spares and parts is compatible with the experience of tram operation and relevant studies in Greece and is estimated as follows:

- Civil engineer's works: approximately € 9.400 per track kilometer.
- Electro-mechanical works: approximately € 8.950 per catenary kilometer.
- Tram-wagons: approximately € 25.000 per tram.

### *3.3.2 Personnel Cost*

Personnel cost in € is presented in the following table.

| | Required Personnel | Annual compensation | Total |
|---|---|---|---|
| Railway Material Sector | 10 | 24.000,00 | 240.000,00 |
| Electronic Systems Department | 11 | 21.600,00 | 237.600,00 |
| Electromechanical Installations Maintenance Sector | 8 | 21.600,00 | 172.800,00 |
| Reception Department | 18 | 21.600,00 | 388.800,00 |
| Power Supply Department | 14 | 21.600,00 | 302.400,00 |
| Preparation of Operations Department | 47 | 24.000,00 | 1.128.000,00 |
| Operation Control Centre Department | 18 | 27.600,00 | 496.800,00 |
| Administrative Personnel | 19 | 20.400,00 | 387.600,00 |
| Total | 145 | | 3.354.000,00 |

Annual compensation includes social security cost.

### *3.3.3 Energy*

Electricity will power the tramway system, the cost of which is estimated to be 0,52 € per traveled -kilometer, taking into account the type of tram and level of operations.

Traveled-kilometers for the tram were calculated to be 1.599.107,86 per year (assumptions: average frequency 7,50 mins, 17,50 working hours per day,

305 regular working days and 60 Sundays and holidays with 70% of tram kms of a regular day).

### *3.3.4 Water Supply*

The cost of water supply is estimated to be 0,05 € per traveled–kilometer.

### *3.3.5 Cleaning Cost*

The annual cost of keeping stations and the rest of the network clean is estimated to be € 175.000 (most likely appointed to a contractor).

### *3.3.6 Insurance Cost*

By assumption, it is considered that the value of the insured project is equal with the construction cost. Although at the end of the analysis, the residual value of the project is different from its initial value, there is no decrease at the insurance cost throughout the analysis because by assumption, the increased insurance cost indicates a higher risk due to the aging equipment. Insurance cost is estimated to be 0,05% of the construction cost (civil engineer works, electromechanical works and tram-wagons cost) or approximately € 146.000 per year, an amount that is similar with relevant cost in Athens.

### *3.3.7 Other Administrative Cost*

It is estimated to be 10% of the operating cost (maintenance, personnel, electricity, water supply and cleaning cost).

## 3.4 Operating Benefits

The commuters' trips of a typical day are estimated to be around 813.000 in 2020 for both with-and-without-tram situations. The share of the public transportation for without-tram situation is expected to be 10,6% and for with-tram situation is expected to be 1,7% higher, that is 12,3%. For both with-and-without-tram situations, 305 days are typical; 60 days are Sundays and holydays with 55% trips of a typical day. For both with-and-without-tram situations, the regular fare is set to be 1 € paid for 65% of the commuters' trips, while 35% of the commuters' trips pay half fare of 0,50 €. Therefore, the inflows from tickets for with-tram situation are € 27,8 million and the inflows from tickets for without-tram situation is € 24,1 million. Having no further data, these assumptions are kept constant throughout the analysis.

In addition, further income will be created for the public transportation system by other sources as advertisement, fines, other charges etc. This is assumed to be 4% of the income from tickets for both with-and-without-tram situations.

## 3.5 Discount Rate

For the reasons referred to in section 2.2, an interest rate of 6% is used for the financial analysis.

## 3.6 Financial Statements and Indicators

### *3.6.1 The Accounts*

According to the above, the financial cash flow for the with- and without-project situations were compiled and are presented in detail at the end of the analysis:

- *Financial cash flow with-project*
- *Financial cash flow without-project*

The difference between the cost and benefit flows of the with-project situation and those of the without-project situation give the incremental effects of the project, allowing its evaluation according to the indicators presented in methodology. For that, the following statement was derived:

- *Incremental financial cash flow*, which is the difference of *financial cash flow with-project* minus *financial cash flow without-project*

### *3.6.2 Indicators*

The assessment of the project resulted in the following values for the evaluation indicators:

Net Present Value (NPV)..... - € 278,2 million

Internal Rate of Return (IRR)..... n/a

Benefit Cost Ratio ($R_{BC}$) ..... 0,18

The above results are negative but expected and compatible with the international experience of similar projects. The decision for the construction of the project should be based on the results of the economic analysis.

## 4. Economic Analysis

The impact of the economic environment (e.g. prices and availability of goods and services, seasonality, national policies and regulations, organization of the sector, sub-sector or international market, regional agreements and regulations) on the project, are analyzed to assess the project's sustainability, which is defined as the ability of the project to generate an acceptable level of

benefits over a period of sufficient length. This analysis of project viability enables to measure the impact of constraints resulting from:

- The international economy into which the national economy is integrated
- The operation of local markets (e.g. market imperfections) and national policies

The aim in analyzing project viability is to estimate the constraints on a project due to its integration in the national, and international economy. To this end, two questions must be asked:

- Within the framework of international prices, and taking into account national factors of production (e.g. wages), does the project produce more wealth than it consumes?
- How do the operations of national markets and the policies, which apply to them, affect these economic results?

In order to carry out such an analysis, the costs and benefits, estimated at market prices, must be evaluated using "shadow" prices for the with- and without-project situations.

## 4.1 Shadow Prices

The value of a good or service is given by the price at which it can be bought or sold. However this price does not necessarily reflect the value of the good or service from the standpoint of society as a whole.

In order that prices and value coincide, economic theory stipulates that prices should be established by the free play of supply (the producers) and demand (the consumers), in an environment of "free and equal competition". Under these conditions, prices give "signals" to entities enabling them to allocate their scarce resources (goods and services, labour, capital, environment) in a way that permits them to maximize overall domestic income and spontaneously to regulate the economy.

There are two reasons why market prices and the actual value to society as a whole may diverge:

- Market distortions hinder the free operation of markets. Distortions mean that market prices do not reflect the value of the resource to society – transfers, government intervention, market "imperfections", over-valuation (or under-valuation) of the exchange rate.

- Externalities: i.e. the changes caused by the project that do not appear in the economic accounts of the entities involved. If externalities are not taken into account, the cost of the resources used in the project is reduced (or increased) by an amount equal to the negative (or positive) external effects.

For the economic analysis it is attempted to establish the "true" economic results of the project by substituting shadow prices for the fixed market prices. These theoretical prices reflect the "real" value of resources for the national economy and to derive them, new information on international economy must be collected (e.g. prices, quality, international trade). This task is not the object of the current study and therefore adjustment factors appropriate for the Cypriot economy are used, which appeared in studies of similar projects. Apart from this price adjustment, the definitions of gross costs and benefits, and the method of calculating the net benefit, are similar to those of financial analysis.

## 4.2 Elimination of Transfers

All the transfer flows that appear in the consolidated account are eliminated.

Transfers are, by definition, flows that do not correspond to any production or real consumption of resources. Having no impact on domestic income, they should not appear in the overall results for society as a whole. Transfers are eliminated in practice by reducing to zero the transfer items appearing explicitly in the consolidated account, that is the taxes and subsidies paid to, or by, the government, and which appear in the financial accounts.

## 4.3 Labour

Additional employment constitutes social cost; it concerns the employment of labour resources on the project, which ceases been available for alternative social objectives. The relevant benefit is denoted by the additional income that is derived by the creation of employment and it is calculated by the evaluation of the direct and indirect net production by the project.

The calculation of labour's social cost is accomplished by the use of an accounting cost lesser than the one paid in by the project, taking into account that under underemployment situation, the current wages are higher than the labour's opportunity cost.

Since labour cost includes skilled workforce, which market is operating under full-employment condition, the estimation about income multiplier is used as well.

In particular, on one hand, the income multiplier is estimated at the analysis, on the other hand, for the unskilled labour a cost lesser than the real is used, but not the one reflecting the current underemployment conditions, while for the skilled labour the same cost is used in order to avoid double calculations.

## 4.4 Land

It is assumed that land (expropriations) is burdening the construction cost with an amount equal to the compensations deposited for the expropriated land. The use of the site for the project will bring about permanent changes that do not allow alternative uses for the land.

## 4.5 Shadow Exchange Rate

The flows of foreign currency can be viewed as far as their utility is concerned in relation to their contribution to the total consumption and in this case, the shadow exchange rate will be the value of the additional consumption that is created by an extra unit of foreign currency, which is marginally available to the country. Therefore, the shadow exchange rate is defined as the weighted average of the rate of market prices to the official c.i.f. prices, where the weighted terms reflect the percentage of the marginal imports of a good over the total imports (Dargupta, Marglin and Sen, 1972).

$$P^F = \sum_{j=1}^{j} r_j \frac{P_j^F}{P_j^{c.i.f.}}$$

where:

$P^F$ = shadow exchange rate

$P_j^{c.i.f}$ = the c.i.f. price for the j imported good in €, calculated by the official exchange rate

$r_j$ = the percentage of marginal imports of the good j over the total imported goods

$j$ = the total of imported goods by the country

$P_j^F$ = the price of the local market which also reflects the need

The shadow “social” exchange rate due to liberalization of the international trade and due to free adjustment of exchange rate, it was considered equal to the nominal value of the exchange rate, that is:

$$\sum_{j=1}^{j} r_j = 1$$

## 4.6 Social Discount Rate

In this study, 5% was used as social discount rate.

## 4.7 Economic Cost

### *4.7.1 Construction Cost*

The economic construction cost concerns only the with-project situation. The economic prices are calculated according to adjustment indicators on market prices excluding V.A.T.

For the calculations it is considered that:

- The construction cost is categorized as follows:
  - Machinery ..... 33%
  - Unskilled labour ..... 17%
  - Skilled labour ..... 12%
  - Materials ..... 38%
- The machinery is categorized as follows:
  - Machinery materials ..... 80%
  - Skilled labour ..... 20%
- The cost of exchange for each category is considered as:
  - Machinery materials ..... 100%
  - Other materials ..... 20%

The following conversion factors (converting from market prices to real prices – shadow prices):

- Unskilled labour: ..... 0,78[2]

[2] It is estimated that unskilled labour market is experiencing involuntary unemployment and the shadow wage is approximated by using the following conversion coefficient:

*Conversion coefficient = (1-u)*(1-t)*

Where: *u* is the regional unemployment rate, which is set to 5,40% according to Statistical Service of the Republic of Cyprus (last update 11.12.2009)
*t* is the rate of social security payments and relevant taxes, which is set to 17,90% according to Social Insurance Services of the Republic of Cyprus

- Skilled labour:..... 0,80[3]
- Local materials: .....1.000
- Imported materials .....1.000
- Cost of exchange: .....1.000

According to the above the economic construction cost is € 311.1 million which is less than the financial one.

### *4.7.2 Replacement Cost*

Replacement cost was calculated as in financial analysis, taking into account investment cost without VAT and social prices.

### *4.7.3 Operating Cost*

The impact of the project's annual operating cost in the economy is estimated based also on the financial flows and on the social prices.

For the calculations it is considered that:

- The cost is categorized as follows:
  - Machinery..... 20%
  - Unskilled labour..... 35%
  - Skilled labour..... 15%
  - Materials..... 30%
- The machinery is categorized as follows:
  - Machinery materials ..... 80%
  - Skilled labour..... 20%
- The cost of exchange for each category is considered as:
  - Machinery materials ..... 100%

Then the conversion coefficient is multiplied by the financial (market) wage producing the shadow wage.

[3] For the skilled workers it is estimated that they are facing a competitive labour market and the shadow wage can be assumed to be equal to the financial (market) wage. Social security payments and relevant taxes are subtracted resulting to a conversion coefficient equal to 0,80.

- Other materials ..... 20%

The following conversion factors (converting from market prices to real prices – shadow prices):

- Unskilled labour:.....0,78
- Skilled labour:.....0,80
- Local materials: .....1.000
- Cost of exchange: .....1.000

### *4.7.4 Disruption Disbenefits*

This cost refers to the negative impact of the construction to the traffic as delays and worse quality of the road is expected. This cost is not estimated.

## 4.8 Economic Benefits

### *4.8.1 Indirect Residual Value*

Residual value was calculated as in financial analysis, taking into account investment cost without VAT and social prices.

### *4.8.2 Indirect Benefits during Construction*

#### 4.8.2.1 Economic growth

The project cost includes the contractors' benefits, which is estimated to be 12% of the budget and it is taxed by 10%. Therefore, the state will be benefited by 1,20% of the investment.

The figure of taxes used is not transfer payment here; in economic analysis is used under a different context: society is devoting economic resources in a project within a prospering industry able to create added value to economy and contribute to economic growth. This added value and benefits to society is not totally ignored and is approximated as follows:

#### 4.8.2.2 Employment

Positive effects are expected to be created during construction period by the implementation of the suggested technology. The advancement of the scientific and managerial personnel is not quantifiable.

The indirect benefits from the employment are estimated to be:

- Construction

  According to the assumptions for the construction, 35,60% of the budget concerns labour cost. The average daily wage is assumed to be € 147.

  Construction cost € 291,3 million x 35,60% = € 103,7 million divided 147 € ≈ 706.000 daily wages, that is roughly 1.340 labour positions (22 days/month x 12 months x 2 years).

- Technical consultant

  According to the assumptions, 60% of the budget concerns labour cost. The average daily wage is assumed to be 205 €.

  Consultant cost € 23,2 million x 60% = € 13,9 million divided 205 € ≈ 68.000 daily wages, that is 129 labour positions (22 days/month x 12 months x 2 years).

The labour that will be required by the project is engineers of small and medium experience, machinery operators and technicians of small and medium experience and unskilled labour. In addition, it will be required personnel for the operation administrative and accounting services.

Above, it is calculated that the labour income will be € 117,6 million. The redistribution of income with income multiplier 1,20 for the local income and local added value of 50% will bring benefits, which are estimated to be around € 11.800 in 2 years or 3,74% of the investment cost and will have significant impact on employment.

The employment on local materials production is expected that it will not be influenced by the project.

#### 4.8.2.3 Economic growth due to producers of local materials during construction

For reasons explained in paragraph “economic growth”, the benefits to society are approximated as follows:

For the construction period the benefits of local producers from the increase of the economic activity were estimated. It is expected that benefits for the national economy (taxes) will occur on the following year by the formation of income.

It is considered that the producers of local materials operate with 15% profit, which is taxed by 10% (ltd companies).

### *4.8.3 Indirect Benefits during Operation*

Since the operation of the public transportation system with tram will cost less than the system without tram, this will have a negative effect on indirect benefits. This indirect cost by employment is estimated as follows:

- Operation

  According to the assumptions for the operation, 54% of the budget concerns labour cost. The average daily wage is assumed to be 117 €.

  Operating cost (negative cost due to savings) –€ 2,6 million x 54% = -€ 1,4 million divided 117 € ≈ -12.000 daily wages, that is -2 labour positions (22 days/month x 12 months x 30 years).

Above, the labour income is calculated. The redistribution of income with income multiplier 1,20 for the local income and local added value of 50% will bring cost, which is estimated to be –€ 350.000 in 30 years or 13,50% of the operating cost and will have some impact on employment.

The employment on local materials production is not expected to be influenced by the project.

#### 4.8.3.1 Economic growth due to producers of local materials during operation

For reasons explained in paragraph “economic growth”, the benefits to society are approximated as follows:

For the operating period the dis-benefits of local producers from the decrease of the economic activity were estimated. It is expected that dis-benefits for the national economy (taxes) will occur on the following year by the formation of income.

It is considered that the producers of local materials operate with 15% profit, which is taxed by 10% (ltd companies).

### *4.8.4 Value of Time Saved*

In the absence of national estimates of the time value by reason or by mode for passengers, the value of time is derived by the study of OASA S.A.[4] from users’ actual choices. The average value of time (for the users of all kinds of means of transportation and for all purposes) was 7,58 € per hour by the revealed preference research through interviews at households at the

[4] Οργανισμός Αστικών Συγκοινωνιών Α.Ε., Γενική Διεύθυνση Συγκοινωνιακού Έργου, *Μελέτη Προέλευσης – Προορισμού Μετακινήσεων*, DENCO ΣΥΜΒΟΥΛΟΙ ΜΗΧΑΝΙΚΟΙ Α.Ε., METRON ANALYSIS A.E., Ιούνιος 2007

prefecture of Attica. This value is calculated to be 8,21 € per hour in 2009 prices.

As it is mentioned in paragraph 2.4, given the very early stage of the project at the time of the pre-feasibility study, the most important element of the transportation projects, i.e. time savings, could not be even roughly estimated. Therefore, the methodology and the scope of the economic appraisal varied from typical. Economic evaluation criteria were kept to base (i.e. NPV = 0, IRR = discount rate and BC ratio = 1), and the economic model was solved for the time savings parameter. The economic appraisal answers to the question: Above which value of average time saving per trip for all modes, the project is economically viable. The result of the economic analysis is in average seconds of time savings per trip for all modes.

### *4.8.5 Other Benefits (not quantified)*

Beyond the above-referred benefits, which are calculated in money terms, it is important, not to ignore other impacts as the ones derived by projects of public nature that create external economies or externalities. The infrastructure projects bring favourable externalities to a great number of households, businesses and productive sectors with positive impact on economic development and quality of life. Some of the positive effects expected are referred below:

- In the absence of conversion factors and according to JASPERS request, the non-market benefits, which are relevant to direct benefits, were excluded from the analysis
- Vehicles operating cost
- Reduction of accidents
- Air pollution
- Noise
- Climate change
- Indirect benefits on tourism
- Indirect benefits on the development of the area

## 4.9 Cash Flow Tables

According to the above, the economic cash flow for the with- and without-project situations were compiled and are presented in detail at the end of the analysis:

- *Economic cash flow with-project*
- *Economic cash flow without-project*

The difference between the cost and benefit flows of the with-project situation and those of the without-project situation give the incremental effects of the project, allowing its evaluation according to the indicators presented in methodology. For that, the following statement was derived:

- *Incremental economic cash flow*, which is the difference of *economic cash flow with-project* minus *economic cash flow without-project*

## 4.10 Indicators

As it is already mentioned in paragraph 2.4, economic evaluation criteria were kept to base (i.e. NPV = 0, IRR = discount rate and BC ratio = 1), and the economic model was solved for the time savings parameter.

The project is economically viable above the average of 33.48 seconds of time saving per trip for all modes.

Stated in a different way, for reasons of precision, this 33.48 seconds savings is an average for all trips, all modes. Since money value is assigned to time, 33.48 seconds equals to € 0.0764.

# 5. Sensitivity Analysis

During project planning, the costs and benefits used are only estimates. The actual costs and benefits will diverge from these estimates, as the project is implemented, for various reasons. The assessment of how changes in project costs and benefits will affect the economic and financial viability of the project is done using sensitivity analysis. The results of sensitivity analysis may greatly modify the overall assessment of the project. It highlights those variables, which have the greatest potential impact on the economic and financial viability of the project, and gives a measure of the overall robustness of the economic and financial analysis.

In both financial and economic analysis, sensitivity analysis involves:

- Identifying the variables whose values are most uncertain;
    - Investment cost (financial and economic analysis)
    - Operating cost (financial and economic analysis)
    - Discount rate (financial and economic analysis)
    - Trips per typical day (financial and economic analysis)
    - Increase of Public Transportation share due to tram introduction (financial analysis)
    - Time saved (economic analysis)
- Estimating the likely range of these values;

  Changes ranging from –30% to +30% in twelve steps for all variables were applied. Within this range the sensitivity trend of the results is adequately defined
- Evaluating how sensitive the results of the economic and financial analysis are through computations based on the specified range for each variable based on the following criteria:
    1. Net Present Value
    2. Internal Rate of Return
    3. Benefit Cost Ratio

One-way and multi-way sensitivity analysis will be performed. One-way sensitivity analysis studies the effect of changes in input variables on the output values of the model. Each input is changed individually while holding all others at their base case value. Multi-way sensitivity analysis shows the impacts of combinations of varying inputs on the model. It is an analysis of the effect of varying multiple variables on outcome of the model and identifies the combination of factors that affect the output most.

## 5.1 Financial Analysis

The summary results of the one way sensitivity analysis for the financial model is presented in the following table:

| Rank | Name | Output Max (in .000 €) | | When Input Value= | | Output Min (in .000 €) | | When Input Value= | |
|---|---|---|---|---|---|---|---|---|---|
| | | NPV Value | % change | Value | % change | NPV Value | % change | Value | % change |
| #1 | Budget | -175.486,30 | 36,91% | 234.311,19 th€ | -30% | -380.843,80 | -36,91% | 435.149,36 th€ | +30% |
| #2 | Trips | -264.135,50 | 5,04% | 1.056.485,30 | +30% | -292.194,50 | -5,04% | 568.876,70 | -30% |
| #3 | % of Public Transportation share | -264.135,50 | 5,04% | 2,16% | +30% | -292.194,50 | -5,04% | 1,16% | -30% |

| Rank | Name | Output Max (in .000 €) | | When Input Value= | | Output Min (in .000 €) | | When Input Value= | |
|---|---|---|---|---|---|---|---|---|---|
| | | NPV Value | % change | Value | % change | NPV Value | % change | Value | % change |
| #4 | Discount Rate | -274.941,30 | 1,16% | 4,20% | -30% | -278.246,00 | -0,03% | 6,30% | +5% |
| #5 | Operating cost | -277.833,60 | 0,12% | -120,38 th€/year | +30% | -278.496,40 | -0,12% | -64,82 th€/year | -30% |

The detailed results are following:

| Variable | % change | Net Present Value (NPV) (in .000 €) | Internal Rate of Return (IRR) | Benefit Cost Ratio (B/C) |
|---|---|---|---|---|
| Operating cost | -30% | -278.496,40 | n/a | 0,18 |
| | -25% | -278.441,20 | n/a | 0,18 |
| | -20% | -278.386,00 | n/a | 0,18 |
| | -15% | -278.330,70 | n/a | 0,18 |
| | -10% | -278.275,50 | n/a | 0,18 |
| | -5% | -278.220,30 | n/a | 0,18 |
| | 5% | -278.109,80 | n/a | 0,18 |
| | 10% | -278.054,50 | n/a | 0,18 |
| | 15% | -277.999,30 | n/a | 0,18 |
| | 20% | -277.944,00 | n/a | 0,18 |
| | 25% | -277.888,80 | n/a | 0,18 |
| | 30% | -277.833,60 | n/a | 0,18 |
| Discount Rate | -30% | -274.941,30 | n/a | 0,24 |
| | -25% | -275.874,50 | n/a | 0,23 |
| | -20% | -276.628,30 | n/a | 0,22 |
| | -15% | -277.219,70 | n/a | 0,21 |
| | -10% | -277.663,80 | n/a | 0,20 |
| | -5% | -277.974,80 | n/a | 0,19 |
| | 5% | -278.246,00 | n/a | 0,18 |
| | 10% | -278.228,30 | n/a | 0,17 |
| | 15% | -278.121,20 | n/a | 0,16 |
| | 20% | -277.933,40 | n/a | 0,16 |
| | 25% | -277.672,70 | n/a | 0,15 |
| | 30% | -277.346,10 | n/a | 0,15 |
| Budget | -30% | -175.486,30 | n/a | 0,25 |
| | -25% | -192.599,40 | n/a | 0,23 |
| | -20% | -209.712,50 | n/a | 0,22 |
| | -15% | -226.825,60 | n/a | 0,21 |
| | -10% | -243.938,80 | n/a | 0,20 |
| | -5% | -261.051,90 | n/a | 0,19 |
| | 5% | -295.278,10 | n/a | 0,18 |
| | 10% | -312.391,30 | n/a | 0,17 |
| | 15% | -329.504,40 | n/a | 0,16 |
| | 20% | -346.617,50 | n/a | 0,16 |
| | 25% | -363.730,60 | n/a | 0,15 |
| | 30% | -380.843,80 | n/a | 0,15 |
| Trips | -30% | -292.194,50 | n/a | 0,14 |
| | -25% | -289.856,30 | n/a | 0,15 |
| | -20% | -287.518,00 | n/a | 0,16 |

| Variable | % change | Net Present Value (NPV) (in .000 €) | Internal Rate of Return (IRR) | Benefit Cost Ratio (B/C) |
|---|---|---|---|---|
| | -15% | -285.179,80 | n/a | 0,16 |
| | -10% | -282.841,50 | n/a | 0,17 |
| | -5% | -280.503,30 | n/a | 0,18 |
| | 5% | -275.826,80 | n/a | 0,19 |
| | 10% | -273.488,50 | n/a | 0,20 |
| | 15% | -271.150,30 | n/a | 0,20 |
| | 20% | -268.812,00 | n/a | 0,21 |
| | 25% | -266.473,70 | n/a | 0,22 |
| | 30% | -264.135,50 | n/a | 0,22 |
| % of Public Transportation share | -30% | -292.194,50 | n/a | 0,14 |
| | -25% | -289.856,30 | n/a | 0,15 |
| | -20% | -287.518,00 | n/a | 0,16 |
| | -15% | -285.179,80 | n/a | 0,16 |
| | -10% | -282.841,50 | n/a | 0,17 |
| | -5% | -280.503,30 | n/a | 0,18 |
| | 5% | -275.826,80 | n/a | 0,19 |
| | 10% | -273.488,50 | n/a | 0,20 |
| | 15% | -271.150,30 | n/a | 0,20 |
| | 20% | -268.812,00 | n/a | 0,21 |
| | 25% | -266.473,70 | n/a | 0,22 |
| | 30% | -264.135,50 | n/a | 0,22 |

## 5.2 Economic Analysis

The summary results of the one way sensitivity analysis for the financial model is presented in the following table:

| Rank | Cell | Name | Output Max | When Input Value= | Output Min | When Input Value= |
|---|---|---|---|---|---|---|
| | | | Value (in .000 €) | % change | Value (in .000 €) | % change |
| #1 | H38 | Budget | 83.155,57 | -30% | -83.155,57 | +30% |
| #2 | N24 | Trips | 79.178,20 | +30% | -79.178,20 | -30% |
| #3 | N62 | Time saved | 79.178,20 | +30% | -79.178,20 | -30% |
| #4 | AP51 | Discount Rate | 54.507,63 | -30% | -37.194,61 | +30% |
| #5 | AP33 | Operating cost | 253,53 | +30% | -253,53 | -30% |

The detailed results are following:

| Variable | % change | Net Present Value (NPV) (in .000 €) | Internal Rate of Return (IRR) | Benefit Cost Ratio (B/C) |
|---|---|---|---|---|
| Operating cost | -30% | -253,53 | 4,99% | 1,00 |
| | -25% | -211,28 | 4,99% | 1,00 |
| | -20% | -169,02 | 4,99% | 1,00 |
| | -15% | -126,77 | 5,00% | 1,00 |
| | -10% | -84,51 | 5,00% | 1,00 |

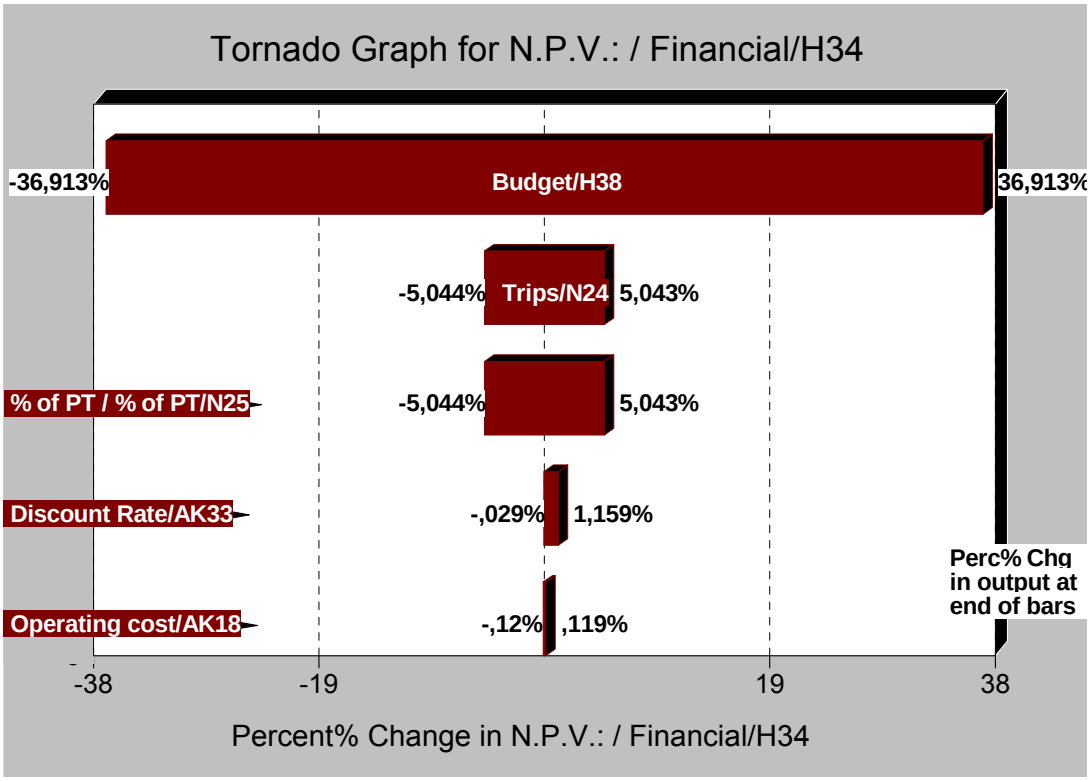
| Variable | % change | Net Present Value (NPV) (in .000 €) | Internal Rate of Return (IRR) | Benefit Cost Ratio (B/C) |
|---|---|---|---|---|
| | -5% | -42,26 | 5,00% | 1,00 |
| | 5% | 42,26 | 5,00% | 1,00 |
| | 10% | 84,51 | 5,00% | 1,00 |
| | 15% | 126,77 | 5,00% | 1,00 |
| | 20% | 169,02 | 5,01% | 1,00 |
| | 25% | 211,28 | 5,01% | 1,00 |
| | 30% | 253,53 | 5,01% | 1,00 |
| Discount Rate | -30% | 54.507,63 | 5,00% | 1,17 |
| | -25% | 43.907,28 | 5,00% | 1,14 |
| | -20% | 33.967,29 | 5,00% | 1,11 |
| | -15% | 24.644,93 | 5,00% | 1,08 |
| | -10% | 15.900,49 | 5,00% | 1,05 |
| | -5% | 7.696,98 | 5,00% | 1,03 |
| | 5% | -7.222,50 | 5,00% | 0,98 |
| | 10% | -14.000,38 | 5,00% | 0,95 |
| | 15% | -20.361,46 | 5,00% | 0,93 |
| | 20% | -26.331,67 | 5,00% | 0,91 |
| | 25% | -31.935,20 | 5,00% | 0,89 |
| | 30% | -37.194,61 | 5,00% | 0,86 |
| Budget | -30% | 83.155,57 | 8,73% | 1,41 |
| | -25% | 69.296,30 | 7,94% | 1,32 |
| | -20% | 55.437,05 | 7,23% | 1,24 |
| | -15% | 41.577,79 | 6,59% | 1,17 |
| | -10% | 27.718,52 | 6,01% | 1,10 |
| | -5% | 13.859,26 | 5,48% | 1,05 |
| | 5% | -13.859,26 | 4,55% | 0,96 |
| | 10% | -27.718,52 | 4,14% | 0,92 |
| | 15% | -41.577,79 | 3,76% | 0,88 |
| | 20% | -55.437,05 | 3,40% | 0,84 |
| | 25% | -69.296,30 | 3,07% | 0,81 |
| | 30% | -83.155,57 | 2,75% | 0,79 |
| Trips | -30% | -79.178,20 | 2,19% | 0,73 |
| | -25% | -65.981,83 | 2,68% | 0,78 |
| | -20% | -52.785,46 | 3,16% | 0,82 |
| | -15% | -39.589,10 | 3,64% | 0,87 |
| | -10% | -26.392,73 | 4,10% | 0,91 |
| | -5% | -13.196,37 | 4,55% | 0,96 |
| | 5% | 13.196,37 | 5,44% | 1,04 |
| | 10% | 26.392,73 | 5,87% | 1,09 |
| | 15% | 39.589,10 | 6,30% | 1,13 |
| | 20% | 52.785,46 | 6,71% | 1,18 |
| | 25% | 65.981,83 | 7,13% | 1,22 |
| | 30% | 79.178,20 | 7,53% | 1,27 |
| Time saved | -30% | -79.178,20 | 2,19% | 0,73 |
| | -25% | -65.981,83 | 2,68% | 0,78 |
| | -20% | -52.785,46 | 3,16% | 0,82 |
| | -15% | -39.589,10 | 3,64% | 0,87 |
| | -10% | -26.392,73 | 4,10% | 0,91 |
| | -5% | -13.196,37 | 4,55% | 0,96 |

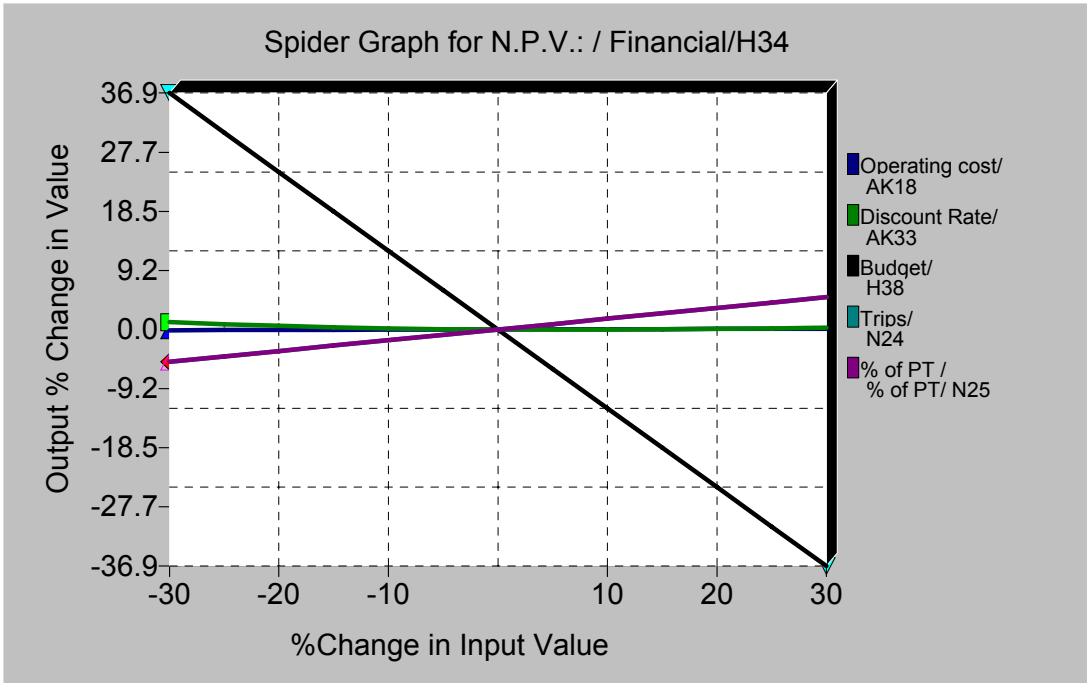
| Variable | % change | Net Present Value (NPV) (in .000 €) | Internal Rate of Return (IRR) | Benefit Cost Ratio (B/C) |
|---|---|---|---|---|
| | 5% | 13.196,37 | 5,44% | 1,04 |
| | 10% | 26.392,73 | 5,87% | 1,09 |
| | 15% | 39.589,10 | 6,30% | 1,13 |
| | 20% | 52.785,46 | 6,71% | 1,18 |
| | 25% | 65.981,83 | 7,13% | 1,22 |
| | 30% | 79.178,20 | 7,53% | 1,27 |

## 5.3 Sensitivity Analysis Diagrams

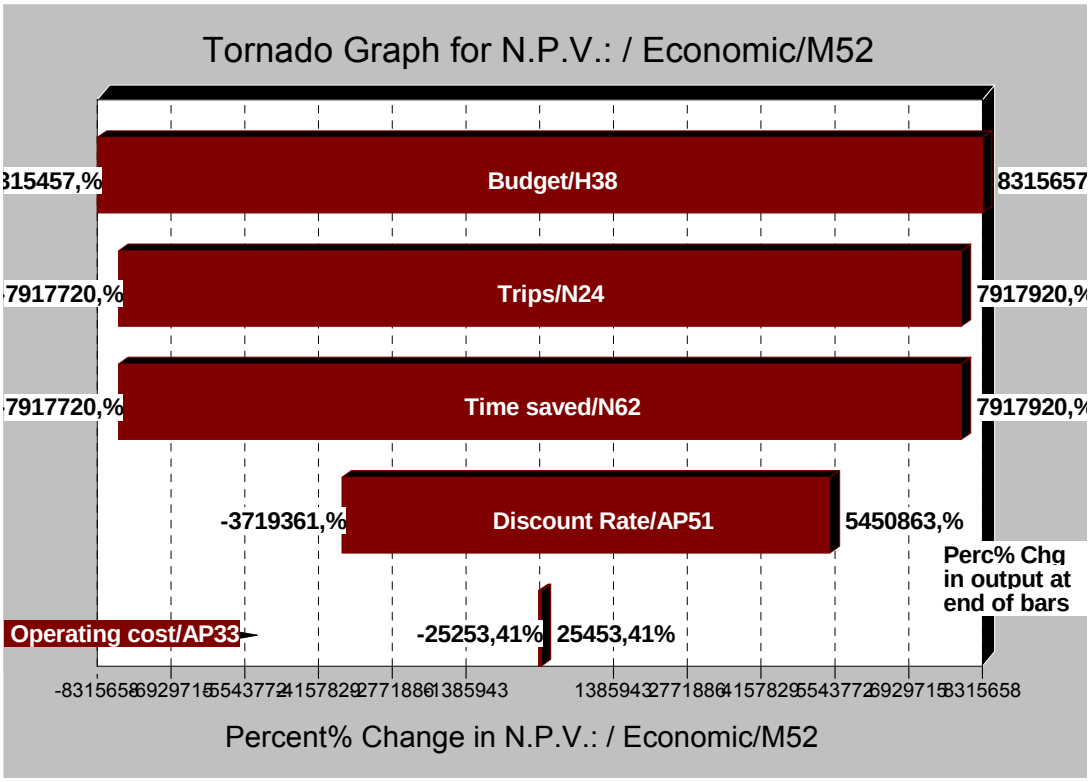
For the financial and economic analysis the following diagrams are presented, which demonstrate the influence of variables on project's Net Present Value. It is thus presented graphically the relative sensitivity of variables and their importance on the project's results.

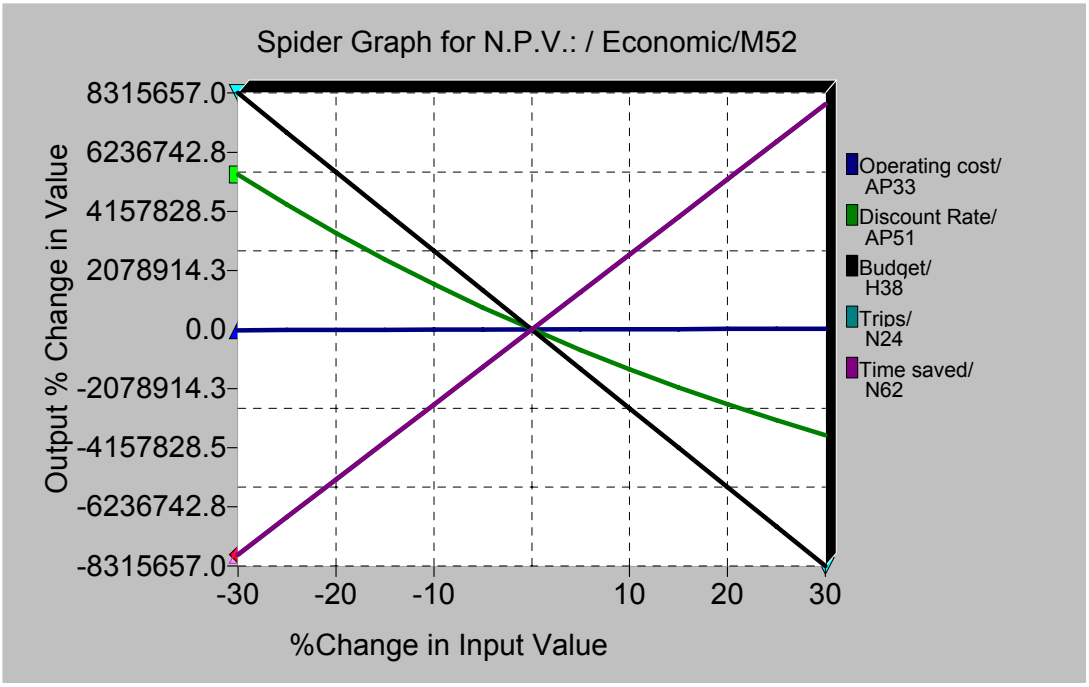
### *5.3.1 Financial Analysis*






## *5.3.2 Economic Analysis*

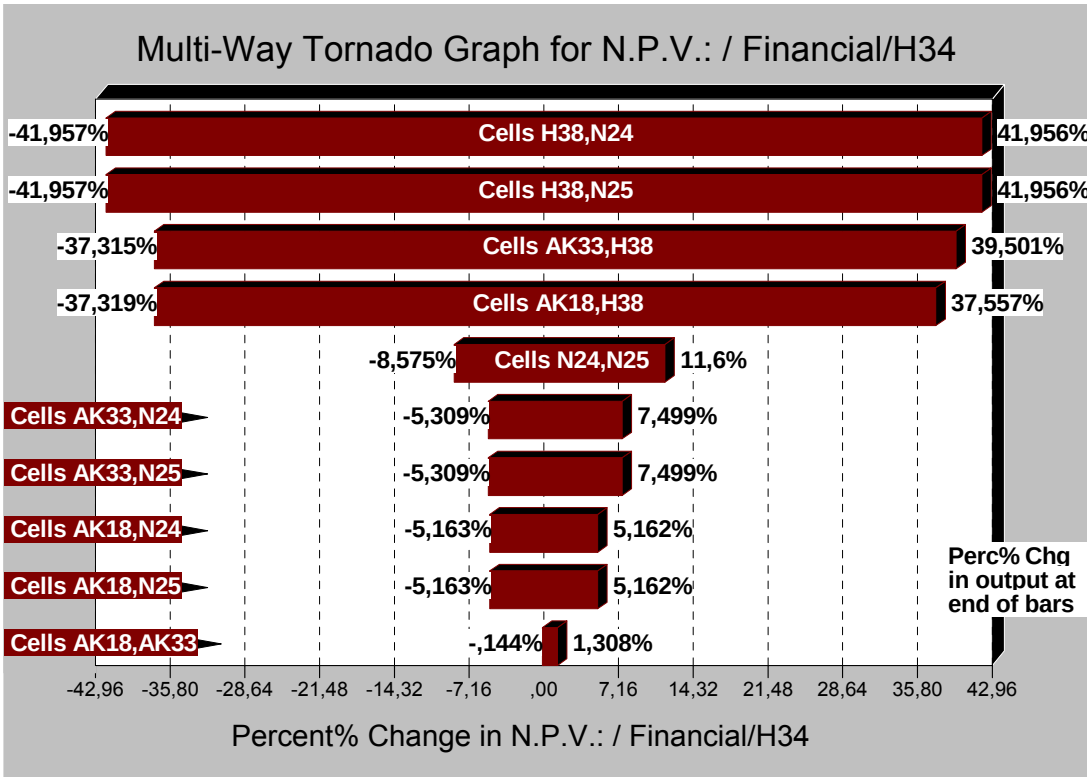





## 5.4 Multi-way Sensitivity Analysis

*Financial Analysis*: The results of the multi-way sensitivity analysis are presented in the following tables showing the first 4 ranks (most significant inputs) and graphs.

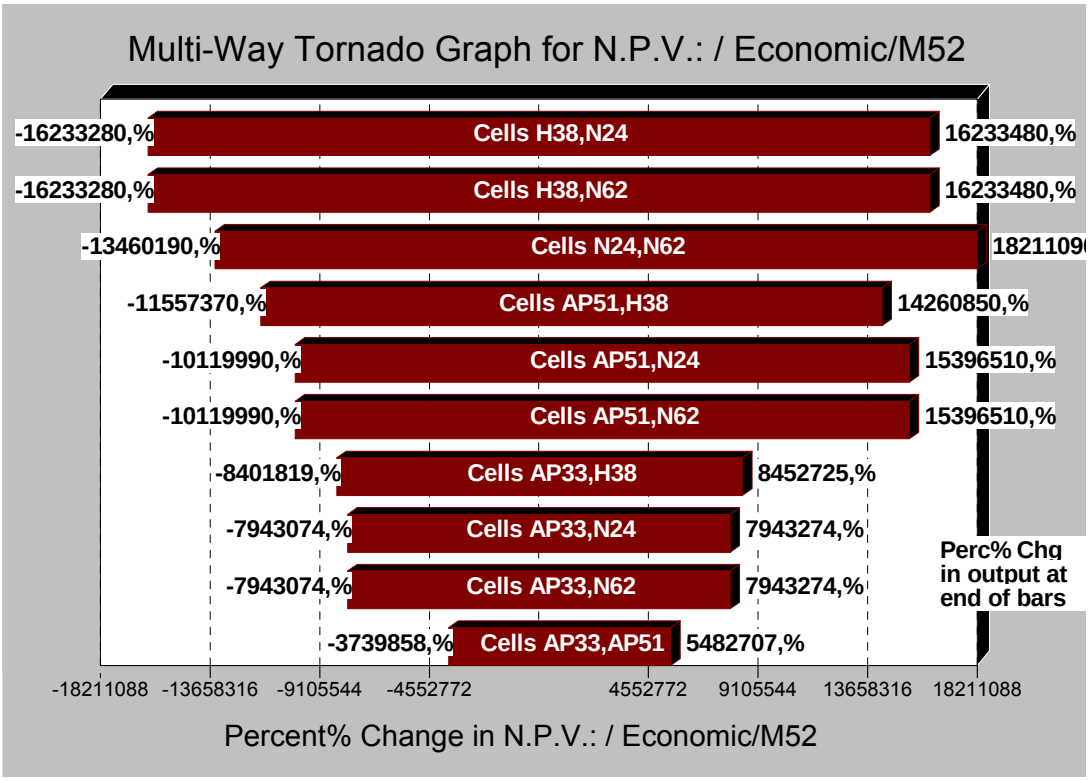
| Rank | Inputs Used in this Combination (Group Size=2) | Output Max (in .000 €) | Output Min (in .000 €) | Output % change |
|---|---|---|---|---|
| #1 | Budget (-30%), Trips (+30%) | -161.456,70 | | 41,96% |
| | Budget (+30%), Trips (-30%) | | -394.873,30 | -41,96% |
| #2 | Budget (-30%), % of PT share (+30%) | -161.456,70 | | 41,96% |
| | Budget (+30%), % of PT share (-30%) | | -394.873,30 | -41,96% |
| #3 | Discount Rate (-30%), Budget (-30%) | -168.285,80 | | 39,50% |
| | Discount Rate (-20%), Budget (+30%) | | -381.961,50 | -37,31% |
| #4 | Operating cost (+30%), Budget (-30%) | -173.694,30 | | 37,56% |
| | Operating cost (+30%), Budget (+30%) | | -381.972,80 | -37,32% |




where:

| Cell | Input value |
|---|---|
| AK18 | Operating cost |
| AK33 | Discount Rate |
| H38 | Budget |
| N24 | Trips |
| N25 | % of Public Transportation share |

*Economic Analysis*: The results of the multi-way sensitivity analysis are presented in the following graph.




where:

| Cell | Input value |
|---|---|
| H38 | Budget |
| N24 | Trips |
| N62 | Time saved |
| AP51 | Discount Rate |
| AP33 | Operating cost |

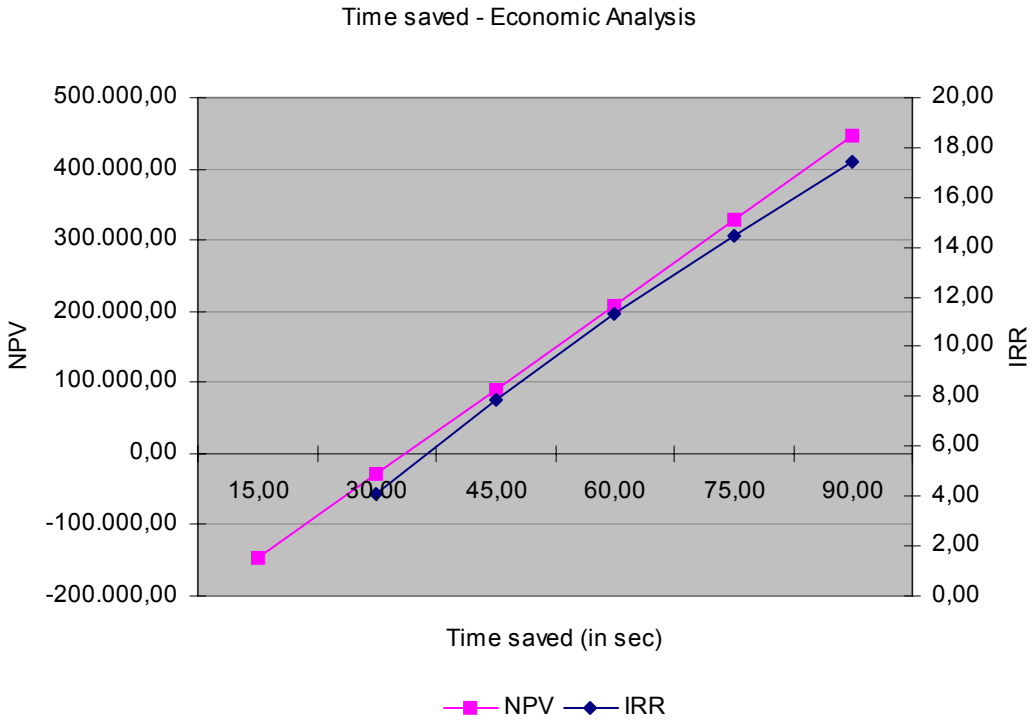
## 5.5 Sensitivity Analysis Comments

As it is expected, any increase of variables that improve the inflows or any decrease of variables which decrease the outflows improve the results. For the financial analysis, the greater risk is from the budget of the project and then from the inflows side (either from trips or share of public transportation). From the society's point of view, that is the economic analysis, the greater risk is from the budget of the project and then from the inflows side (either from trips or time saved).

## 5.6 Economic Analysis – Time savings

Additional sensitivity analysis was performed for the economic analysis examining the time savings per tip parameter only. The results are presented in the following table and graph.

| Time saved (in sec) | NPV (in .000 €) | IRR | BC |
|---|---|---|---|
| 15,00 | -145.689,62 | | 0,51 |
| 30,00 | -27.451,92 | 4,06 | 0,91 |
| 45,00 | 90.785,78 | 7,89 | 1,31 |
| 60,00 | 209.023,48 | 11,31 | 1,71 |
| 75,00 | 327.261,18 | 14,47 | 2,11 |
| 90,00 | 445.498,89 | 17,46 | 2,51 |




## 6. General Conclusion – Critical Point

The most important issue of this study is the high degree of uncertainty concerning commuters' time savings and public transportation share. The results of the project depend on the conditions that can be realized at the time of its implementation.

In order to be able to judge more reliably the economic feasibility of a tram, a comprehensive Feasibility Study should be carried out. Such a Study should rely on a well-established Traffic Forecast Model that predicts travel times for users of the private car, the Public Transport System (with and without the availability of a tram) with an acceptable level of reliability.

## Table 1 Incremental Financial Cash Flow (1 of 4)

| Period: | | Construction | | Operation ⇨ ⇨ ⇨ ⇨ | | | |
|---|---|---|---|---|---|---|---|
| (in .000 €) Year: | Value | 1 | 2 | 3 | 4 | 5 | 6 |
| ***INFLOWS*** | | ***0,00*** | ***0,00*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** |
| Tickets | | 0,00 | 0,00 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 |
| Other infows | | 0,00 | 0,00 | 150,75 | 150,75 | 150,75 | 150,75 |
| Residual value | | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| ***OUTFLOWS*** | ***334.730,28*** | ***167.365,14*** | ***167.365,14*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***-92,60*** |
| Construction cost (without VAT) | 334.730,28 | 167.365,14 | 167.365,14 | 0,00 | | | |
| Designs and studies | 0,00 | 0,00 | 0,00 | | | | |
| Relocation of public utility networks / | 20.281,12 | 10.140,56 | 10.140,56 | | | | |
| Civil engineer works | 155.539,41 | 77.769,71 | 77.769,71 | | | | |
| Electromechanical works | 90.731,32 | 45.365,66 | 45.365,66 | | | | |
| Tram-wagons | 45.000,00 | 22.500,00 | 22.500,00 | | | | |
| Project management | 23.178,42 | 11.589,21 | 11.589,21 | | | | |
| Operating cost | | 0,00 | 0,00 | -92,60 | -92,60 | -92,60 | -92,60 |
| Bus | | 0,00 | 0,00 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 |
| Tram | | | | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 |
| Maintenance cost | | | | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 |
| Personnel cost | | | | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 |
| Energy | | | | 831,54 | 831,54 | 831,54 | 831,54 |
| Water supply | | | | 79,96 | 79,96 | 79,96 | 79,96 |
| Cleaning cost | | | | 175,00 | 175,00 | 175,00 | 175,00 |
| Insurance cost | | | | 145,64 | 145,64 | 145,64 | 145,64 |
| Other administrative cost | | | | 554,45 | 554,45 | 554,45 | 554,45 |
| Replacement cost | | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| ***Cash Flow*** | | ***-167.365,14*** | ***-167.365,14*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** |
| ***Cumulative Cash Flow*** | | ***-167.365,14*** | ***-334.730,28*** | ***-330.718,19*** | ***-326.706,11*** | ***-322.694,03*** | ***-318.681,94*** |

| | |
|---|---|
| Discount Rate: | 6,00% |
| N.P.V.: | -278.165,00 |
| I.R.R.: | #DIV/0! |
| B/C: | 0,18 |

## Table 1 Incremental Financial Cash Flow (2 of 4)

| Period: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (in .000 €) Year: | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| ***INFLOWS*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** |
| Tickets | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 |
| Other infows | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 |
| Residual value | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| ***OUTFLOWS*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***22.590,23*** | ***-92,60*** | ***-92,60*** |
| Construction cost (without VAT) | | | | | | | | |
| Designs and studies | | | | | | | | |
| Relocation of public utility networks / | | | | | | | | |
| Civil engineer works | | | | | | | | |
| Electromechanical works | | | | | | | | |
| Tram-wagons | | | | | | | | |
| Project management | | | | | | | | |
| Operating cost | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 |
| Bus | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 |
| Tram | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 |
| Maintenance cost | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 |
| Personnel cost | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 |
| Energy | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 |
| Water supply | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 |
| Cleaning cost | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 |
| Insurance cost | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 |
| Other administrative cost | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 |
| Replacement cost | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 22.682,83 | 0,00 | 0,00 |
| ***Cash Flow*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***-18.670,75*** | ***4.012,08*** | ***4.012,08*** |
| ***Cumulative Cash Flow*** | ***-314.669,86*** | ***-310.657,78*** | ***-306.645,69*** | ***-302.633,61*** | ***-298.621,53*** | ***-317.292,27*** | ***-313.280,19*** | ***-309.268,11*** |

## Table 1 Incremental Financial Cash Flow (3 of 4)

| Period: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (in .000 €) Year: | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| ***INFLOWS*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** |
| Tickets | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 |
| Other infows | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 |
| Residual value | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| ***OUTFLOWS*** | ***8.907,40*** | ***-92,60*** | ***31.015,28*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***22.590,23*** |
| Construction cost (without VAT) | | | | | | | | |
| Designs and studies | | | | | | | | |
| Relocation of public utility networks / | | | | | | | | |
| Civil engineer works | | | | | | | | |
| Electromechanical works | | | | | | | | |
| Tram-wagons | | | | | | | | |
| Project management | | | | | | | | |
| Operating cost | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 |
| Bus | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 |
| Tram | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 |
| Maintenance cost | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 |
| Personnel cost | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 |
| Energy | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 |
| Water supply | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 |
| Cleaning cost | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 |
| Insurance cost | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 |
| Other administrative cost | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 |
| Replacement cost | 9.000,00 | 0,00 | 31.107,88 | 0,00 | 0,00 | 0,00 | 0,00 | 22.682,83 |
| ***Cash Flow*** | ***-4.987,92*** | ***4.012,08*** | ***-27.095,80*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***-18.670,75*** |
| ***Cumulative Cash Flow*** | ***-314.256,02*** | ***-310.243,94*** | ***-337.339,74*** | ***-333.327,66*** | ***-329.315,57*** | ***-325.303,49*** | ***-321.291,41*** | ***-339.962,15*** |

## Table 1 Incremental Financial Cash Flow (4 of 4)

| Period: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (in .000 €) Year: | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| ***INFLOWS*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***3.919,48*** | ***92.637,95*** |
| Tickets | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 | 3.768,74 |
| Other infows | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 | 150,75 |
| Residual value | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 88.718,46 |
| ***OUTFLOWS*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***-92,60*** | ***8.907,40*** | ***-92,60*** | ***-92,60*** |
| Construction cost (without VAT) | | | | | | | | |
| Designs and studies | | | | | | | | |
| Relocation of public utility networks / | | | | | | | | |
| Civil engineer works | | | | | | | | |
| Electromechanical works | | | | | | | | |
| Tram-wagons | | | | | | | | |
| Project management | | | | | | | | |
| Operating cost | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 |
| Bus | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 | -6.337,20 |
| Tram | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 |
| Maintenance cost | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 |
| Personnel cost | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 |
| Energy | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 |
| Water supply | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 |
| Cleaning cost | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 |
| Insurance cost | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 |
| Other administrative cost | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 |
| Replacement cost | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 9.000,00 | 0,00 | 0,00 |
| ***Cash Flow*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***4.012,08*** | ***-4.987,92*** | ***4.012,08*** | ***92.730,54*** |
| ***Cumulative Cash Flow*** | ***-335.950,07*** | ***-331.937,99*** | ***-327.925,90*** | ***-323.913,82*** | ***-319.901,74*** | ***-324.889,65*** | ***-320.877,57*** | ***-228.147,02*** |

## Table 2 Financial Cash Flow Without Project (1 of 4)

| (in .000 €) Year: | Value | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| ***INFLOWS*** | | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** |
| Tickets | | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 |
| Other infows | | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 |
| Residual value | | | | | | | | | |
| ***OUTFLOWS*** | ***0,00*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** |
| Construction cost (without VAT) | 0,00 | 0,00 | 0,00 | 0,00 | | | | | |
| Designs and studies | 0,00 | | | | | | | | |
| Relocation of public utility networks / | 0,00 | | | | | | | | |
| Civil engineer works | 0,00 | | | | | | | | |
| Electromechanical works | 0,00 | | | | | | | | |
| Tram-wagons | 0,00 | | | | | | | | |
| Project management | 0,00 | | | | | | | | |
| Operating cost | | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Bus | | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Replacement cost | | | | | | | | | |
| ***Cash Flow*** | | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** |
| ***Cumulative Cash Flow*** | | ***-6.427,02*** | ***-12.854,04*** | ***-19.281,05*** | ***-25.708,07*** | ***-32.135,09*** | ***-38.562,11*** | ***-44.989,13*** | ***-51.416,15*** |

## Table 2 Financial Cash Flow Without Project (2 of 4)

| (in .000 €) Year: | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|
| ***INFLOWS*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** |
| Tickets | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 |
| Other infows | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 |
| Residual value | | | | | | | | |
| ***OUTFLOWS*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** |
| Construction cost (without VAT) | | | | | | | | |
| Designs and studies | | | | | | | | |
| Relocation of public utility networks / | | | | | | | | |
| Civil engineer works | | | | | | | | |
| Electromechanical works | | | | | | | | |
| Tram-wagons | | | | | | | | |
| Project management | | | | | | | | |
| Operating cost | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Bus | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Replacement cost | | | | | | | | |
| ***Cash Flow*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** |
| ***Cumulative Cash Flow*** | ***-57.843,16*** | ***-64.270,18*** | ***-70.697,20*** | ***-77.124,22*** | ***-83.551,24*** | ***-89.978,26*** | ***-96.405,27*** | ***-102.832,29*** |

## Table 2 Financial Cash Flow Without Project (3 of 4)

| (in .000 €) Year: | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|
| ***INFLOWS*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** |
| Tickets | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 |
| Other infows | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 |
| Residual value | | | | | | | | |
| ***OUTFLOWS*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** |
| Construction cost (without VAT) | | | | | | | | |
| Designs and studies | | | | | | | | |
| Relocation of public utility networks / | | | | | | | | |
| Civil engineer works | | | | | | | | |
| Electromechanical works | | | | | | | | |
| Tram-wagons | | | | | | | | |
| Project management | | | | | | | | |
| Operating cost | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Bus | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Replacement cost | | | | | | | | |
| ***Cash Flow*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** |
| ***Cumulative Cash Flow*** | ***-109.259,31*** | ***-115.686,33*** | ***-122.113,35*** | ***-128.540,37*** | ***-134.967,38*** | ***-141.394,40*** | ***-147.821,42*** | ***-154.248,44*** |

## Table 2 Financial Cash Flow Without Project (4 of 4)

| (in .000 €) Year: | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|
| ***INFLOWS*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** | ***25.029,29*** |
| Tickets | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 | 24.066,63 |
| Other infows | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 | 962,67 |
| Residual value | | | | | | |
| ***OUTFLOWS*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** | ***31.456,31*** |
| Construction cost (without VAT) | | | | | | |
| Designs and studies | | | | | | |
| Relocation of public utility networks / | | | | | | |
| Civil engineer works | | | | | | |
| Electromechanical works | | | | | | |
| Tram-wagons | | | | | | |
| Project management | | | | | | |
| Operating cost | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Bus | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Replacement cost | | | | | | |
| ***Cash Flow*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** | ***-6.427,02*** |
| ***Cumulative Cash Flow*** | ***-160.675,46*** | ***-167.102,48*** | ***-173.529,49*** | ***-179.956,51*** | ***-186.383,53*** | ***-192.810,55*** |

## Table 3 Financial Cash Flow With Project (1 of 4)

| Period: | | Construction | | Operation ⇨ ⇨ ⇨ ⇨ | | | |
|---|---|---|---|---|---|---|---|
| (in .000 €) Year: | Value | 1 | 2 | 3 | 4 | 5 | 6 |
| ***INFLOWS*** | | ***25.029,29*** | ***25.029,29*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** |
| Tickets | | 24.066,63 | 24.066,63 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 |
| Other infows | | 962,67 | 962,67 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 |
| Residual value | | | | | | | |
| ***OUTFLOWS*** | ***334.730,28*** | ***198.821,45*** | ***198.821,45*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** |
| Construction cost (without VAT) | 334.730,28 | 167.365,14 | 167.365,14 | 0,00 | | | |
| Designs and studies | 0,00 | 0,00 | 0,00 | | | | |
| Relocation of public utility networks / | 20.281,12 | 10.140,56 | 10.140,56 | | | | |
| Civil engineer works | 155.539,41 | 77.769,71 | 77.769,71 | | | | |
| Electromechanical works | 90.731,32 | 45.365,66 | 45.365,66 | | | | |
| Tram-wagons | 45.000,00 | 22.500,00 | 22.500,00 | | | | |
| Project management | 23.178,42 | 11.589,21 | 11.589,21 | | | | |
| Operating cost | | 31.456,31 | 31.456,31 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 |
| Bus | | 31.456,31 | 31.456,31 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 |
| Tram | | | | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 |
| Maintenance cost | | | | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 |
| Personnel cost | | | | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 |
| Energy | | | | 831,54 | 831,54 | 831,54 | 831,54 |
| Water supply | | | | 79,96 | 79,96 | 79,96 | 79,96 |
| Cleaning cost | | | | 175,00 | 175,00 | 175,00 | 175,00 |
| Insurance cost | | | | 145,64 | 145,64 | 145,64 | 145,64 |
| Other administrative cost | | | | 554,45 | 554,45 | 554,45 | 554,45 |
| Replacement cost | | | | | | | |
| ***Cash Flow*** | | ***-173.792,16*** | ***-173.792,16*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** |
| ***Cumulative Cash Flow*** | | ***-173.792,16*** | ***-347.584,31*** | ***-349.999,25*** | ***-352.414,18*** | ***-354.829,12*** | ***-357.244,05*** |

## Table 3 Financial Cash Flow With Project (2 of 4)

| Period: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (in .000 €) Year: | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| ***INFLOWS*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** |
| Tickets | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 |
| Other infows | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 |
| Residual value | | | | | | | | |
| ***OUTFLOWS*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***54.046,55*** | ***31.363,71*** | ***31.363,71*** |
| Construction cost (without VAT) | | | | | | | | |
| Designs and studies | | | | | | | | |
| Relocation of public utility networks / | | | | | | | | |
| Civil engineer works | | | | | | | | |
| Electromechanical works | | | | | | | | |
| Tram-wagons | | | | | | | | |
| Project management | | | | | | | | |
| Operating cost | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 |
| Bus | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 |
| Tram | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 |
| Maintenance cost | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 |
| Personnel cost | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 |
| Energy | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 |
| Water supply | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 |
| Cleaning cost | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 |
| Insurance cost | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 |
| Other administrative cost | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 |
| Replacement cost | | | | | | 22.682,83 | | |
| ***Cash Flow*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-25.097,77*** | ***-2.414,93*** | ***-2.414,93*** |
| ***Cumulative Cash Flow*** | ***-359.658,99*** | ***-362.073,92*** | ***-364.488,86*** | ***-366.903,79*** | ***-369.318,73*** | ***-394.416,49*** | ***-396.831,43*** | ***-399.246,36*** |

## Table 3 Financial Cash Flow With Project (3 of 4)

| Period: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (in .000 €) Year: | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| ***INFLOWS*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** |
| Tickets | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 |
| Other infows | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 |
| Residual value | | | | | | | | |
| ***OUTFLOWS*** | ***40.363,71*** | ***31.363,71*** | ***62.471,60*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***54.046,55*** |
| Construction cost (without VAT) | | | | | | | | |
| Designs and studies | | | | | | | | |
| Relocation of public utility networks / | | | | | | | | |
| Civil engineer works | | | | | | | | |
| Electromechanical works | | | | | | | | |
| Tram-wagons | | | | | | | | |
| Project management | | | | | | | | |
| Operating cost | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 |
| Bus | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 |
| Tram | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 |
| Maintenance cost | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 |
| Personnel cost | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 |
| Energy | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 |
| Water supply | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 |
| Cleaning cost | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 |
| Insurance cost | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 |
| Other administrative cost | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 |
| Replacement cost | 9.000,00 | | 31.107,88 | | | | | 22.682,83 |
| ***Cash Flow*** | ***-11.414,93*** | ***-2.414,93*** | ***-33.522,82*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-25.097,77*** |
| ***Cumulative Cash Flow*** | ***-410.661,30*** | ***-413.076,23*** | ***-446.599,05*** | ***-449.013,99*** | ***-451.428,92*** | ***-453.843,85*** | ***-456.258,79*** | ***-481.356,56*** |

## Table 3 Financial Cash Flow With Project (4 of 4)

| Period: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (in .000 €) Year: | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| ***INFLOWS*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***28.948,78*** | ***117.667,24*** |
| Tickets | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 | 27.835,36 |
| Other infows | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 | 1.113,41 |
| Residual value | | | | | | | | 88.718,46 |
| ***OUTFLOWS*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***31.363,71*** | ***40.363,71*** | ***31.363,71*** | ***31.363,71*** |
| Construction cost (without VAT) | | | | | | | | |
| Designs and studies | | | | | | | | |
| Relocation of public utility networks / | | | | | | | | |
| Civil engineer works | | | | | | | | |
| Electromechanical works | | | | | | | | |
| Tram-wagons | | | | | | | | |
| Project management | | | | | | | | |
| Operating cost | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 |
| Bus | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 | 25.119,11 |
| Tram | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 | 6.244,61 |
| Maintenance cost | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 | 1.104,03 |
| Personnel cost | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 | 3.354,00 |
| Energy | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 | 831,54 |
| Water supply | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 | 79,96 |
| Cleaning cost | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 | 175,00 |
| Insurance cost | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 | 145,64 |
| Other administrative cost | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 | 554,45 |
| Replacement cost | | | | | | 9.000,00 | | |
| ***Cash Flow*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-2.414,93*** | ***-11.414,93*** | ***-2.414,93*** | ***86.303,53*** |
| ***Cumulative Cash Flow*** | ***-483.771,49*** | ***-486.186,43*** | ***-488.601,36*** | ***-491.016,29*** | ***-493.431,23*** | ***-504.846,16*** | ***-507.261,10*** | ***-420.957,57*** |

## Table 4 Incremental Economic Cash Flow (1 of 3)

| Period: | | Construction | | Operation ⇨ ⇨ ⇨ ⇨ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (in .000 C\ Year: | Value | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ***INFLOWS (1+2)*** | | ***5.879,97*** | ***8.662,85*** | ***43.785,55*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** |
| 1. Direct benefits | | 0,00 | 0,00 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 |
| Tickets and other inflows | | 0,00 | 0,00 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 |
| Residual value | | | | | | | | | | |
| 2. Indirect benefits | | 5.879,97 | 8.662,85 | 39.866,07 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 |
| Accident savings | | | | | | | | | | |
| Benefits from vehicle and passenger cost | | | | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 |
| Employment during construction | | 5.879,97 | 5.879,97 | 0,00 | | | | | | |
| Income taxes of producers of local materials during construction | | 0,00 | 896,18 | 896,18 | 0,00 | | | | | |
| Employment during operation | | 0,00 | 0,00 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 |
| Income taxes of producers of local materials during operation | | 0,00 | 0,00 | 0,00 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 |
| Income taxes of contractors, designers | | 0,00 | 1.886,69 | 1.886,69 | 0,00 | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | | ***155.547,07*** | ***155.547,07*** | ***-81,84*** | ***-81,84*** | ***-81,84*** | ***-81,84*** | ***-81,84*** | ***-81,84*** | ***-81,84*** |
| Project cost (without V.A.T.) | 314.449,16 | 157.224,58 | 157.224,58 | | | | | | | |
| Expropriations | 20.281,12 | 10.140,56 | 10.140,56 | | | | | | | |
| Equipment | | 51.884,11 | 51.884,11 | | | | | | | |
| Equipment materials | | 41.507,29 | 41.507,29 | | | | | | | |
| Skilled labour | | 10.376,82 | 10.376,82 | | | | | | | |
| Unskilled labour | | 26.728,18 | 26.728,18 | | | | | | | |
| Skilled labour | | 18.866,95 | 18.866,95 | | | | | | | |
| Materials | | 59.745,34 | 59.745,34 | | | | | | | |
| 1. Indirect project cost | 290.813,03 | 145.406,51 | 145.406,51 | | | | | | | |
| Local materials | | 47.796,27 | 47.796,27 | | | | | | | |
| Unskilled labour | | 20.758,87 | 20.758,87 | | | | | | | |
| Cost of exchange | | 53.456,36 | 53.456,36 | | | | | | | |
| Other sources | | 23.395,02 | 23.395,02 | | | | | | | |
| 2. Expropriations | 20.281,12 | 10.140,56 | 10.140,56 | | | | | | | |
| Operating cost | | 0,00 | 0,00 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 |
| Equipment | | | | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 |
| Equipment materials | | | | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 |
| Skilled labour | | | | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 |
| Unskilled labour | | | | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 |
| Skilled labour | | | | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 |
| Materials | | | | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 |
| 3. Indirect operating cost | | | | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 |
| Local materials | | | | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 |
| Unskilled labour | | | | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 |
| Cost of exchange | | | | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 |
| Other sources | | | | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 |
| 4. Indirect replacement cost | | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 5. Traffic disruption disbenefits | | | | | | | | | | |
| ***Cash Flow*** | | ***-149.667,10*** | ***-146.884,23*** | ***43.867,39*** | ***41.084,10*** | ***41.084,10*** | ***41.084,10*** | ***41.084,10*** | ***41.084,10*** | ***41.084,10*** |
| ***Cumulative cash flow*** | | ***-149.667,10*** | ***-296.551,33*** | ***-252.683,93*** | ***-211.599,83*** | ***-170.515,73*** | ***-129.431,63*** | ***-88.347,53*** | ***-47.263,42*** | ***-6.179,32*** |

| | |
|---|---|
| Discount Rate: | 5,00% |
| N.P.V.: | 238.784,48 |
| I.R.R.: | 12,12% |
| B/C: | 1,81 |

## Table 4 Incremental Economic Cash Flow (2 of 3)

| Period: | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (in .000 C\ Year: | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| ***INFLOWS (1+2)*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** |
| 1. Direct benefits | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 |
| Tickets and other inflows | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 |
| Residual value | | | | | | | | | | |
| 2. Indirect benefits | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 |
| Accident savings | | | | | | | | | | |
| Benefits from vehicle and passenger cost | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 |
| Employment during construction | | | | | | | | | | |
| Income taxes of producers of local materials during construction | | | | | | | | | | |
| Employment during operation | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 |
| Income taxes of producers of local materials during operation | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 |
| Income taxes of contractors, designers | | | | | | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | ***-81,84*** | ***-81,84*** | ***20.895,99*** | ***-81,84*** | ***-81,84*** | ***8.241,66*** | ***-81,84*** | ***28.687,76*** | ***-81,84*** | ***-81,84*** |
| Project cost (without V.A.T.) | | | | | | | | | | |
| Expropriations | | | | | | | | | | |
| Equipment | | | | | | | | | | |
| Equipment materials | | | | | | | | | | |
| Skilled labour | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | |
| Skilled labour | | | | | | | | | | |
| Materials | | | | | | | | | | |
| 1. Indirect project cost | | | | | | | | | | |
| Local materials | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | |
| Cost of exchange | | | | | | | | | | |
| Other sources | | | | | | | | | | |
| 2. Expropriations | | | | | | | | | | |
| Operating cost | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 |
| Equipment | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 |
| Equipment materials | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 |
| Skilled labour | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 |
| Unskilled labour | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 |
| Skilled labour | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 |
| Materials | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 |
| 3. Indirect operating cost | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 |
| Local materials | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 |
| Unskilled labour | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 |
| Cost of exchange | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 |
| Other sources | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 |
| 4. Indirect replacement cost | 0,00 | 0,00 | 20.977,84 | 0,00 | 0,00 | 8.323,50 | 0,00 | 28.769,60 | 0,00 | 0,00 |
| 5. Traffic disruption disbenefits | | | | | | | | | | |
| ***Cash Flow*** | ***41.084,10*** | ***41.084,10*** | ***20.106,27*** | ***41.084,10*** | ***41.084,10*** | ***32.760,60*** | ***41.084,10*** | ***12.314,50*** | ***41.084,10*** | ***41.084,10*** |
| ***Cumulative cash flow*** | ***34.904,78*** | ***75.988,88*** | ***96.095,15*** | ***137.179,25*** | ***178.263,35*** | ***211.023,96*** | ***252.108,06*** | ***264.422,56*** | ***305.506,66*** | ***346.590,76*** |

## Table 4 Incremental Economic Cash Flow (3 of 3)

| Period: | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (in .000 C\ Year: | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| ***INFLOWS (1+2)*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***41.002,26*** | ***123.052,04*** |
| 1. Direct benefits | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 85.969,26 |
| Tickets and other inflows | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 | 3.919,48 |
| Residual value | | | | | | | | | | | 82.049,78 |
| 2. Indirect benefits | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 | 37.082,78 |
| Accident savings | | | | | | | | | | | |
| Benefits from vehicle and passenger cost | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 |
| Employment during construction | | | | | | | | | | | |
| Income taxes of producers of local materials during construction | | | | | | | | | | | |
| Employment during operation | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 | -12,50 |
| Income taxes of producers of local materials during operation | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 | -0,42 |
| Income taxes of contractors, designers | | | | | | | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | ***-81,84*** | ***-81,84*** | ***20.895,99*** | ***-81,84*** | ***-81,84*** | ***-81,84*** | ***-81,84*** | ***-81,84*** | ***8.241,66*** | ***-81,84*** | ***-81,84*** |
| Project cost (without V.A.T.) | | | | | | | | | | | |
| Expropriations | | | | | | | | | | | |
| Equipment | | | | | | | | | | | |
| Equipment materials | | | | | | | | | | | |
| Skilled labour | | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | | |
| Skilled labour | | | | | | | | | | | |
| Materials | | | | | | | | | | | |
| 1. Indirect project cost | | | | | | | | | | | |
| Local materials | | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | | |
| Cost of exchange | | | | | | | | | | | |
| Other sources | | | | | | | | | | | |
| 2. Expropriations | | | | | | | | | | | |
| Operating cost | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 | -92,60 |
| Equipment | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 | -18,52 |
| Equipment materials | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 | -14,82 |
| Skilled labour | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 | -3,70 |
| Unskilled labour | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 | -32,41 |
| Skilled labour | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 | -13,89 |
| Materials | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 | -27,78 |
| 3. Indirect operating cost | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 | -81,84 |
| Local materials | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 | -22,22 |
| Unskilled labour | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 | -25,17 |
| Cost of exchange | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 | -20,37 |
| Other sources | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 | -14,08 |
| 4. Indirect replacement cost | 0,00 | 0,00 | 20.977,84 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 8.323,50 | 0,00 | 0,00 |
| 5. Traffic disruption disbenefits | | | | | | | | | | | |
| ***Cash Flow*** | ***41.084,10*** | ***41.084,10*** | ***20.106,27*** | ***41.084,10*** | ***41.084,10*** | ***41.084,10*** | ***41.084,10*** | ***41.084,10*** | ***32.760,60*** | ***41.084,10*** | ***123.133,88*** |
| ***Cumulative cash flow*** | ***387.674,87*** | ***428.758,97*** | ***448.865,23*** | ***489.949,34*** | ***531.033,44*** | ***572.117,54*** | ***613.201,64*** | ***654.285,75*** | ***687.046,35*** | ***728.130,45*** | ***851.264,33*** |

**Table 5 Economic Cash Flow Without Project (1 of 3)**

| Period: | | Construction | | Operation ⇨ ⇨ ⇨ ⇨ | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (in .000 C' Year: | Value | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| ***INFLOWS (1+2)*** | | ***29.275,90*** | ***29.275,90*** | ***29.275,90*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** |
| 1. Direct benefits | | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 |
| Tickets and other inflows | | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 |
| Residual value | | | | | | | | | | | |
| 2. Indirect benefits | | 4.246,60 | 4.246,60 | 4.246,60 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 |
| Accident savings | | | | | | | | | | | |
| Benefits from vehicle and passenger cost | | | | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Employment during construction | | 0,00 | 0,00 | 0,00 | | | | | | | |
| Income taxes of producers of local materials during c | | 0,00 | 0,00 | 0,00 | 0,00 | | | | | | |
| Employment during operation | | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 |
| Income taxes of producers of local materials during o | | 0,00 | 0,00 | 0,00 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 |
| Income taxes of contractors, designers | | 0,00 | 0,00 | 0,00 | 0,00 | | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | | ***0,00*** | ***0,00*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** |
| Project cost (without V.A.T.) | 0,00 | | | | | | | | | | |
| Expropriations | 0,00 | | | | | | | | | | |
| Equipment | | 0,00 | 0,00 | | | | | | | | |
| Equipment materials | | 0,00 | 0,00 | | | | | | | | |
| Skilled labour | | 0,00 | 0,00 | | | | | | | | |
| Unskilled labour | | 0,00 | 0,00 | | | | | | | | |
| Skilled labour | | 0,00 | 0,00 | | | | | | | | |
| Materials | | 0,00 | 0,00 | | | | | | | | |
| 1. Indirect project cost | 0,00 | 0,00 | 0,00 | | | | | | | | |
| Local materials | | 0,00 | 0,00 | | | | | | | | |
| Unskilled labour | | 0,00 | 0,00 | | | | | | | | |
| Cost of exchange | | 0,00 | 0,00 | | | | | | | | |
| Other sources | | 0,00 | 0,00 | | | | | | | | |
| 2. Expropriations | 0,00 | 0,00 | 0,00 | | | | | | | | |
| Operating cost | | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Equipment | | | | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 |
| Equipment materials | | | | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 |
| Skilled labour | | | | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 |
| Unskilled labour | | | | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 |
| Skilled labour | | | | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 |
| Materials | | | | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 |
| 3. Indirect operating cost | | | | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 |
| Local materials | | | | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 |
| Unskilled labour | | | | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 |
| Cost of exchange | | | | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 |
| Other sources | | | | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 |
| 4. Indirect replacement cost | | | | | | | | | | | |
| 5. Traffic disruption disbenefits | | | | | | | | | | | |
| ***Cash Flow*** | | ***29.275,90*** | ***29.275,90*** | ***1.473,77*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** |
| ***Cumulative cash flow*** | | ***29.275,90*** | ***58.551,79*** | ***60.025,56*** | ***61.640,88*** | ***63.256,20*** | ***64.871,52*** | ***66.486,84*** | ***68.102,16*** | ***69.717,48*** | ***71.332,80*** |

**Table 5 Economic Cash Flow Without Project (2 of 3)**

| Period: | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (in .000 C' Year: | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| ***INFLOWS (1+2)*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** |
| 1. Direct benefits | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 |
| Tickets and other inflows | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 |
| Residual value | | | | | | | | | | | |
| 2. Indirect benefits | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 |
| Accident savings | | | | | | | | | | | |
| Benefits from vehicle and passenger cos | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Employment during construction | | | | | | | | | | | |
| Income taxes of producers of local mate | | | | | | | | | | | |
| Employment during operation | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 |
| Income taxes of producers of local mate | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 |
| Income taxes of contractors, designers | | | | | | | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** |
| Project cost (without V.A.T.) | | | | | | | | | | | |
| Expropriations | | | | | | | | | | | |
| Equipment | | | | | | | | | | | |
| Equipment materials | | | | | | | | | | | |
| Skilled labour | | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | | |
| Skilled labour | | | | | | | | | | | |
| Materials | | | | | | | | | | | |
| 1. Indirect project cost | | | | | | | | | | | |
| Local materials | | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | | |
| Cost of exchange | | | | | | | | | | | |
| Other sources | | | | | | | | | | | |
| 2. Expropriations | | | | | | | | | | | |
| Operating cost | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Equipment | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 |
| Equipment materials | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 |
| Skilled labour | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 |
| Unskilled labour | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 |
| Skilled labour | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 |
| Materials | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 |
| 3. Indirect operating cost | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 |
| Local materials | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 |
| Unskilled labour | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 |
| Cost of exchange | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 |
| Other sources | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 |
| 4. Indirect replacement cost | | | | | | | | | | | |
| 5. Traffic disruption disbenefits | | | | | | | | | | | |
| ***Cash Flow*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** |
| ***Cumulative cash flow*** | ***72.948,12*** | ***74.563,44*** | ***76.178,76*** | ***77.794,08*** | ***79.409,40*** | ***81.024,72*** | ***82.640,04*** | ***84.255,36*** | ***85.870,68*** | ***87.486,00*** | ***89.101,32*** |

**Table 5 Economic Cash Flow Without Project (3 of 3)**

| Period: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (in .000 C' Year: | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| ***INFLOWS (1+2)*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** | ***29.417,45*** |
| 1. Direct benefits | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 |
| Tickets and other inflows | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 | 25.029,29 |
| Residual value | | | | | | | | | |
| 2. Indirect benefits | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 | 4.388,16 |
| Accident savings | | | | | | | | | |
| Benefits from vehicle and passenger cos | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Employment during construction | | | | | | | | | |
| Income taxes of producers of local mate | | | | | | | | | |
| Employment during operation | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 | 4.246,60 |
| Income taxes of producers of local mate | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 | 141,55 |
| Income taxes of contractors, designers | | | | | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** | ***27.802,13*** |
| Project cost (without V.A.T.) | | | | | | | | | |
| Expropriations | | | | | | | | | |
| Equipment | | | | | | | | | |
| Equipment materials | | | | | | | | | |
| Skilled labour | | | | | | | | | |
| Unskilled labour | | | | | | | | | |
| Skilled labour | | | | | | | | | |
| Materials | | | | | | | | | |
| 1. Indirect project cost | | | | | | | | | |
| Local materials | | | | | | | | | |
| Unskilled labour | | | | | | | | | |
| Cost of exchange | | | | | | | | | |
| Other sources | | | | | | | | | |
| 2. Expropriations | | | | | | | | | |
| Operating cost | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 | 31.456,31 |
| Equipment | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 | 6.291,26 |
| Equipment materials | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 | 5.033,01 |
| Skilled labour | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 | 1.258,25 |
| Unskilled labour | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 | 11.009,71 |
| Skilled labour | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 | 4.718,45 |
| Materials | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 | 9.436,89 |
| 3. Indirect operating cost | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 | 27.802,13 |
| Local materials | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 | 7.549,52 |
| Unskilled labour | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 | 8.550,87 |
| Cost of exchange | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 | 6.920,39 |
| Other sources | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 | 4.781,36 |
| 4. Indirect replacement cost | | | | | | | | | |
| 5. Traffic disruption disbenefits | | | | | | | | | |
| ***Cash Flow*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** | ***1.615,32*** |
| ***Cumulative cash flow*** | ***90.716,63*** | ***92.331,95*** | ***93.947,27*** | ***95.562,59*** | ***97.177,91*** | ***98.793,23*** | ***100.408,55*** | ***102.023,87*** | ***103.639,19*** |

**Table 6 Economic Cash Flow With Project (1 of 3)**

| Period: | | Construction | | Operation ⇨ ⇨ ⇨ ⇨ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (in .000 C' Year: | Value | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ***INFLOWS (1+2)*** | | ***35.155,87*** | ***37.938,74*** | ***73.061,45*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** |
| 1. Direct benefits | | 25.029,29 | 25.029,29 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 |
| Tickets and other inflows | | 25.029,29 | 25.029,29 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 |
| Residual value | | | | | | | | | | |
| 2. Indirect benefits | | 10.126,57 | 12.909,45 | 44.112,67 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 |
| Accident savings | | | | | | | | | | |
| Benefits from vehicle and passenger cost | | | | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 |
| Employment during construction | | 5.879,97 | 5.879,97 | 0,00 | | | | | | |
| Income taxes of producers of local materials during co | | 0,00 | 896,18 | 896,18 | 0,00 | | | | | |
| Employment during operation | | 4.246,60 | 4.246,60 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 |
| Income taxes of producers of local materials during op | | 0,00 | 0,00 | 0,00 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 |
| Income taxes of contractors, designers | | 0,00 | 1.886,69 | 1.886,69 | 0,00 | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | | ***155.547,07*** | ***155.547,07*** | ***27.720,29*** | ***27.720,29*** | ***27.720,29*** | ***27.720,29*** | ***27.720,29*** | ***27.720,29*** | ***27.720,29*** |
| Project cost (without V.A.T.) | 314.449,16 | 157.224,58 | 157.224,58 | | | | | | | |
| Expropriations | 20.281,12 | 10.140,56 | 10.140,56 | | | | | | | |
| Equipment | | 51.884,11 | 51.884,11 | | | | | | | |
| Equipment materials | | 41.507,29 | 41.507,29 | | | | | | | |
| Skilled labour | | 10.376,82 | 10.376,82 | | | | | | | |
| Unskilled labour | | 26.728,18 | 26.728,18 | | | | | | | |
| Skilled labour | | 18.866,95 | 18.866,95 | | | | | | | |
| Materials | | 59.745,34 | 59.745,34 | | | | | | | |
| 1. Indirect project cost | 290.813,03 | 145.406,51 | 145.406,51 | | | | | | | |
| Local materials | | 47.796,27 | 47.796,27 | | | | | | | |
| Unskilled labour | | 20.758,87 | 20.758,87 | | | | | | | |
| Cost of exchange | | 53.456,36 | 53.456,36 | | | | | | | |
| Other sources | | 23.395,02 | 23.395,02 | | | | | | | |
| 2. Expropriations | 20.281,12 | 10.140,56 | 10.140,56 | | | | | | | |
| Operating cost | | 31.456,31 | 31.456,31 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 |
| Equipment | | | | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 |
| Equipment materials | | | | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 |
| Skilled labour | | | | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 |
| Unskilled labour | | | | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 |
| Skilled labour | | | | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 |
| Materials | | | | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 |
| 3. Indirect operating cost | | | | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 |
| Local materials | | | | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 |
| Unskilled labour | | | | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 |
| Cost of exchange | | | | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 |
| Other sources | | | | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 |
| 4. Indirect replacement cost | | | | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 5. Traffic disruption disbenefits | | | | | | | | | | |
| ***Cash Flow*** | | ***-120.391,20*** | ***-117.608,33*** | ***45.341,16*** | ***42.699,42*** | ***42.699,42*** | ***42.699,42*** | ***42.699,42*** | ***42.699,42*** | ***42.699,42*** |
| ***Cumulative cash flow*** | | ***-120.391,20*** | ***-237.999,53*** | ***-192.658,37*** | ***-149.958,95*** | ***-107.259,53*** | ***-64.560,11*** | ***-21.860,69*** | ***20.838,74*** | ***63.538,16*** |

**Table 6 Economic Cash Flow With Project (2 of 3)**

| Period: | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (in .000 C' Year: | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| ***INFLOWS (1+2)*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** |
| 1. Direct benefits | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 |
| Tickets and other inflows | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 |
| Residual value | | | | | | | | | | |
| 2. Indirect benefits | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 |
| Accident savings | | | | | | | | | | |
| Benefits from vehicle and passenger cos | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 |
| Employment during construction | | | | | | | | | | |
| Income taxes of producers of local mate | | | | | | | | | | |
| Employment during operation | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 |
| Income taxes of producers of local mate | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 |
| Income taxes of contractors, designers | | | | | | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | ***27.720,29*** | ***27.720,29*** | ***48.698,12*** | ***27.720,29*** | ***27.720,29*** | ***36.043,79*** | ***27.720,29*** | ***56.489,89*** | ***27.720,29*** | ***27.720,29*** |
| Project cost (without V.A.T.) | | | | | | | | | | |
| Expropriations | | | | | | | | | | |
| Equipment | | | | | | | | | | |
| Equipment materials | | | | | | | | | | |
| Skilled labour | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | |
| Skilled labour | | | | | | | | | | |
| Materials | | | | | | | | | | |
| 1. Indirect project cost | | | | | | | | | | |
| Local materials | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | |
| Cost of exchange | | | | | | | | | | |
| Other sources | | | | | | | | | | |
| 2. Expropriations | | | | | | | | | | |
| Operating cost | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 |
| Equipment | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 |
| Equipment materials | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 |
| Skilled labour | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 |
| Unskilled labour | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 |
| Skilled labour | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 |
| Materials | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 |
| 3. Indirect operating cost | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 |
| Local materials | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 |
| Unskilled labour | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 |
| Cost of exchange | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 |
| Other sources | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 |
| 4. Indirect replacement cost | 0,00 | 0,00 | 20.977,84 | 0,00 | 0,00 | 8.323,50 | 0,00 | 28.769,60 | 0,00 | 0,00 |
| 5. Traffic disruption disbenefits | | | | | | | | | | |
| ***Cash Flow*** | ***42.699,42*** | ***42.699,42*** | ***21.721,59*** | ***42.699,42*** | ***42.699,42*** | ***34.375,92*** | ***42.699,42*** | ***13.929,82*** | ***42.699,42*** | ***42.699,42*** |
| ***Cumulative cash flow*** | ***106.237,58*** | ***148.937,00*** | ***170.658,59*** | ***213.358,01*** | ***256.057,43*** | ***290.433,35*** | ***333.132,78*** | ***347.062,60*** | ***389.762,02*** | ***432.461,44*** |

**Table 6 Economic Cash Flow With Project (3 of 3)**

| Period: | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (in .000 C' Year: | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| ***INFLOWS (1+2)*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** | ***70.419,71*** |
| 1. Direct benefits | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 |
| Tickets and other inflows | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 | 28.948,78 |
| Residual value | | | | | | | | | | |
| 2. Indirect benefits | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 | 41.470,93 |
| Accident savings | | | | | | | | | | |
| Benefits from vehicle and passenger cos | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 | 37.095,69 |
| Employment during construction | | | | | | | | | | |
| Income taxes of producers of local mate | | | | | | | | | | |
| Employment during operation | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 | 4.234,10 |
| Income taxes of producers of local mate | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 | 141,14 |
| Income taxes of contractors, designers | | | | | | | | | | |
| ***OUTFLOWS (1+2+3+4+5)*** | ***27.720,29*** | ***27.720,29*** | ***48.698,12*** | ***27.720,29*** | ***27.720,29*** | ***27.720,29*** | ***27.720,29*** | ***27.720,29*** | ***36.043,79*** | ***27.720,29*** |
| Project cost (without V.A.T.) | | | | | | | | | | |
| Expropriations | | | | | | | | | | |
| Equipment | | | | | | | | | | |
| Equipment materials | | | | | | | | | | |
| Skilled labour | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | |
| Skilled labour | | | | | | | | | | |
| Materials | | | | | | | | | | |
| 1. Indirect project cost | | | | | | | | | | |
| Local materials | | | | | | | | | | |
| Unskilled labour | | | | | | | | | | |
| Cost of exchange | | | | | | | | | | |
| Other sources | | | | | | | | | | |
| 2. Expropriations | | | | | | | | | | |
| Operating cost | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 | 31.363,71 |
| Equipment | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 | 6.272,74 |
| Equipment materials | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 | 5.018,19 |
| Skilled labour | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 | 1.254,55 |
| Unskilled labour | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 | 10.977,30 |
| Skilled labour | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 | 4.704,56 |
| Materials | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 | 9.409,11 |
| 3. Indirect operating cost | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 | 27.720,29 |
| Local materials | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 | 7.527,29 |
| Unskilled labour | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 | 8.525,70 |
| Cost of exchange | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 | 6.900,02 |
| Other sources | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 | 4.767,28 |
| 4. Indirect replacement cost | 0,00 | 0,00 | 20.977,84 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 8.323,50 | 0,00 |
| 5. Traffic disruption disbenefits | | | | | | | | | | |
| ***Cash Flow*** | ***42.699,42*** | ***42.699,42*** | ***21.721,59*** | ***42.699,42*** | ***42.699,42*** | ***42.699,42*** | ***42.699,42*** | ***42.699,42*** | ***34.375,92*** | ***42.699,42*** |
| ***Cumulative cash flow*** | ***475.160,86*** | ***517.860,28*** | ***539.581,87*** | ***582.281,29*** | ***624.980,71*** | ***667.680,14*** | ***710.379,56*** | ***753.078,98*** | ***787.454,90*** | ***830.154,32*** |

# APPENDIX Section 5.2

# Terms of Reference for the Study of a Controlled On-Street Parking System

## Article 1. Technical Description of the Project

### 1.1 General

Part of the Greater Nicosia area, containing approximately 2000 on-street parking spaces shall be designated as a pilot area for controlled parking. This area and the exact number of spaces shall be selected from a list to be proposed by the PMU and shall include administrative and commercial as well as residential uses. It is important for these areas to be clearly separated from the rest of the surrounding area by, for example, a park or major arteries etc., so that the application of the controlled parking system does not lead to shifting of demand to adjacent areas.

**The implementation and management** of such a controlled parking system may be carried out by a managing agent to be selected by tender by the Municipality, **with the exception of policing and issuing of fines** which will be carried out by specialized personnel of the Municipal Police and by the Fines Department of the Municipality respectively.

**Final decisions** for the planning for parking spaces, their classification according to categories of users (visitors, residents etc.) as well as the hours of operation of the system shall be taken by the Municipality**.**

**The Municipality shall also set the parking charges to be applied.**

### 1.2 Aim of the Controlled Parking Study

The basic aims of parking strategy are the following:

- Residential parking priority
- Minimization or restriction of free parking by visitors to the city centre
- Estimation of the number of spaces and the costs involved concerning short and long term parking.
- The perceived cost of car usage + parking should not be less than the cost of public transport use.
- Reduction of the parking spaces in the areas adequately served by public transport
- Minimization of on-street parking together with provision of parking areas planned in such a way as to minimize searching for an on-street space together with provision of signs and information for the driver.

The extension of the system to cover new areas and the planning of an integrated system of controlled planning, necessitates the **collection and evaluation of data from the operation of the pilot scheme in the area covered by the design**. Therefore, following the pilot application of the controlled parking system, suitable surveys should be conducted in order to

provide data and conclusions leading to possible additions or small scale corrections to the extended system.

A separate objective of the present design is the elaboration of policy and planning concerning **parking areas for motorcycles and bicycles** as well as for **loading/unloading spaces for goods** within the controlled parking area.

## 1.3 Scope of the Controlled Parking Study

The contractual scope of the Controlled Parking Design includes the following parts:

### 1.3.1 Determination of the Design Area – Collection of Data

- Determination of the area of the pilot scheme. The area shall be selected from a list to be provided by the PMU.
- Collection, recording and evaluation of already approved (if any) planning studies or existing designs or proposals of other institutions concerning the scope of the design.
- Creation of suitable infrastructure in a GIS environment based on the city blocks and the existing numbering from the Statistics Office.

1.3.2 **Parking Surveys** in order to obtain data which accurately reflect the total traffic and parking conditions in the area under study. In more detail, the following actions shall be undertaken on each side of the building block:

- Coding of streets with their official naming.
- Recording of existing traffic regulations and detailed description of the building blocks, clearly noting all interruptions of continuity such as bus stops, taxi stations, parking area exits, refuse bins etc.
- Recording of existing parking regulations: free parking, controlled parking, monthly alternate side parking, special spaces (for the disabled, banks, embassies) parking prohibition etc.
- Determination of the existing on-street parking supply as well as off-street public parking areas.
- Recording of the existing parking space demand, determined by the occupancy of the legal spaces and the number of illegally parked cars. This survey will be carried out for private vehicles and motorcycles during peak periods of commercial activities, as well as at after midnight periods, in order to separate maximum demand into demand by visitors and demand by residents.
- Recording of all house addresses, i.e. the street number of the first and last building on each side of all blocks.

All data collected from these surveys and counts shall be recorded **in a database** in order to be processed and evaluated to arrive at useful conclusions regarding supply and demand for the controlled parking system. **This database shall be capable of data output and presentation in a GIS environment.**

1.3.3 **Surveys for parking characteristics** in two representative parts (routes) of the area under study in order to measure supply and demand. Surveys shall take the form of recordings of the last four digits of the number plates of parked vehicles and motorcycles. Recordings shall be made every hour, starting from 6.00 until 21.00 and shall take place on typical days of the week, with shops open in the afternoon as well. The data collected shall be processed for each side of all blocks that line the route under study and for each route, classifying parking into legal and illegal and obtaining the various parking parameters and characteristics:

- The number and percentage value of vehicles per parking category.
- Variations in parking duration, the mean duration and the most frequently occurring duration.
- Variations in accumulation, maximum accumulation and its time of occurrence.
- The turnover (vehicles/space) based on the number of spaces as well as on the maximum accumulation.
- Distribution of demand based on time duration for the following three categories:
  - Short term parking (up to 3 hours)
  - Medium term parking (>3 to 8 hours)
  - Long term parking (> 8 hours)
- The hourly variation of demand for parking and the development of the relationship between supply and demand during the day.
- Parking characteristics per category of user (visitors – residents)

1.3.4 **Presentation of the Existing Situation.** The processed results of the survey of parking and its characteristics shall be presented and illustrated in a Technical Report and drawings.

1.3.5 **Parking Plan**. Based on the results and conclusions from recordings and surveys the Parking plan shall be prepared including the following:

- Parking Zones (if more than one is deemed necessary).

- Parking space Categories. There will be a different category for motorcycles and supply vehicles so that they don't occupy spaces belonging to other uses.
- Detailed planning for the controlled parking spaces.
- Hours and days for the Operation of the system.
- Parking Charges and methods of payment.
- Traffic analysis and proposals for possible traffic management.
- Economic analysis. Cost estimation for the operation and maintenance of the system. Estimation of costs vs. income.
- Updating – Additions to the Parking Database for the following data.
    - The proposed parking status (total prohibition, paid spaces, residential spaces, special spaces etc.) codified by a number so that it can be represented by a different color on maps (through the ArcView program)
    - The number of short term paid spaces for visitors
    - The number of spaces for residents
    - The number of mixed use spaces (if required)
    - The number of special spaces
    - The number of motorcycle spaces
    - The number of supply vehicle spaces

## Article 2. Base of the Consultant

The base of the Consultant shall be in his Offices and the area of the design.

## Article 3. Duration of the Contract

The deadline for the fulfillment of the contract is within six (6) months from the signing of the private agreement, not including the time required for approval of deliverables. The beginning of this time period coincides with the day following the signing of the contract, unless specified otherwise in the contract itself.

The Design shall be carried out in two phases.

**The 1st Phase** shall be completed **within four (4) months** from the signing of the contract and shall include all works described in paragraphs 1.3.1, 1.3.2, 1.3.3 and 1.3.4 of the present document.

**The 2nd Phase** shall be completed **within two (2) months** from the decision to proceed to be issued by the Service following approval of Phase 1, and will include all works described in paragraph 1.3.5.

## Article 4. Deliverables

At the end of each Phase, the Concessionaire is required to deliver a technical report with the results of the design accompanied by Tables and Drawings. Documents and Drawings shall be delivered in five (5) copies as well as electronically. All files of the Parking database shall also be delivered electronically. All deliverables shall be in Greek.

## Article 5. Fee

The “Consultant”, in the case of assigning the studies only, or the “Operator”, in the case of assigning the operation or both studies and operation of the controlled parking system, will prepare his offer on the basis of the terms of reference and the other requirements asked by the concessionaire in the tender documents.

# APPENDIX Chapter 8

# Actions of the Marketing Plan

## 1. *Identity*

***Action : design a logo***
***Target group : general***
***Main goal : make the IMMP recognizable***
***Effect : drawing peoples attention and building a high quality image***
***Costs : - (no additional costs, they are in the project)***

It is important that we present the IMMP as a project with its own identity. People than will recognize it, and a well designed logo contributes to a serious, professional image. It will also emphasize that the project lasts and actions will be continued through several years.

4 concepts of a logo were designed (see below).

*Information about the bus should be always present in official government communication that addresses the public. It contributes to create a constant 'level of presence' of the IMMP.*




## *2. Marketing Unit*

***Action : install a dedicated Marketing Unit***
***Target group : decision makers, stakeholders, the public in general***
***Main goal : have actions deployed continuously***
***Effect : making people aware of the project and its contents***
***Costs : € .... /year***

This plan can be considered the first attempt to enhance visibility and making people aware and enthusiastic about the goals of the IMMP. However, changing an attitude and – in the long run – behaviour, takes some time. Therefore it is recommended that a (small) marketing unit monitors the purpose and the progress of the IMMP. The unit should also have carried out specific marketing actions.

The unit could consist of one or two employees of the Ministry, and might have the assistance of consultant(s). Maybe the PR-manager of the Ministry can be a part of this marketing unit. Or he or she could cooperate with the unit.

The impact of a marketing unit shouldn't be underestimated; one can define an ambitious project, but having the associated actions be carried out takes a special effort. People in general, and especially decision makers and stakeholders should be aware of the goals and incorporate them in their policies and activities.

*Conclusion: a small and agile unit should monitor and adjust the marketing plan of the IMMP, and have actions carried out properly.*

## 3. Benefits of the plan

***Action : gather and publish specific information***
***Target group : the public in general***
***Main goal : gain support, enhance awareness***
***Effect : making implementation easier***
***Costs : € ..... /year***

The actions that will be carried out by the IMMP can be considered as unpopular. At least car drivers in general will do so, and the the majority of the population consists of car drivers...

We have learned from the introduction of other somehow unpopular measures that support is dramatically increased by explaining the need and benefits of them. Over and over, and in a smart way.

It might be considered the main task of the PMU and/or the Marketing Unit of the IMMP to constant tell the public and publish about these benefits. Those messages could consist of the following elements:

- Environmental benefits
- Cost reductions
- Space saving (reduction of parking space)
- Quick on certain routes
- Easy to use
- Healthy

*The PMU and the Marketing Unit should have in mind the question: "What's in it for me?" in developing a communications strategy!*

## *4. Minister = Ambassador*

***Action : have the Minister declare devotion to the IMMP continuesly***
***Target group : the inhabitants of Cyprus***
***Main goal : influence the public***
***Effect : (contributes to) positive attitude***
***Costs : none; it should be one of the tasks of the marketing unit, #2)***

The conversion of a private car based transport system to a more sustainable mobility system is an important issue! People only take this seriously if the directors are serious about it themselves.

The Minister is the most important player in this field. He should constant emphasize the need and importance of the conversion. 'Sustainable' should be clearly visible in his policy. He will speak about it and act positively about the IMMP and its impact, and show no hesitation.

Campaigns that aim to change behaviour, always start by informing the target group. After the people are aware of the situation, they recognize the advantages of a sustainable mobility system. Only under those circumstances they tend to adopt its measurements.

The Minister should set an example by showing enthusiasm about the IMMP and its measurements! It is an important task of the IMMP marketing unit to inform the Minister and hand him the appropriate arguments (see also #3).

*The minister is the beacon for all inhabitants of Cyprus. He should promote the IMMP by highlighting the benefits of sustainable mobility, on every possible occasion, continuously, without hesitation, in an enthusiastic way!*

## 5. *Information on progress*

***Action : publish a Newsletter of the IMMP***
***Target group : primarily insiders, decision makers & stakeholders***
***Main goal : add support to the IMMP.***
***Effect : have more people supporting the aims of the IMMP***
***Costs : € .....***

It is important to inform insiders, decision makers and stakeholders about the progress of the IMMP. It shows that there actually is progress, and eventually they might be a participant in the project. The idea is to address those people in two ways:

1. Send an email newsletter, monthly
2. Publish a printed newsletter every 3 months (3 or 4 times per year)

*Email newsletter*
This could be a very basic email message, consisting of 4 to 5 messages about the progress. One could use a simple template containing the IMMP logo and – if applicable – 1 or 2 photos or pictures.
The newsletter is made bij the Marketing unit/PMU. It is distributed to many stakeholders and actors, mainly from the various ministries and other organisations.

*Printed newsletter*
Every 3 months a printed newsletter is published. This consists of an outline of the articles that have been posted in the email versions. Other components are:
- Introduction by the Minister
- Column by one of the staff members or consultants
- Calendar of interesting events

The tone of voice is friendly yet professional. It is distributed in the Ministries and on public places such as libraries and City hall.


*By publishing a multi media newsletter professionals and stakeholders are informed about both progress of the IMMP and the contents of the plans.*

## 6. Content information

***Action : provide information about the contents of the project***
***Target group : the general public***
***Main goal : create knowledge and awareness***
***Effect : increase involvement***
***Costs : € .....***

The IMMP is not just a logo or a goal or a slogan. It is a plan containing a series of actions and activities. This should be told to the public constantly.

One should monitor the activities of the IMMP and set up a smart schedule of handing out this information to the inhabitants of Cyprus. Unlike the actions of #3 (that emphasizes the benefits of the plan) we provide exact information on – for instance – the new bus contract. What is in it, what will change and when will this all happen.

This information is published in various ways, to reach as many people as possible. You can think of:

- Newspapers, both advertisements and 'free publicity' articles
- Special brochures or folders, handed out at desks of public buildings
- The IMMP-newsletters


The information can be detailed and thorough. Other actions (#3, #5, #6) have different goals. They have a more marketing/PR-orientated function. This activity focuses on conveying the content of the project and its activities as good as possible.
The actor in gathering this information can be the Marketing unit, but the content itself will be delivered by the PMU and employees of the Ministry.

*Besides communication on the benefits and progress of the project, we must also properly explain and present the content of all various activities.*

## *7. Improve IMMP visibility*

***Action : advertise via regular newspapers***
***Target group : the public in general***
***Main goal : increase reputation***
***Effect : improving image and reputation***
***Costs : € 30.000 /year, depending on the free publicity vs. advertisements ratio***

"Unknown, unloved".... "I never listen to or see commercials, for I only buy the well known brands"…. These and other quotes express that we tend to use and buy things and services that are well known and popular. Therefore it is an important task to 'brand' the IMMP, in general and continuously! We recommend using a combination of advertising and free publicity. Likely it is possible to make deals with newspapers to accommodate this.

Information of the IMMP should be in articles in the newspapers on a regular basis. We could use the pages that are already used by the Ministry and/or the Municipality (?) to inform the public. These need not be spectacular or even news as such; the main goal is to enhance visibility and improve the reputation of the IMMP.

We recommend posting some information about the IMMP every week or month (?) when an edition of the government-news is published. This should be initiated by the Marketing Unit (see #3)

*Information about the bus should be always present in official government communication that addresses the public. It contributes to create a constant 'level of presence' of the IMMP and its goals.*

## 8. *Two way communication*

***Action : enforce response to the plans and measures***
***Target group : the public in general***
***Main goal : improve plans and marketing***
***Effect : people get involved.***
***Costs : € .....***

Once we have improved visibility of the IMMP and its actions (#7, #6), and communicated both the benefits of the plan and its progress (#3, #5), we should listen to what people have to say about this. This serves two goals:

1. We can learn from the reactions and improve both the plans and our marketing/communication efforts
2. We achieve that people feel more involved in the project; it isn't only the governments project any longer, but it is also from and for the people!

The way that people can respond are various. It is recommended to at least do the following:

- Set up and publish a website
- Install a dedicated telephone service
- Create the possibility of sending in vouchers


Optional, maybe in the (near) future and/or combined with special occasions, we could add the possibility to communicate via:

- SMS
- Chat
- Twitter

In all cases, it is very important to actually respond to the reactions! Especially questions should be answered in a reasonable term. It is also recommended to post an outline of the reactions and questions in a special publication.

*The reactions of the public provides an excellent occasion to respond to the common questions and refute wrong assumptions. It also improves involvement. One could start by setting up a website (and email response), and expand the response opportunities by opening telephone, sms and chat services.*

## *9. Meet and Greet*

***Action : organize meetings & happenings***
***Target group : decision makers & stakeholders, the public***
***Main goal : get them involved***
***Effect : generating support for the IMMP***
***Costs : € ....***

It is important that next to al the communication efforts, we undertake actions to actually meet the decision makers and stakeholders. Personal contact and interaction is still the most effective way to communicate!

We suggest to organize a special IMMP-meeting, probably this could be an annual event, and be held in the European Mobility Week. This week is generally the 3rd week of September. Throughout Europe all sorts of meetings and activities are organised that focus on Sustainable Mobility. For instance big cities like Amsterdam, Athens and Milano close their city centre for cars on one or more days. Of course extra buses are deployed and all kind of festivities are being organised.

In this week a Symposium or Congress could be organized to tell about the project as such, to show the progress and answer questions. If it is combined with some sort of market, one could demonstrate vehicles that use less or no fossil fuels.

*Throughout Europe there are good examples of focussing on Sustainable Mobility in the European Mobility Week in September. Cyprus and Nicosia could line up with cities like Athens and Milano to emphasize the advantages and need of a more sustainable mobility system!*

## *10. Milestones*

***Action : make project goals milestones that can be celebrated when reached***
***Target group : IMMP personel***
***Main goal : keep people enthusiastic about IMMP goals***
***Effect : generating enthusiasm***
***Costs : considerably small, possibly ponsored***

Building a brand new PT-system, is characterized by several steps taken and moments of success. These moments, or milestones, form a roadmap to the remarkable goals of the IMMP.

The organization of the IMMP, its leaders, management and personnel need these milestones so activities:

- can be effectively planed
- are tangible
- form a deadline in time
- result in a “landmark”
- make people aware and proud of what they are doing.

Working on the success of the PT-plan and reaching the objected milestones is remarkable. People directly involved with the development of the PT-system deserve to celebrate this success. Every PT-milestone reached, should be given special attention by its stakeholders and IMMP leaders.

Celebration can be modest: a cake, free tickets for the cinema, nice gestures. Most important is that people, IMMP-personal get a signal of confirmation and a “thumbs-up” feeling in a process that takes considerable time and energy.