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Generic Analysis Tool for Business Cases

(Analysis Procedure + User Guideline)

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EXECUTIVE SUMMARY

This report represents Deliverable D2.4.1 from the CityMobil project. It describes a tool developed within the project for assessing the business case for new automated transport systems. The tool itself is provided in the form of an Excel Spreadsheet together with a User Guidelines document. The spreadsheet is a stand alone item, available from the project. The User Guidelines document is provided as an Appendix to this report

This report sets the scene in terms of the goals of the CityMobil project and the requirements and expectations of a business case tool. It then goes on to describe the results of a literature survey of earlier economic analyses undertaken in association with the development of new automated transport systems. The literature survey also includes an inspection of previous guidelines developed to assist in the economic and value for money assessments of new transport systems and schemes.

From the literature review a list of criteria and a methodology are developed for the assessment of a wider ‘transport case’ that will enable a local authority partner to assess a scheme and also for a more focussed ‘business case’ that is needed to satisfy the funding partners.

The main outputs from the analysis enable a direct comparison of the system options analysed, including: system description, performance parameters, operating characteristics, economic analysis and the qualitative assessment of other system benefits. Where benefits can be quantified, they are included in the calculation of a benefit cost ratio (BCR). Where benefits are not quantifiable, they can nevertheless be recognised and rated. The need to study alternative schemes and the use of a TOAST (technology options and appraisal summary table) for comparing them and assessing value for money are proposed.

The proposed model for a business case is then presented in terms of its functionalities and structure; the data and information that is required to be input by the user, and the data and information that are output by the spreadsheet. The way in which the tool has been implemented in spreadsheet form is then described.

The spreadsheet is accompanied by User Guidelines which are provided in the form of a stand alone document in an Appendix to the report.

Two particular features of the tool are designed to assist the user:

i) The tool contains ‘simulations’ of PRT and CTS systems so that the user can specify a system either in terms of user needs e.g. required performance characteristics such as average, minimum, and maximum in-vehicle travel times and waiting times; or in terms of system design parameters such as the size of vehicles (passenger carrying capacity) and the number and speed of vehicles required for the operation. The simulations also facilitate testing of a range of ‘what if’ questions so that effects of changing demand, network length or vehicle carrying capacity can be easily answered;

ii) The tool provides guidance on a range of information and parameters taken from real life examples, such as data on the costs of different systems.

The tool has been developed to be comprehensive, so that the methodology and lists of criteria encompass a full range of factors that should be taken into account in a scheme evaluation. However, at the same time the tool has been designed for use at a ‘high level’ and can, for example, easily be used in a first pass with incomplete and unrefined data to get an initial and rough idea of a business case.

In addition the model can be used as an iterative process through varying and refining the values for a number of different model inputs in order to assess the effects of these alterations on the overall BCR and TOAST results. This will help to determine the optimal system operating characteristics to be taken forward for a full design.

1 Introduction

The CityMobil project ‘Towards Advanced Transport for the Urban Environment’ aims at achieving a more effective organisation of urban transport, resulting in a more rational use of motorised traffic with less congestion and pollution, safer driving, a higher quality of living and enhanced integration with spatial development.

This should be achieved by promoting the introduction of advanced technologies (e.g. PRT, CTS, dual-mode, high-tech buses, etc.) into the transport environment. The concepts, methods and tools developed will then be validated and demonstrated in a number of different European cities under different circumstances.

Sub-project SP2 ‘Future scenarios’ has the aim to investigate how automated road transport systems fit into the expected scenarios for advanced urban transport in the future, particularly how they will contribute to sustainability. Tools for cities and operators will be developed to analyse transport requirements and potential impacts.

Within SP2, WP2.4 ‘Business Cases’ has aimed at assessing the economic viability of a range of specific applications and solutions to develop a generic economic analysis tool, to aid the site selection process through economic analysis, and to contribute to the overall evaluation framework for the CityMobil project.

The analysis tool therefore has to be applicable to all CityMobil case study cities as well as to be used by planners and decision-makers for the evaluation of potential future applications. Although the tool will be tested using the CityMobil case study cities, it has mainly been developed to be used outside/ after the project.

The specific objectives/ planned activities for task 2.4.4 ‘Generic Economic Analysis Tool’ were: “a generic analysis tool will be developed to evaluate the transport and business case of implementing new systems. This will show the methodology required to confirm economic viability of systems and can be used after the project”.

This deliverable gives an overview of the work undertaken in WP2.4 and provides a detailed description of the business case analysis tool developed within task 2.4.4. A first step is a review of related guideline documents. Based on this review, the analysis process leading to the development of the tool, and the implementation of it in the form of a spreadsheet is presented. In addition to the detailed description of the spreadsheet model, the deliverable also contains User Guidelines, presented in the form of a stand alone document in an Appendix.

2 Literature Review

The first activity in the work on WP2.4 was to carry out a background literature review. Due to the innovative characteristics of automated transport systems, only limited information regarding the economic analysis of these systems was found. The results of the literature review were grouped under related systems, previous research in the area, and guideline documents for the economic assessment of transport schemes. The results are discussed below.

2.1 Related Systems

Related systems include Personal Rapid Transit (PRT) applications, Advanced Driver Assistance Systems (ADAS), people mover systems, and dual mode concepts. Previous research relates mainly to results from earlier research projects on Cybernetic Transport Systems (CTS), particularly CYBERCARS, CYBERMOVE, EDICT, and NETMOBIL.

A number of systems with functionalities and technologies similar to those to be used within the CityMobil project have been developed, tested and implemented - although often only on a small scale - in the past. When carrying out studies to prove the feasibility of these systems for a particular application, results of the economic analysis are an important indictor.

Yoder et al (2000) used regression analyses to compare costs of 25 Automated Guideway Transit (AGT) systems. This was used as a basis for estimating costs for the planned PRT application in Rosemont, Illinois. Based on the regression analysis, a cost range was determined for different system components. Cost components analysed in the study were:

- Guideway
- Stations
- Maintenance/ Control
- Power Systems
- Vehicles
- Communication
- Engineering

In a study on introducing a city wide dual mode system in Boston (Benjamin, 1990), the costs of implementing three different systems (pallet, automated highway, PRT) were compared to the projected 1990 baseline that did not consider the use of any advanced transport systems.

The vehicles used for the three technologies included private cars, buses and specialised vehicles. Here the analysis of costs and benefits considered did not only cover capital and operating costs, but also pollution levels, noise impacts and the need for any household displacements.

A recent review of the state of the art of PRT and other emerging technologies (Buchanan, 2005) includes a compilation of results from economic analyses carried out for a variety of systems. It was found that these systems can offer relatively low capital and operating costs, due to small light weight vehicles and guideways, and the fully automated operation. Furthermore, potential improvements in safety, convenience and less environmental impacts also have to be considered.

In a study on Cooperative Vehicle Highway Systems (CVHS) business cases for clusters of ADAS technologies were developed for different future scenarios (DfT, 2004). A cost benefit analysis was carried out comparing the costs of implementing in-vehicle and/ or road-side systems with the potential benefits. The costs varied widely with estimated market penetration. Benefits included safety, decreased fuel consumption and emissions, and journey time savings.

2.2 Previous Research

A number of EU funded research and developments project have been carried out prior to the start of CityMobil, which have dealt with similar technologies and systems. Of specific interest for this review of business cases were the CYBERCARS, CYBERMOVE, EDICT and NETMOBIL projects.

The CYBERCARS and CYBERMOVE projects have analysed the suitability of Cybernetic Transport Systems for urban passenger transport applications. Whereas CYBERCARS was more concerned with development, testing and evaluation of components, CYBERMOVE contained a full socio-economic evaluation of different CTS applications.

The EDICT project focused on applications of Personal Rapid Transit, and an evaluation - including an economic analysis - was carried out for a number of study sites. The NETMOBIL project was a cluster project comprising the CYBERCARS, CYBERMOVE, EDICT and STARDUST projects.

The main aim of the NETMOBIL project was to identify common issues and gaps in research across the four cluster projects. The STARDUST project focused entirely on in-vehicle Driver Assistance Systems and is therefore of less interest in this context. The NETMOBIL project developed a comparison of transport and business cases for PRT and CTS study sites.

As part of the EDICT project comparative analyses were carried out between PRT systems and more conventional systems like Light Rail Transit (LRT) and bus systems. This study found that investment costs for a PRT (based on the ULTRa system to be built and demonstrated at Heathrow in CityMobil) are only 35% of the costs for the more conventional systems and that, for example, a 10km track implementation of a PRT system could achieve savings of up to 111 M€.

These savings in investments costs were mainly due to the use of lighter vehicles and correspondingly lighter guideway constructions. But the study also found that In terms of system operating costs large savings can be achieved due to the automated operation of PRT, and the consequent saving in manpower costs.

The vehicles used in a PRT are much smaller than those used in bus or rail systems, but through high frequencies similar capacities can be reached. Due to the higher convenience of a PRT for the end user, when compared to conventional modes of transport, a higher modal shift to public transport can be anticipated, resulting in a greater reduction in car traffic. Furthermore, additional travel time savings, reduced congestion, reduced air pollution, increased traffic safety, and increased land values can also be achieved from PRT.

As part of the socio-economic assessment in CYBERMOVE, the evaluation framework contained a number of evaluation categories, impacts and indicators, relating to economic analysis and business cases. These are summarised below:

- Energy
  - Energy consumption
    - Daily consumption
    - Average kW/km

- Financial impacts
  - Start up costs
    - Track construction and civil works
    - Vehicle acquisition/construction
    - Control systems and apparatus

  - Operating costs
    - Personnel
    - Vehicle maintenance
    - Track and civil infrastructures maintenance
    - Control system maintenance

  - Revenues
    - Operating revenues

  - Subsidies
    - Received public subsidies

- Employment
  - Temporary jobs provided by installation and demonstration
    - Jobs provided at the demonstration site
    - Jobs increase induced at the manufacturers

  - Long terms effects on jobs
    - Local effects on employment
    - Non local effects on employment

2.3 Guideline Documents

A number of different guideline documents for economic evaluation and assessment and for scheme selection for transport projects have been reviewed, They are mainly UK based and relate to Cost Benefit Analysis (CBA) and affordability. They include: 'Affordable Mass Transit - Guidance, Helping you choose the best system for your area' (CIT, 2005), 'Guidance on Value for Money' (DfT, 2006), and 'Guidance on Multi Modal Studies MMS' (DfT, 2003).

Aspects of the analysis processes described in these guideline documents, which are applicable for the economic assessment of advanced transport systems including CityMobil solutions, have been identified and incorporated into the analysis process for the business case analysis tool. In these documents the concepts of affordability and value for money were introduced.

Furthermore the guideline documents reviewed gave details on calculating the benefit cost ratios (BCR) for a given system application proposed for a specific site. In addition to this a technology options and appraisal summary table (TOAST) has been introduced. Use of this technique enables an assessment of the less tangible impacts of the options considered to be taken into account.

3 Model Description

3.1 General Outline

The final output of WP2.4 'Business Cases' of the CityMobil project is deliverable D2.4.1 'Analysis Tool for Business Cases'. This analysis tool is aimed at planners and decision makers to help them make a case for the implementation of an automated system. For this a list of criteria relevant to the development of a wider transport case has been developed based on information obtained from the literature review.

The economic feasibility of a particular system is considered to be part of this wider transport case and the essence of the business case. A sub-set of the list of criteria, which are particularly relevant to the development of a business case has therefore been identified. In addition some guidance for identifying and addressing barriers to deployment and risks has also been developed.

- Criteria for Transport Cases

Based on the background literature review, particularly the results from the NETMOBIL project, it was found that a transport case is generally made up from criteria in the following areas:

- Relevant statements of Local and National Policy Objectives
- Identification of the Stakeholders and Users involved and affected
- Analysis of Stakeholder and User Needs
- Likely Acceptance by Stakeholders and Users
- Identification of the Potential Risks and Barriers
- Analysis of Feasibility (= Business Case)

- Criteria for Business Cases

One of the criteria for the transport case above is the analysis of the feasibility of a system. This can be analysed through criteria which are clearly more specific to the business case, namely:

- Estimated Costs of the System
    - Capital costs
    - Operating costs
- Predicted Patronage and Revenues
- Estimated System Benefits from:
    - Energy Savings
    - Travel Time Savings
    - Network Efficiency improvements
- Non-quantifiable benefits/disbenefits (e.g. Environmental impacts, Image, visual intrusion, severence, improved Accessibility, etc.)

- Risks and Barriers to Deployment

In addition to the criteria for transport and business cases, potential risks and deployment barriers have to be identified at an early stage. Deployment barriers can include a variety of issues falling under the following headings:

- Operational and institutional
- Political and procurement
- Legal issues and liability
- Societal (including acceptance)
- Technical and certification
- Financial and commercial
- Organisation and management
- Impacts on the city image

Following on from the guideline documents identified as relevant for this economic analysis of advanced transport systems, as reviewed in the previous section, the detailed outline of the business case analysis tool is now described. It is concluded that two cases are required to justify a new transport scheme, a transport and a business case.

The wider transport case shows why a particular scheme should be preferred over various possible alternatives and determines value for money, in particular for the local authority involved. The business case shows the affordability of a particular scheme and in particular if the capital costs and risks are acceptable to the funding partners, and if the operating costs and financing costs and any required subsidies are sustainable

The transport case includes an analysis of costs and of both the quantifiable and non-quantifiable benefits of a scheme, and will include factors such as user time savings, mode shift, environmental impacts and jobs creation. The business case is also concerned with the costs and benefits, but is more focused on cash flows from the quantifiable costs and benefits.

The main components of the transport case are:

- Statement(s) of relevant policy objectives, which could include, for example:

- Acceptance
- Quality of service
- Transport patterns
- Social Impacts
- Environmental impacts
- Financial Impacts

- Economic considerations
- Legal impacts
- Technological success

- An appreciation of the context, which could include, for example statements on:

- Fit of the new scheme with existing/ planned demand management measures
- Likely impacts during construction
- System image and public acceptability
- Extent to which other existing PT modes will lose passengers
- Technology risk
- Legal and institutional issues

- An appreciation of the Physical opportunities and constraints, such as:

- Segregation of system (i.e. is it necessary, and if so how and where to provide?)
- Built environment (e.g. impacts on structures, historic centre)
- Physical constraints (e.g. gradients, curves, need for land take etc)
- Constructability (e.g. disruption, costs)
- Severance (e.g. effects on the movements of people)

- An understanding of the Scheme and Operational factors, including:

- Scheme characteristics
  - Numbers and passenger carrying capacity of vehicles
  - Number of stations/stops
  - Operating headway
  - Average Journey time and reliability
- Fare level
- Forecast demand
- Revenue = f (fare, demand)
- Other income (developer funds, parking or RUC schemes, subsidies etc).

- An analysis of the Benefits (both quantifiable and non-quantifiable) including:

- User time savings
- Saved operating costs of cars given up, and increased efficiency for traffic
- Saved accidents
- Time savings of non-users from reduced congestion and delays
- Saved pollutants
- Jobs generated
- Any other intangible benefits and disbenefits (eg revenues lost on existing services)

- An appreciation of the Capital cost, including:

- Land take and utilities diversion
- Vehicles
- Civils and trackwork
- Stations and stops
- Electrical power
- Communications and signalling
- Depot/ control centre
- Highway works

- Traffic management
- Design and management- An appreciation of the Operating costs, including:
- Fuel
- Fixed costs (tax, insurance)
- Salaries (drivers and system operators)
- Maintenance (vehicles, Infrastructure)
- Security
- Depreciation

Finally, all the parameters that can be quantified can be combined in the Calculation of the benefit cost ratio (BCR) for a scheme given by:

BCR = (NPB - NPC) / NPC

where:

NPB = Net Present Benefit
NPC = Net Present Cost

While a limited business case assessment would include solely a financial benefit-cost ratio, the business case envisaged here includes those benefits to society, such as travel time savings, which can be valued. Thus the output is a social benefit-cost ratio. However, it excludes those elements which cannot readily be valued, and which are treated instead, within the transport case, in the TOAST methodology.

While a financial benefit-cost ratio can be constructed relative to a base case in which nothing is done, and no costs or revenues are incurred, a social benefit-cost ratio requires a set of base conditions against which to assess the net benefits, for example of travel time savings, which are generated by the strategy. It is for the city to decide what this set of base conditions should be. However, as a default we recommend comparison against a conventional bus service which would serve the same market as the proposed new technology. This, in our experience, is the most probable conventional alternative to new technologies.

All values are present values, i.e. measured over the lifetime of the project (say for example, 20 years) and then discounted to the present day. This will show the extent to which a scheme is likely to cover its operating costs. An assessment of value for money (VfM) must then be made, where judgement is used to assess the overall findings, including the benefits, costs, intangibles, impacts and risks of each of the alternative schemes considered.

The individual options considered for a particular site can then be ranked so as to determine the scheme offering the best VfM. To help this process, and to ensure that proper account is taken of the unquantifiable benefits and impacts in identifying a preferred option, a technology options appraisal summary table (TOAST) can be used. This will enable a more complete assessment compared to just relying on the purely economic evaluation using the BCR.

Decisions will then be possible for the funding partners from a consideration of the cash flows revealed by the BCR analysis as described above, plus any additional funding needed, and of any subsidy required. For the business case to be decided there is, in principle at least, no need for a comparison of alternative schemes, or for a full appreciation of the background, i.e. policy and context. In practice however, it is highly unlikely that a (local) government partner in particular would, or could commit to funding a particular scheme without the larger view and justification provided by the transport case.

3.2 Functionalities

In the following the basic functionalities of the business case analysis tool are described, including a flow diagram showing the main processes, the main model inputs and outputs, and the data types used.

This is then followed by a section on detailed processes, which describes how the basic functionalities are incorporated into the developed spreadsheet model and what processes are carried out by the model i.e. the tool.

3.2.1 Structure

Figure 1 shows the structure of the business case analysis tool. The analysis process is based on the analysis of the transport and the business case of new transport schemes described above, including calculation of the BCR and a comparison of alternatives using TOAST.

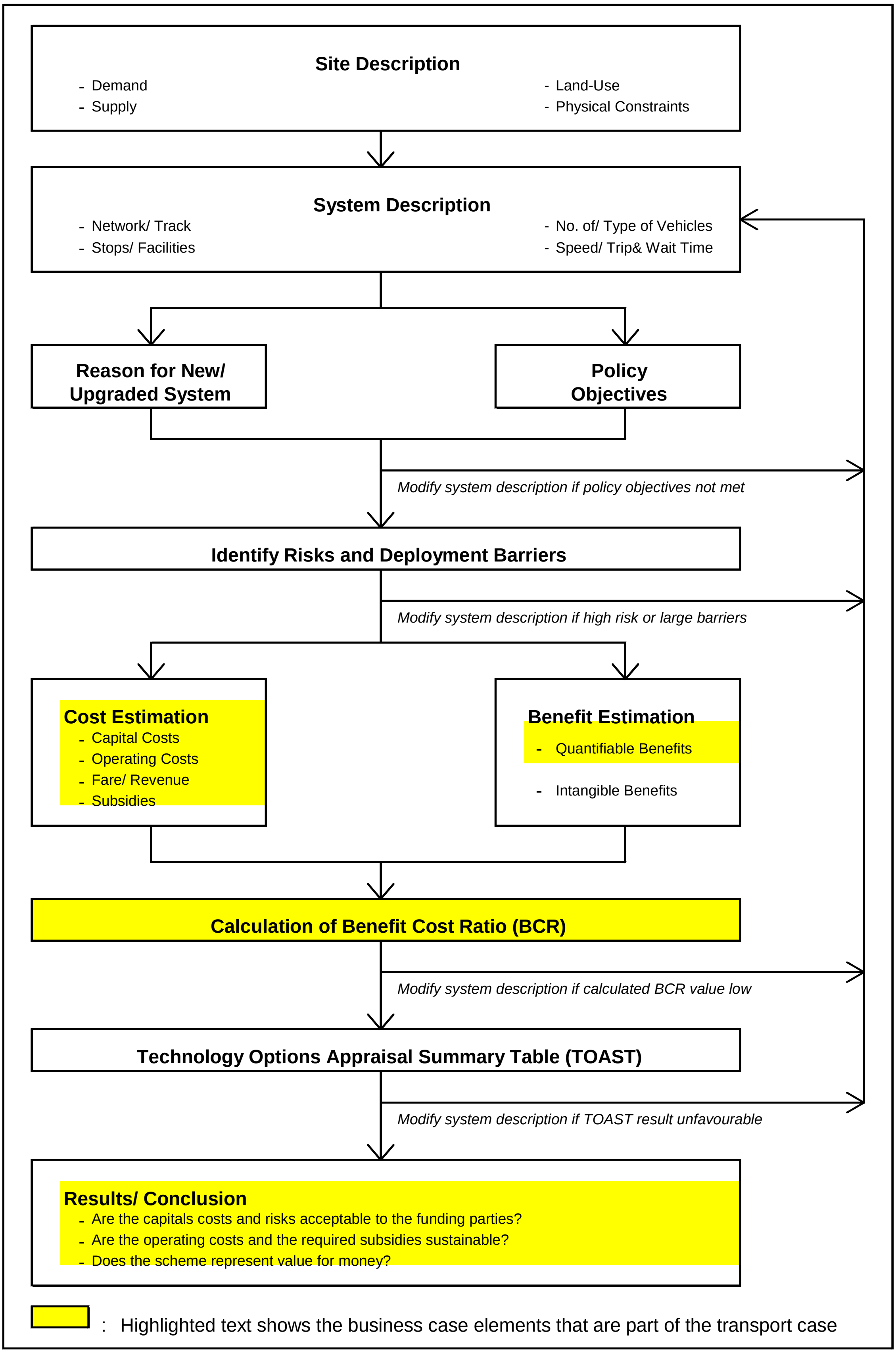

Figure 1: Structure of the Business Case Analysis Tool

The business case analysis tool flow diagram above shows the general process used to compare the transport and business case for different system options (generally including one of the CityMobil solutions and at least one alternative conventional public transport system, e.g. bus, metro, LRT, tram, or railway) that have been considered for a specific site.

The analysis process can be split into three main steps: 1) the site and system description including the reasons for the new system or system upgrade in relation to the policy objectives and an identification of risks and potential barriers to deployment; 2) the estimation of costs and benefits including all tangible and intangible issues; and 3) the calculation of the benefit cost ratio together with the technology appraisals summary table and results/ conclusion.

In the first step the site is described, including demand, supply, land-use and any physical constraints. This is followed by the description of system options, including network/ track, stops/ facilities, number of/ type of vehicle, and speed and trip/ wait time. The reasons for implementing the system have to meet policy objectives, and risks and deployment barriers have to be minimised.

In the second step the costs and the benefits of the system options considered for the specific site are estimated. Costs estimated for this analysis include system operating costs, capital costs, fares and other revenues, and subsidies. The system benefits relate to quantifiable benefits including saved time and accidents as well as to reliability and punctuality, attractiveness and image, sustainability and other intangible impacts.

In the third and final step of the three step business case analysis process the benefit cost ratios for all system options considered are calculated. For a system to be viable the BCR value should strictly be above 1.5 for the system to provide medium or high value for money. Furthermore, in addition to the pure economic analysis, the system options will be compared in the TOAST table to help identify the preferred option.

Within the TOAST, the user is required to specify a rating in the range 1 - 7 and, optionally, a weighting in the range 0 – 100 % for each benefit category. Where benefit categories have been assigned money values, they should be included within the benefit-cost ratio rather than in TOAST, and the ratings and weights within TOAST for these attributes will then be set to zero. Appropriate ratings and weights can be based on the professional judgment of the user, or dedicated surveys of relevant stakeholders. An example of the process of obtaining weights can be found in D5.1.2. As a default, equal weights can be applied to all attributes.

At four points in the analysis process an iteration is possible to allow modification of the system description. These occur: i) if the reasons for implementing/ upgrading the system do not meet policy objectives, ii) if risks and deployment barriers are too large, iii) if the BCR value is too low, and iv) if the TOAST results are unfavourable. In the following the model input/ outputs, and the types of information required will be described.

For purposes of presenting the business case tool in the form of a spreadsheet, and facilitating ease of use and the entry of data by users, the process of Fig 1 has been restructured in the form of a logical sequence of 9 steps as shown in Fig 2.

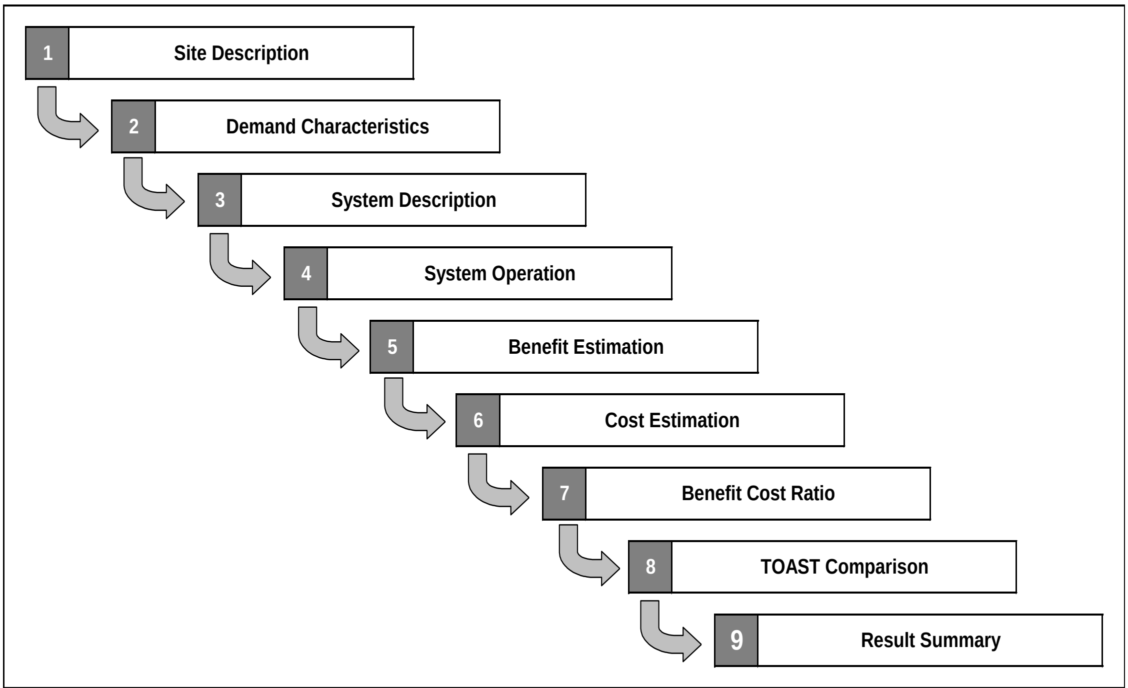

Figure 2: Structure of the Spreadsheet Model User-Interface

3.2.2 Inputs/ Outputs

Figure 3 below shows the main inputs into the business case analysis tool, the processes that are carried out by the analysis tool, and the outputs that are produced by it. These relate directly to the flow diagram described in the previous section.

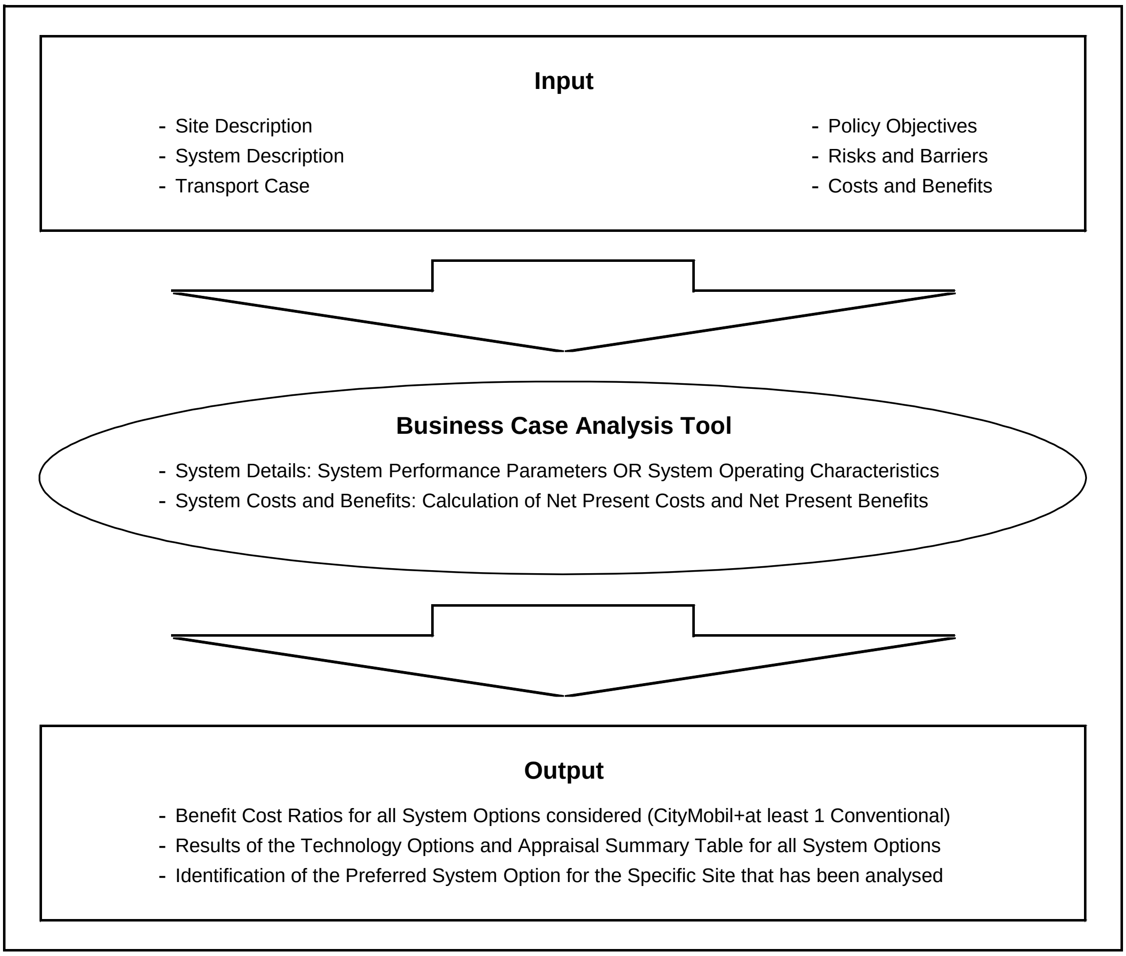

Figure 3: Inputs and Outputs of the Business Case Analysis Tool

In the following the key inputs, processes and outputs of the business case analysis tool are described in more detail. This is then be followed by a section detailing the types of data and the more general descriptive information required, including the possible sources for these.

Inputs into the business case analysis tool are: site description, system description, the transport case, policy objectives, risks and barriers, and intangible benefits. The site description includes passenger demand data (for all origins and destinations, peak and off-peak, if available), information on the existing transport system (if applicable) and the context of the application, and any physical constraints affecting the system implementation. The system description includes network/ track design, stops and facilities, type/ number of vehicle, and operating characteristics such as speed and trip/ waiting time.

Processes carried out by the business case analysis tool are to determine the system details and to calculate the costs and benefits. When determining the system details either the system performance parameters, or the system characteristics have to be provided as an input for the model to carry out this task (this will be automatically carried out by the model for PRT or CTS).

This is so that the system can either be specified by a user in terms of user needs e.g. required performance parameters such as average, minimum, and maximum in-vehicle travel times and waiting times; or by a system designer in terms of system characteristics such as the size of vehicles (passenger carrying capacity) and the number and speed of vehicles required for the operation.

Outputs from the business case analysis tool are the benefit cost ratio (BCR) and the presentation of findings in the technology options and appraisal summary table (TOAST) for all the alternative systems considered. Based on the comparison, the value for money and preferred system option for the specific site that has been analysed can be identified.

Note that while the tool has been developed to be comprehensive, it can easily be used in a first pass with incomplete and unrefined data to get an initial and rough idea of the business case. As mentioned before the business case analysis can be carried out as an iterative process, with opportunities to modify or refine the inputs at four points in the process. Consequently, if the CityMobil option has a low ranking in the TOAST table compared to the other systems considered, the opportunity is provided to refine the data and system description in order to try and improve the result.

In the following the types of data and general more descriptive information that are required to be input into the business case analysis tool are described in more detail. This includes specific items mentioned under the more general headings described above and in the section on the flow diagram for the analysis process.

For each type of data or information the unit (whether a specific unit or a ‘description’), the source (whether the local authority/ planner ie the user of the tool or the analysis tool itself), and whether or not the analysis tool provides any guidance on it (e.g. a likely range of values), is specified.

3.2.3 Types of Data

Figure 3 below shows the types of data and more general descriptive information required for the business case analysis tool. These relate directly to the flow diagram and the diagram of inputs, processes, and outputs of the analysis tool, that have been described in the previous section.

Type of Information		Unit	Source	Guidance
Site Description	Demand Data	O-D Matrix	Local Authority/ Planner	No
	Existing Transport System	Description	Local Authority/ Planner	No
	Application and Context	Description	Local Authority/ Planner	No
	Physical Constraints	Description	Local Authority/ Planner	No
System Description	Network/ Track Design	Description, km	Local Authority/ Planner are to decide either on Performance ***OR*** System Characteristics	Yes
	Stops and Facilities	Description, no. of		Yes
	Type of Vehicles	Description, no. of, pax		Yes
	Speed/ Trip and Wait Time	km/hr, min		Yes
System Benefits	Reliability/ Punctuality	7-Point Scale OR EUR/Year	Local Authority/ Planner	Yes
	Attractiveness/ Image	7-Point Scale OR EUR/Year	Local Authority/ Planner	Yes
	Improvements to Safety	7-Point Scale OR EUR/Year	Local Authority/ Planner	Yes
	Sustainability Impacts	7-Point Scale OR EUR/Year	Local Authority/ Planner	Yes
Capital Costs	Network/ Track	EUR/Unit	Range of Values from Tool	Yes
	Stations	EUR/Unit	Range of Values from Tool	Yes
	Facilities	EUR/Unit	Range of Values from Tool	Yes
	Vehicles	EUR/Unit	Range of Values from Tool	Yes
Operating Costs	System Operation	EUR/Year	Range of Values from Tool	Yes
	Maintenance	EUR/Year	Range of Values from Tool	Yes
	Staff Costs	EUR/Year	Range of Values from Tool	Yes
	Other Costs	EUR/Year	Range of Values from Tool	Yes
System Revenues	Passenger Fares	EUR/Year	Local Authority/ Planner	No
	System Subsidies	EUR/Year	Local Authority/ Planner	No
	Advertising	EUR/Year	Local Authority/ Planner	No
	Other Revenues	EUR/Year	Local Authority/ Planner	No
Barriers/ Risks	Technical/ Certification	Description	Examples from Tool	Yes
	Financial/ Commercial	Description	Examples from Tool	Yes
	Legal Issues/ Liability	Description	Examples from Tool	Yes
	Societal/ Public Acceptance	Description	Examples from Tool	Yes

Table 1: Types of Information required for the Business Case Analysis Tool

In the following the individual items under the main headings site description, system description, system benefits, capital costs, operating costs, system revenues and risks and deployment barriers, are described in more detail, including unit, source, and whether or not the analysis tool contains guidance.

The category *site description* includes demand data, information on the existing transport system, context of the application, and on physical constraints. The demand data has to be in the form of an O-D matrix showing passengers per hour in the time interval(s) to be analysed, whereas all other data is descriptive only. If no data is available, use estimates based on the methods developed in the City Application Manual.

The category *system description* includes network/ track layout, stops/ stations and facilities, types of vehicle(s), speed, and trip/ wait time. The data has specific units (km, km/hr, min, no. of) as well as descriptive elements. For this either the performance or the system characteristics have to be specified. Guidance is provided by the tool, based on examples.

The category *system benefits* includes quantifiable benefits such as time and accident savings as well as unquantifiable benefits such as reliability and punctuality, attractiveness, image, and sustainability impacts. All system benefit items are to be monetised where possible, or rated on a five point scale if not. The assessment has to be carried out by local authority/ planner. Guidance is provided by the analysis tool, if required.

The category *capital costs* includes network and track, stops/ stations, other facilities (e.g. maintenance, depot, recharging, etc.), and vehicles. The unit for all items is cost in Euros. For all items and for all transport systems the analysis tool provides a range of values for individual costs to be assumed if more specific data are not available.

The category *operating costs* includes the system operation, maintenance, staff cost and other cost relating to the specific system application. The unit for all items is cost in Euros/ year. For all items and for all transport systems the analysis tool provides a range of values for individual costs to be assumed if specific data are not available.

The category *system revenues* includes passenger fares, system subsidies, advertising and other revenues relating to specific system applications. The unit for all items is Euros/ year. These amounts of potential system revenues have to be specified by local authority/ planner. No guidance is available for this.

The category *risks and deployment barriers* includes technical and certification, financial and commercial, legal issues and liability, and societal issues and public acceptance of the system. This information is descriptive only. The analysis tool contains guidance for identifying risks/ deployment barriers, based on examples.

3.3 Detailed Processes

In this section the detailed processes performed by the business case analysis tool in order to offer the functionalities described in the previous section are described. This includes an overview of the main screens of the spreadsheet model where various types of data can be entered and/ or where results of the calculations carried out by the model are displayed.

In the following the main variables are described. This description includes the type of information to be entered or to be displayed and the unit in which the information is given. For data to be entered there will also be an indication whether or not the User Guidelines (described in the next chapter) contain advice or in the case of costs and benefits, give a range of values.

3.3.1 Screens

The description of the main variables to be entered/ displayed is given in relation to the nine main screens used by the spreadsheet model. For every input/output cell on these screens an individual variable name is given. The nine main screens are:

- Screen 1: Site Description
- Screen 2: Demand Characteristics
- Screen 3: System Description
- Screen 4: System Operation
- Screen 5: Benefit Estimation
- Screen 6: Cost Estimation
- Screen 7: Benefit Cost Ratio
- Screen 8: TOAST Comparison
- Screen 9: Result Summary

They are described below.

3.3.2 Spreadsheet Model

3.3.2.1 Screen 1: Site Description

Figure 4 below shows a screenshot of the spreadsheet model for site description.

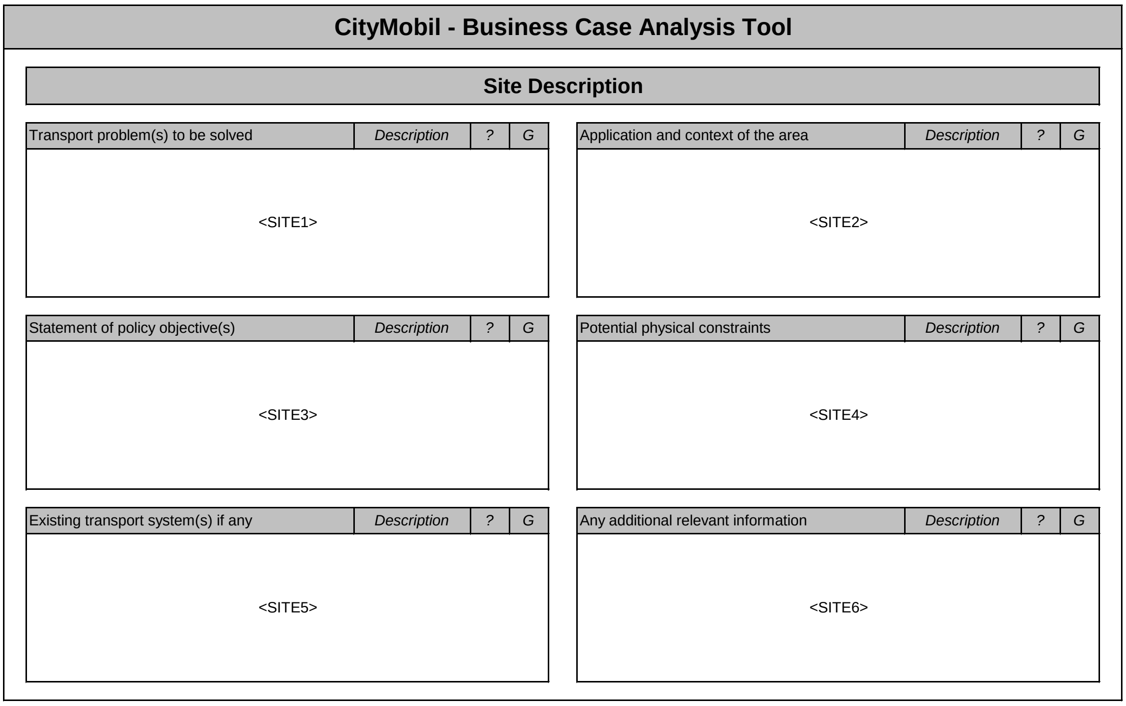

Figure 4: Spreadsheet Model - Site Description

<SITE1> : Statement of transport problem(s) to be solved [descriptive]

<SITE2> : Information on application and context [descriptive]

<SITE3> : Statement of the policy objectives [descriptive]

<SITE4> : Potential physical constraints affecting the system [descriptive]

<SITE5> : Existing transport systems in the area [descriptive]

<SITE6> : Any additional information relevant to system [descriptive]

3.3.2.2 Screen 2: Demand Characteristics

Figure 5 below shows a screenshot of the spreadsheet model for demand characteristics.

CityMobil - Business Case Analysis Tool

Number of passengers per year	[Pass/year]	?	G	<DEM1>
Number of origins/ destinations	#	?	-	<DEM2>

Demand Characteristics*

Demand data [Pass/15min] **

OD	1	2	3	4	5	6	7	8	9	10	Sum
1	<DEM3.1>	<DEM3.2>	<DEM3.3>	<DEM3.4>	<DEM3.5>	<DEM3.6>	<DEM3.7>	<DEM3.8>	<DEM3.9>	<DEM3.10>	<DEM3.11>
2	<DEM4.1>	<DEM4.2>	<DEM4.3>	<DEM4.4>	<DEM4.5>	<DEM4.6>	<DEM4.7>	<DEM4.8>	<DEM4.9>	<DEM4.10>	<DEM4.11>
3	<DEM5.1>	<DEM5.2>	<DEM5.3>	<DEM5.4>	<DEM5.5>	<DEM5.6>	<DEM5.7>	<DEM5.8>	<DEM5.9>	<DEM5.10>	<DEM5.11>
4	<DEM6.1>	<DEM6.2>	<DEM6.3>	<DEM6.4>	<DEM6.5>	<DEM6.6>	<DEM6.7>	<DEM6.8>	<DEM6.9>	<DEM6.10>	<DEM6.11>
5	<DEM7.1>	<DEM7.2>	<DEM7.3>	<DEM7.4>	<DEM7.5>	<DEM7.6>	<DEM7.7>	<DEM7.8>	<DEM7.9>	<DEM7.10>	<DEM7.11>
6	<DEM8.1>	<DEM8.2>	<DEM8.3>	<DEM8.4>	<DEM8.5>	<DEM8.6>	<DEM8.7>	<DEM8.8>	<DEM8.9>	<DEM8.10>	<DEM8.11>
7	<DEM9.1>	<DEM9.2>	<DEM9.3>	<DEM9.4>	<DEM9.5>	<DEM9.6>	<DEM9.7>	<DEM9.8>	<DEM9.9>	<DEM9.10>	<DEM9.11>
8	<DEM10.1>	<DEM10.2>	<DEM10.3>	<DEM10.4>	<DEM10.5>	<DEM10.6>	<DEM10.7>	<DEM10.8>	<DEM10.9>	<DEM10.10>	<DEM10.11>
9	<DEM11.1>	<DEM11.2>	<DEM11.3>	<DEM11.4>	<DEM11.5>	<DEM11.6>	<DEM11.7>	<DEM11.8>	<DEM11.9>	<DEM11.10>	<DEM11.11>
10	<DEM12.1>	<DEM12.2>	<DEM12.3>	<DEM12.4>	<DEM12.5>	<DEM12.6>	<DEM12.7>	<DEM12.8>	<DEM12.9>	<DEM12.10>	<DEM12.11>
Sum	<DEM13.1>	<DEM13.2>	<DEM13.3>	<DEM13.4>	<DEM13.5>	<DEM13.6>	<DEM13.7>	<DEM13.8>	<DEM13.9>	<DEM13.10>	<DEM13.11>

OR***

*) If no demand data available at this stage, use city application manual
**) Scale of matrix relates to the number of origins/ destinations specifie
***) Specity EITHER O-D matrix OR total demand

Total demand	[Pass/15min]	?	G	<DEM14>

Figure 5: Spreadsheet Model - Demand Characteristics

<DEM1> *	: Number of pax per year, guidance [Pax/ year]
<DEM2>	: Number of origins and destinations [#]
<DEM3.1-12.10>*/ **	: Demand data as O-D matrix [pax/ 15min]
<DEM3.11-12.11/ 13.1-13.10>	: Sums of demand data for each O/ D [Pass/ 15min]

Specify EITHER O-D matrix (sum of demand data calculated) OR total demand

<DEM13.11>***	: Sum of demand data for O-D matrix [Pass/ 15min]
<DEM14>*/ ***	: Total demand, guidance available [Pass/ 15min]

*) If no demand data available at this stage, use estimates based on the methods developed in the City Application Manual

**) Scale of matrix relates to the number of origins/ destinations specified

***) Specify EITHER O-D matrix OR total demand

3.3.2.3 Screen 3: System Description

Figure 6 below shows a screenshot of the spreadsheet model for system description.

CityMobil - Business Case Analysis Tool					
System Description				**CityMobil System**	**Conventional Alternative System**
Transport mode/ vehicle	*From list*	**?**	G	<SYSTEM 1.1>	<SYSTEM 1.2>
Type of guideway	*From list*	**?**	G	<SYSTEM 2.1>	<SYSTEM 2.2>
Length of guideway	*[m]*	**?**	-	<SYSTEM 3.1>	<SYSTEM 3.2>
Depot required	*Yes/ No*	**?**	-	<SYSTEM 4.1>	<SYSTEM 4.2>
Other facilities	*Description*	**?**	-	<SYSTEM 5.1>	<SYSTEM 5.2>
Comply with policy objectives	*7-point-scale*	**?**	-	<SYSTEM 6.1>	<SYSTEM 6.2>
Identification of risks/ barriers	*Description*	**?**	G	<SYSTEM 7.1>	<SYSTEM 7.2>
Severity of risk/ barriers	*7-point-scale*	**?**	-	<SYSTEM 8.1>	<SYSTEM 8.2>
Minimise risks/ barriers	*Description*	**?**	G	<SYSTEM 9.1>	<SYSTEM 9.2>
Additional Information	*Description*	**?**	-	<SYSTEM 10.1>	<SYSTEM 10.2>

Figure 6: Spreadsheet Model - System Description

<SYSTEM1.1-1.2> : Transport mode/ vehicle, guidance available [from list]
<SYSTEM2.1-2.2> : Type of guideway, guidance available [from list]
<SYSTEM3.1-3.2> : Length of guideway, from system design [m]
<SYSTEM4.1-4.2> : Depot required, yes/ no [-]
<SYSTEM5.1-5.2> : Other facilities, description [descriptive]
<SYSTEM6.1-6.2> : Comply with policy objectives, judgement [7-point scale]
<SYSTEM7.1-7.2> : Identification of barriers, examples available [descriptive]
<SYSTEM8.1-8.2> : Severity of risks, judgement [7-point scale]
<SYSTEM9.1-9.2> : Minimise barriers, examples available [descriptive]
<SYSTEM10.1-10.2> : Additional information, description [descriptive]

3.3.2.4 Screen 4: System Operation

Figure 7 below shows a screenshot of the spreadsheet model for system operation.

CityMobil - Business Case Analysis Tool

System Operation*				**CityMobil System**	**Conventional Alternative System**
Transport mode/ vehicle	From list	⇨	n/a	<SYSTEM 1.1>	<SYSTEM 1.2>
Average vehicle speeds	*[km/hr]*	?	-	<OPERATION 1.1A>	<OPEATION 1.2A>
Average trip times	*[min]*	?	-	<OPERATION 2.1A>	<OPEATION 2.2A>
Average waiting times	*[min]*	?	-	<OPERATION 3.1A>	<OPEATION 3.2A>
Number of vehicles	#	=	*n/a*	<OPERATION 4.1A>	<OPEATION 4.2A>
Passengers per vehicle	*[Pass/veh]*	=	*n/a*	<OPERATION 5.1A>	<OPEATION 5.2A>
Number of stops	#	=	*n/a*	<OPERATION 6.1A>	<OPEATION 6.2A>
Number of vehicles	#	?	-	<OPERBTION 1.1B>	<OPEBTION 1.2B>
Passengers per vehicle	*[Pass/veh]*	?	-	<OPERBTION 2.1B>	<OPEBTION 2.2B>
Number of stops	#	?	-	<OPERBTION 3.1B>	<OPEBTION 3.2B>
Average vehicle speeds	*[km/hr]*	=	*n/a*	<OPERBTION 4.1B>	<OPEBTION 4.2B>
Average trip times	*[min]*	=	*n/a*	<OPERBTION 5.1B>	<OPEBTION 5.2B>
Average waiting times	*[min]*	=	*n/a*	<OPERBTION 6.1B>	<OPEBTION 6.2B>

*) Specify EITHER performance (speed, trip time, waiting time) OR system characteristics (number and size of vehicles, number of stops)

Figure 7: Spreadsheet Model - System Operation

Specify EITHER system performance parameters OR operation characteristic:

<OPERATION1.1A-1.2A/ 1.1B-1.2B> : Average speeds [km/hr]
<OPERATION2.1A-2.2A/ 2.1B-2.2B > : Average trip times [min]
<OPERATION3.1A-3.2A/ 3.1B-3.2B > : Average waiting time [min]
} Performance

<OPERATION4.1A-4.2A/ 4.1B-4.2B > : Number of vehicles [no.]
<OPERATION5.1A-5.2A/ 5.1B-5.2B > : Pass per vehicle [no.]
<OPERATION6.1A-6.2A/ 6.1B-6.2B > : Number of stops [no.]
} Operation

Calculations carried out by the business case analysis tool follow the process described in chapter 3.3.3 System Simulation.

3.3.2.5 Screen 5: Benefit Estimation

Figure 8 below shows a screenshot of the spreadsheet model for benefit estimation.

CityMobil - Business Case Analysis Tool

Benefit Estimation					CityMobil System	Conventional Alternative System
System Revenue	Fare per passenger	[EUR/Pass]	?	-	<BENEFIT 1.1>	<BENEFIT 1.2>
	Number of passengers	[Pass/year]	⇨	n/a	<BENEFIT 2.1>	<BENEFIT 2.2>
	Total Fare	[EUR/year]	=	n/a	<BENEFIT 3.1>	<BENEFIT 3.2>
	Subsidies	[EUR/year]	?	-	<BENEFIT 4.1>	<BENEFIT 4.2>
	Other system revenue	[EUR/year]	?	-	<BENEFIT 5.1>	<BENEFIT 5.2>
	Σ System Revenues	[EUR/year]	=	n/a	<BENEFIT 6.1>	<BENEFIT 6.2>
System Benefits*	User time savings	[EUR/year]	?	-	<BENEFIT 7.1>	<BENEFIT 7.2>
	System reliability	[EUR/year]	?	-	<BENEFIT 8.1>	<BENEFIT 8.2>
	System punctuality	[EUR/year]	?	-	<BENEFIT 9.1>	<BENEFIT 9.2>
	Image/ attractiveness	[EUR/year]	?	-	<BENEFIT 10.1>	<BENEFIT 10.2>
	Sustainability impacts	[EUR/year]	?	-	<BENEFIT 11.1>	<BENEFIT 11.2>
	Saved operating costs	[EUR/year]	?	-	<BENEFIT 12.1>	<BENEFIT 12.2>
	Accident savings	[EUR/year]	?	-	<BENEFIT 13.1>	<BENEFIT 13.2>
	Saved pollutants	[EUR/year]	?	-	<BENEFIT 14.1>	<BENEFIT 14.2>
	Jobs generated	[EUR/year]	?	-	<BENEFIT 15.1>	<BENEFIT 15.2>
	Non-user benefits	[EUR/year]	?	-	<BENEFIT 16.1>	<BENEFIT 16.2>
	Other system benefits	[EUR/year]	?	-	<BENEFIT 17.1>	<BENEFIT 17.2>
	Σ System Benefits	[EUR/year]	=	n/a	<BENEFIT 18.1>	<BENEFIT 18.2>

*) If not possible to monetise leave blank and apply rating on 7-point scale as part of TOAST comparison instead

Figure 8: Spreadsheet Model - Benefit Estimation

<BENEFIT1.1-1.2> : Fare per passenger [EUR/Passenger]
<BENEFIT2.1-2.2> : Number of passengers, = DEM1 [Pass/Year]
<BENEFIT3.1-3.2> : Total fare = BENEFIT1 * BENEFIT2 [EUR/Year]
<BENEFIT4.1-4.2> : Subsidies [EUR/Year]
<BENEFIT5.1-5.2> : Other system revenue, specify [EUR/Year]
<BENEFIT6.1-6.2> : Sum system revenue, = BENEFIT1+4+5 [EUR/Year]

<BENEFIT7.1-7.2>* : User time savings [EUR/Year]
<BENEFIT8.1-8.2>* : System reliability [EUR/Year]
<BENEFIT9.1-9.2>* : System punctuality [EUR/Year]
<BENEFIT10.1-10.2>* : Image/ attractiveness [EUR/Year]
<BENEFIT11.1-11.2>* : Sustainability impacts [EUR/Year]
<BENEFIT12.1-12.2>* : Saved operating costs [EUR/Year]
<BENEFIT13.1-13.2>* : Accident savings [EUR/Year]
<BENEFIT14.1-14.2>* : Saved pollutants [EUR/Year]
<BENEFIT15.1-15.2>* : Jobs generated [EUR/Year]
<BENEFIT16.1-16.2>* : Non-user benefits [EUR/Year]
<BENEFIT17.1-17.2> : Other system benefits, specify [EUR/Year]
<BENEFIT18.1-18.2> : Sum system benefits, = Sum of BENEFIT7-17 [EUR/Year]

*) If not possible to monetise leave blank and apply rating as part of TOAST

3.3.2.6 Screen 6: Cost Estimation

Figure 9 below shows a screenshot of the spreadsheet model for cost estimation.

CityMobil - Business Case Analysis Tool

Cost Estimation					CityMobil System	Conventional Transport System
Capital Costs	Cost of guideway per m	[EUR/m]	?	G	<COST 1.1>	<COST 1.2>
	Length of guideway	[m]	⇨	n/a	<COST 2.1>	<COST 2.2>
	Total cost of guideway	[EUR]	=	n/a	<COST 3.1>	<COST 3.2>
	Cost per vehicle	[EUR/vehicle]	?	G	<COST 4.1>	<COST 4.2>
	Number of vehicles	#	⇨	n/a	<COST 5.1>	<COST 5.2>
	Total cost of vehicles	[EUR]	=	n/a	<COST 6.1>	<COST 6.2>
	Cost per stop	[EUR/stop]	?	G	<COST 7.1>	<COST 7.2>
	Number of stops	#	⇨	n/a	<COST 8.1>	<COST 8.2>
	Total cost of stops	[EUR]	=	n/a	<COST 9.1>	<COST 9.2>
	Cost of depot	[EUR]	?	G	<COST 10.1>	<COST 10.2>
	Cost of other facilities	[EUR]	?	-	<COST 11.1>	<COST 11.2>
	Other capital costs	[EUR]	?	-	<COST 12.1>	<COST 12.2>
	Σ Capital Costs	[EUR]	=	n/a	<COST 13.1>	<COST 13.2>
Operating Costs	Operating costs per m	[EUR/m]	?	G	<COST 14.1>	<COST 14.2>
	Length of guideway	[m]	⇨	n/a	<COST 15.1>	<COST 15.2>
	Total perating costs	[EUR]	=	n/a	<COST 16.1>	<COST 16.2>
	Other operating costs	[EUR]	?	-	<COST 17.1>	<COST 17.2>
	Σ Operating Costs	[EUR]	=	n/a	<COST 18.1>	<COST 18.2>

Figure 9: Spreadsheet Model - Cost Estimation

<COST1.1-1.2> : Cost of guideway per m, range of values available [EUR/m]
<COST2.1-2.2> : Length of guideway, = SYSTEM3 [m]
<COST3.1-3.2> : Total cost of guideway, = COST1 * COST2 [EUR]
<COST4.1-4.2> : Cost per vehicle, range of values available [EUR/Vehicle]
<COST5.1-5.2> : Number of vehicles, = OPERATION4A or B [#]
<COST6.1-6.2> : Total cost of vehicles, = COST4 * COST5 [EUR]
<COST7.1-7.2> : Cost per stop, range of values available [EUR/Stop]
<COST8.1-8.2> : Number of stops, = OPERATION6A or B [#]
<COST9.1-9.2> : Total cost of stops, = COST7 * COST8 [EUR]
<COST10.1-10.2>: Cost of depot, range of values available [EUR]
<COST11.1-11.2> : Cost of other facilities [EUR]
<COST12.1-12.2>: Other capital costs [EUR]
<COST13.1-13.2>: Sum of capital costs, = COST 3 + 6 + 9 + 10 + 11 + 12 [EUR]

<COST14.1-14.2>: Operating costs per m, range of values available [EUR/m]
<COST15.1-15.2>: Length of guideway, SYSTEM3 [m]
<COST16.1-16.2>: Total operating costs, = COST14 * COST15 [EUR]
<COST17.1-17.2>: Other operating costs [EUR]
<COST18.1-18.2>: Sum of operating costs, = COST16 + COST17 [EUR]

3.3.2.7 Screen 7: Benefit Cost Ratio

Figure 10 below shows a screenshot of the spreadsheet model for Benefit Cost Ratio.

CityMobil - Business Case Analysis Tool

Project lifetime		[years]	?	-	<BCR 1>	
Discount rate		[%]	?	-	<BCR 2>	
Benefit Cost Ratio					**CityMobil System**	**Conventional Alternative System**
Costs	Capital costs	[EUR]	⇨	n/a	<BCR 3.1.>	<BCR 3.2>
	Operating costs	[EUR/year]	⇨	n/a	<BCR 4.1.>	<BCR 4.2>
	Net Present Costs	[EUR]	=	n/a	<BCR 5.1.>	<BCR 5.2>
Benefits	System revenues	[EUR/year]	⇨	n/a	<BCR 6.1>	<BCR 6.2>
	System benefits	[EUR/year]	⇨	n/a	<BCR 7.1>	<BCR 7.2>
	Net Present Benefits	[EUR]	=	n/a	<BCR 8.1>	<BCR 8.2>
BCR Values*		-	=	n/a	<BCR 9.1>	<BCR 9.2>

*) BCR = (NPB - NPC) / NPC

where:

NPB = Net Present Benefit
NPC = Net Present Cost

i.e. all values are present values measured over project lifetime and then discounted

Figure 10: Spreadsheet Model - Benefit Cost Ratio

<BCR1> : Project life time [Years]

<BCR2> : Discount rate [%]

<BCR3.1-3.2> : Capital costs, = COST13 [EUR]
<BCR4.1-4.2> : Operating costs, = COST18 [EUR/Year]
<BCR5.1-5.2> : Net present costs [EUR]

<BCR6.1-6.2> : System revenue, = BENEFIT6 [EUR/Year]
<BCR7.1-7.2> : System benefits, = BENEFIT17 [EUR/Year]
<BCR8.1-8.2> : Net present benefits [EUR]

<BCR9.1-9.2> : BCR value, = equation as below

BCR = (NPB - NPC) / NPC

where:

NPB = Net Present Benefit*
NPC = Net Present Cost*

*) All values are present values, measured over project lifetime and then discounted, therefore the accounting period and the discount rate have to be defined.

3.3.2.8 Screen 8: TOAST Comparison

Figure 11 below shows a screenshot of the spreadsheet model for TOAST.

CityMobil - Business Case Analysis Tool

Transport Options Appraisal Summary Table (TOAST)						CityMobil System	Conventional Transport System
System Benefits*	User time savings	Rating	7-point-scale	?	-	<TOAST 1.1>	<TOAST 1.2>
		Weighting	Percentage	?	-	<TOAST 2.1>	<TOAST 2.2>
	System reliability	Rating	7-point-scale	?	-	<TOAST 3.1>	<TOAST 3.2>
		Weighting	Percentage	?	-	<TOAST 4.1>	<TOAST 4.2>
	System punctuality	Rating	7-point-scale	?	-	<TOAST 5.1>	<TOAST 5.2>
		Weighting	Percentage	?	-	<TOAST 6.1>	<TOAST 6.2>
	Image/ attractiveness	Rating	7-point-scale	?	-	<TOAST 7.1>	<TOAST 7.2>
		Weighting	Percentage	?	-	<TOAST 8.1>	<TOAST 8.2>
	Sustainability impacts	Rating	7-point-scale	?	-	<TOAST 9.1>	<TOAST 9.2>
		Weighting	Percentage	?	-	<TOAST 10.1>	<TOAST 10.2>
	Saved operating costs	Rating	7-point-scale	?	-	<TOAST 11.1>	<TOAST 11.2>
		Weighting	Percentage	?	-	<TOAST 12.1>	<TOAST 12.2>
	Accident savings	Rating	7-point-scale	?	-	<TOAST 13.1>	<TOAST 13.2>
		Weighting	Percentage	?	-	<TOAST 14.1>	<TOAST 14.2>
	Saved pollutants	Rating	7-point-scale	?	-	<TOAST 15.1>	<TOAST 15.2>
		Weighting	Percentage	?	-	<TOAST 16.1>	<TOAST 16.2>
	Jobs generated	Rating	7-point-scale	?	-	<TOAST 17.1>	<TOAST 17.2>
		Weighting	Percentage	?	-	<TOAST 18.1>	<TOAST 18.2>
	Non-user benefits	Rating	7-point-scale	?	-	<TOAST 19.1>	<TOAST 19.2>
		Weighting	Percentage	?	-	<TOAST 20.1>	<TOAST 20.2>
	Other system benefits	Rating	7-point-scale	?	-	<TOAST 21.1>	<TOAST 21.2>
		Weighting	Percentage	?	-	<TOAST 22.1>	<TOAST 22.2>
	Overall rating	Rating	7-point-scale	?	n/a	<TOAST 23.1>	<TOAST 23.2>

*) If possible to monetise leave blank and fill in values as part of the benefit estimation for the BCR calculation

Rating on 7-point scale:			
	1	LB	Large beneficial
	2	MB	Moderate beneficial
	3	SB	Slight beneficial
	4	N	Neutral
	5	SA	Slight adverse
	6	MA	Moderate adverse
	7	LA	Large adverse

Figure 11: Spreadsheet Model - TOAST Comparison

<TOAST1.1-1.2>* : User time savings rating, judgement [7-point scale]
<TOAST2.1-2.2>* : User time savings weighting, judgement [%]
<TOAST3.1-3.2>* : System reliability rating, judgement [7-point scale]
<TOAST4.1-4.2>* : System reliability weighting, judgement [%]
<TOAST5.1-5.2>* : System punctuality rating, judgement [7-point scale]
<TOAST6.1-6.2>* : System punctuality weighting, judgement [%]
<TOAST7.1-7.2>* : Image/ attractiveness rating, judgement [7-point scale]
<TOAST8.1-8.2>* : Image/ attractiveness weighting, judgement [%]
<TOAST9.1-9.2>* : Sustainability impacts rating, judgement [7-point scale]
<TOAST10.1-10.2>* : Sustainability impacts weighting, judgement [%]
<TOAST11.1-11.2>* : Saved operating costs rating, judgement [7-point scale]
<TOAST12.1-2.2>* : Saved operating costs weighting, judgement [%]
<TOAST13.1-3.2>* : Accident savings rating, judgement [7-point scale]
<TOAST14.1-14.2>* : Accident savings weighting, judgement [%]
<TOAST15.1-15.2>* : Saved pollutants rating, judgement [7-point scale]
<TOAST16.1-16.2>* : Saved pollutants weighting, judgement [%]
<TOAST17.1-17.2>* : Jobs generated rating, judgement [7-point scale]
<TOAST18.1-18.2>* : Jobs generated weighting, judgement [%]
<TOAST19.1-19.2>* : Non-user benefits rating, specify, judgement [7-point scale]
<TOAST20.1-20.2>* : Non-user benefits weighting, judgement [%]
<TOAST21.1-21.2>* : Other system benefits rating, specify, judgement [7-point scale]
<TOAST22.1-22.2>* : Other system benefits weighting, judgement [%]

<TOAST23.1-23.2> : Overall system benefits, = normalised sum of the products of each rating and its weighting

*) If possible to monetise leave blank and fill in benefit estimation for BCR calculation

3.3.2.9 Screen 9: Result Summary

Figure 12 below shows a screenshot of the spreadsheet model for Result Summary.

CityMobil - Business Case Analysis Tool

Result Summary				CityMobil System	Conventional Transport System
Transport mode/ vehicle	*From list*	⇨	*n/a*	<RESULT 1.1>	<RESULT 1.2>
Number of vehicles	#	⇨	*n/a*	<RESULT 2.1>	<RESULT 2.2>
Passengers per vehicle	*[Pass/veh]*	⇨	*n/a*	<RESULT 3.1>	<RESULT 3.2>
Type of guideway	*From list*	⇨	*n/a*	<RESULT 4.1>	<RESULT 4.2>
Length of guideway	*[m]*	⇨	*n/a*	<RESULT 5.1>	<RESULT 5.2>
Number of stops	#	⇨	*n/a*	<RESULT 6.1>	<RESULT 6.2>
Average vehicle speeds	*[km/hr]*	⇨	*n/a*	<RESULT 7.1>	<RESULT 7.2>
Average trip times	*[min]*	⇨	*n/a*	<RESULT 8.1>	<RESULT 8.2>
Average waiting times	*[min]*	⇨	*n/a*	<RESULT 9.1>	<RESULT 9.2>
BCR value	-	⇨	*n/a*	<RESULT 10.1>	<RESULT 10.2>
TOAST rating	*7-point-scale*	⇨	*n/a*	<RESULT 11.1>	<RESULT 11.2>

Figure 12: Spreadsheet Model - Result Summary

<RESULT1.1-1.2> = <SYSTEM1.1-1.2> Transport mode
<RESULT2.1-2.2> = <OPERATION4A or B>Number of vehicles
<RESULT3.1-3.2> = <OPERATION5A or B>Passengers per vehicle
<RESULT4.1-4.2> = <SYSTEM2.1-2.2> Type of guideway
<RESULT5.1-5.2> = <SYSTEM3.1-3.2> Length of guideway
<RESULT6.1-6.2> = <OPERATION6A or B>Number of stops
<RESULT7.1-7.2> = <OPERATION1A or B> Average vehicle speeds
<RESULT8.1-8.2> = <OPERATION2A or B>Average trip times
<RESULT9.1-9.2> = <OPERATION3A or B>Average waiting times
<RESULT10.1-10.2> = <BCR9.1-9.2> BCR value
<RESULT11.1-11.2> = <TOAST21.1-21.2>Average system benefits

In the following section the system simulation process used in order to determine the vehicle performance parameters from the assumed system operating characteristics (or vice versa) as set out on the screen for the system description shown above, is described in detail.

3.3.3 System Simulation

This section is based on modelling and simulation work carried out by DITS, and reported more fully in Section 5 of CityMobil deliverable D2.3.1 'Modelling Background Report'.

One of the main components of the spreadsheet model is to calculate either the vehicle performance parameters (vehicle speed, trip/ waiting time) from the assumed system characteristics (number of vehicles, passengers per vehicle, number of stops), or the system characteristics from the assumed performance parameters.

The system simulation has been realised for Personal Rapid Transit (PRT) and for CyberCars (CTS). A series of simulations have been performed to obtain relationships allowing the calculation of the vehicle performance parameters from the system characteristics (or vice versa).

Different network configurations (i.e. with different length, number of stops, etc.) have been simulated varying the inputs (i.e. number of vehicles, the maximum allowed waiting time, etc.). In such a way linear relationships between vehicle performance parameters and system characteristics have been found.

The site characteristics needed to be known a-priori are network length and foreseen demand. Results refer to PRT systems with the following characteristics: maximum speed equal to 40 kph, vehicles capacity equal to 4 places, "dedicated" system (i.e. the vehicles go directly to the chosen destination, without intermediate stops).

Alternatively, the simulated CTS have the following characteristics: maximum speed equal to 40 kph, vehicles capacity equal to 10 places, "shared" system (i.e. the vehicles can be used at the same time by users having different origin and/or destination; thus the vehicles can stop at intermediate stations during a journey).

In addition to the relationships between vehicle performance parameters and system characteristics, simulation results also allow the determination of relationships between site characteristics (network length and foreseen demand) and system performances (total vehicle kilometres, trip production, mean vehicles spacing, mean headway between vehicles).

3.3.3.1 Relationship between number of stops and vehicle speed

The number of stops which comprise the network influences the average speed of the vehicles. The more the number of stops, the lower the average speed. On the other hand, the average vehicle speed is not strongly influenced by the demand. The speed stays almost constant even if the demand increases (e.g. for a PRT the average speed varies from about 27 kph for a demand equal to 500 requests per hour to about 26 kph for a demand equal to 6000 requests per hour).

The relationships between the average speed and the number of stops and vice versa are shown in Table 2.

Output	PRT	CTS
Average speed	y = -0.3351 x + 31.001	y = -0.2245 x + 20.77
Number of stops	y = (x – 31.001) / (-0.3351)	y = (x – 20.77) / (-0.2245)

Table 2: Number of stops vs. average vehicle speed

Here x is the input data (average speed or number of stops) and y is the output data (number of stops or average speed). The average vehicle speed (number of stops) is directly available by inserting the number of stops (average vehicles speed) in the formula.

3.3.3.2 Relationship between passengers per vehicle and trip times

The number of passengers per vehicle influences the average trip time of the vehicle. In particular, a linear relationship has been found between the number of passengers per vehicle and the ratio between the average trip time and the network length.

Table 3 shows the formulae relating the number of passengers per vehicle and the ratio of trip time / network length for both PRT and CTS systems.

Output	PRT	CTS
Passenger per vehicles	y = 0.4608 x + 0.7018	y = 1.3825 x + 3.1902
Trip time / network length	y = (x – 0.7018) / 0.4608	y = (x – 3.1902) / 1.3825

Table 3: Passengers per vehicle vs. ratio of trip time/network length

In table 3, x is the input data (passengers per vehicles or trip time / network length) and y is the output data. The number of passengers per vehicle (or the ratio between trip time and network length) is directly available by inserting the ratio between trip time and network length (or the number of passenger per vehicles) in the formula.

For the second formula (calculation of trip time), once the value of y is known, by multiplying it with the network length the average trip time is obtained.

3.3.3.3 Relationship between number of vehicles and waiting time

The number of vehicles circulating on a network is influenced by the maximum allowed waiting time[1] (max WT), the demand and the network length. The average waiting time depends on the maximum allowed waiting time.

To calculate the number of vehicles from the average waiting time, a two step method can be used. First the average waiting time is used to calculate the maximum allowed waiting time. Then, this last is used to calculate the number of vehicles.

Alternatively, the number of vehicles can be used to calculate the maximum allowed waiting time and then this last is used to find the average waiting time.

Linear relationships between the number of vehicles and the ratio of demand / network length have been found for different values of the maximum allowed waiting time (see table 4). One set of relationships is presented for CTS. For PRT systems, two different relationships have been found, depending on the number of stops.

max WT	**PRT (n° stops < 15)**	**PRT (n° stops < 15)**	**CTS**
60 s	y = 0.1072 x + 0.9662	y = 0.1599 x - 0.2865	y = 0.0193 x + 0.3139
180 s	y = 0.0946 x + 0.0362	y = 0.1412 x + 0.5421	y = 0.0211 x - 1.9844
300 s	y = 0.0828 x + 0.2039	y = 0.1242 x + 2.1371	y = 0.0211 x - 2.8055

Table 4: Number of vehicles vs. ratio demand/network length

[1] The maximum allowed waiting time is the maximum time that users are disposed to wait for a vehicle.

In table 4, x is the number of vehicles and y is the ratio between demand and network length. The number of vehicles is available by inserting the ratio between demand and network length in the formula.

Once the average waiting time is known, the maximum allowed waiting time can be easily determined (see table 5). Consequently, the formula to be used for calculating the number of vehicles is also determined.

max WT	PRT (n° stops < 15)	PRT (n° stops < 15)	CTS
60 s	0.33 min	0.27 min	0.46 min
180 s	1.48 min	1.37 min	1.72 min
300 s	2.76 min	2.65 min	3.10 min

Table 5: Maximum allowed waiting time vs. average waiting time

Alternatively, once the number of vehicles is known, inverting the formulas in table 4, the corresponding demand can be calculated. Comparing the calculated demand with the fixed one input of the model), the maximum allowed waiting time allowing to cope with the demand can be found. Consequently, the average waiting time is also known (see table 5).

3.3.3.4 Vehicle Kilometres

A linear relationship between the ratio of vehicle kilometres / network length and the ratio of demand / network length has been found for both PRT and CTS systems.

The formulae used to calculate this ratio, for PRT and CTS, are shown in table 6 for three maximum allowed waiting times. In the table, x is the demand / network length and y is the vehicle kilometres / network length. Also in this case, for PRT, two different relationships have been found, depending on the number of stops.

The maximum allowed waiting time depends on the average waiting time calculated (or fixed) previously.

max WT	PRT (n° stops < 15)	PRT (n° stops < 15)	CTS
60 s	y = 1.7131 x + 14.04	y = 3.0285 x + 8.9259	y = 0.3142 x + 20.249
180 s	y = 1.632 x + 5.636	y = 2.9287 x + 15.876	y = 0.3538 x - 17.782
300 s	y = 1.547 x + 8.221	y = 2.7675 x + 48.943	y = 0.3749 x – 34.65

Table 6: Ratio of vehicle km/network length vs. ratio of demand/network length

Once the value of y is known, by multiplying it with network length the total number of vehicle kilometres run is obtained.

3.3.3.5 Trip production

A linear relationship between the ratio of trip production / network length and the ratio of demand / network length has been found for both PRT and CTS systems.

The formulae used to calculate this ratio, for PRT and CTS, are shown in table 7 for three maximum allowed waiting times. In the table, x is the demand / network length and y is the trip production / network length. Again in this case, for PRT, two different relationships have been found depending on the number of stops.

The maximum allowed waiting time depends on the average waiting time calculated (or fixed) previously.

max WT	PRT (n° stops < 15)	PRT (n° stops < 15)	CTS
60 s	y = 1.2477 x - 1.8562	y = 1.9885 x – 36.702	y = 1.2469 x – 95.355
180 s	y = 1.2225 x – 6.9873	y = 2.0163 x – 37.319	y = 1.3386 x – 164.94
300 s	y = 1.1742 x – 6.8855	y = 1.9997 x – 28.885	y = 1.3964 x – 220.94

Table 7: Ratio of trip production/network length vs. ratio of demand/network length

Once the value of y is known, by multiplying with network length the trip production is obtained.

3.3.3.6 Mean headway between vehicles

The mean headway between vehicles can be calculated based on the results obtained for the number of vehicle per kilometres. In particular, the mean headway is given by:

$$\bar{h} = \frac{\bar{s} - l}{v_{\max}}$$

where:

- $\bar{s}$ is the mean spacing between vehicles (nose to nose), given by the inverse of the number of vehicles per kilometres;
- l is the vehicle's length (i.e. 4.0 meters for PRT and 6.0 meters for CTS);
- $v_{\max}$ is the maximum speed of the vehicles.

Results indicate that a non-linear relationship exists between the mean vehicle headway and the ratio of demand/network length. The formulae used to calculate the mean headway are showed in table 8, where x is the ratio of demand / network length and y is the mean headway. Once the maximum allowed waiting time is chosen, the mean headway is available by inserting the ratio of demand / network length in the formula.

The maximum allowed waiting time depends on the average waiting time calculated (or fixed) previously.

max WT	PRT (n° stops < 15)	PRT (n° stops < 15)	CTS
60 s	$y = 1733.1\ x^{-1.1641}$	$y = 2534.4\ x^{-1.3123}$	$y = 6840.1\ x^{-0.9503}$
180 s	$y = 1966.4\ x^{-1.1542}$	$y = 2062.1\ x^{-1.2512}$	$y = 107487\ x^{-1.3475}$
300 s	$y = 1873.1\ x^{-1.121}$	$y = 1413.3\ x^{-1.1673}$	$y = 320353\ x^{-1.5016}$

Table 8: Mean headway between vehicles vs. ratio of demand/network length

Once the value of y is known, by multiplying it with network length the total number of vehicle kilometres run is obtained.

4 User Guidelines

The spreadsheet model described above has been implemented and is available. User Guidelines have been developed to help users use the spreadsheet and provide guidance on what it i.e. the model, does and how to use it. The User Guidelines are presented as a stand alone document in the Appendix to this document.

In summary, the main outputs of the business case analysis tool as described in the previous section enable a direct comparison of the system options analysed, including system descriptions, performance parameters, operating characteristics, economic analyses and qualitative assessments of other system benefits.

The spreadsheet model is a high level analysis tool that can be used to compare conventional transport options against more advanced systems (i.e. the CityMobil solutions), and take into account a variety of less tangible, including sustainability benefits. This will help enable planners and decision-makers to develop a transport and business case for these systems.

The model can be used is an iterative process through varying and refining the values and detail for a number of different model inputs in order to assess the effects of these alterations on the overall BCR and TOAST results. This will help to determine the optimal system operating characteristics to be taken forward for a full design.

5 Conclusion

The CityMobil project ‘Towards Advanced Transport for the Urban Environment’ aims at achieving a more effective organisation of urban transport, resulting in a more rational use of motorised traffic with less congestion and pollution, safer driving, a higher quality of living and enhanced integration with spatial development.

This will be achieved by promoting the introduction of advanced technologies (e.g. PRT, CTS, dual-mode, high-tech buses, etc.) into the transport environment. The concepts, methods and tools developed will then be validated and demonstrated in a number of different European cities under different circumstances.

Sub-project SP2 ‘Future scenarios’ investigates how automated road transport systems fit into the expected scenarios for advanced urban transport in the future, particularly how they will contribute to sustainability. Tools for cities and operators will be developed to analyse transport requirements and potential impacts.

Within SP2, work-package WP2.4 ‘Business Cases’ has aimed at assessing the economic viability of a range of specific applications and solutions to develop a generic economic analysis tool, to aid the site selection process through economic analysis, and to contribute to the evaluation framework for the CityMobil project.

The analysis tool developed and described in this report is applicable to all CityMobil case study cities as well as to be used by planners and decision-makers for the evaluation of potential future applications. Although the tool has been tested using the CityMobil case study cities, it was mainly developed to be used outside/ after the project.

The objectives and planned activities for task 2.4.4 ‘Generic Economic Analysis Tool’ were: “a generic analysis tool will be developed to evaluate the transport and business case of implementing new systems. This will show the methodology required to confirm economic viability of systems and can be used after the project”.

Deliverable 2.4.1, this document together with the stand alone User Guidelines document provided in the Appendix, provides a detailed outline of the business case analysis tool, including the main processes and calculations carried out by the spreadsheet model, the main inputs required and the outputs given by it, and the user interface used as part of the model.

6 References

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APPENDIX A. USER GUIDELINES FOR THE BUSINESS CASE ANALYSIS TOOL

A1 INTRODUCTION

The CityMobil project 'Towards Advanced Transport for the Urban Environment' aims at achieving a more effective organisation of urban transport, resulting in a more rational use of motorised traffic with less congestion and pollution, safer driving, a higher quality of living and enhanced integration with spatial development.

This should be achieved by promoting the introduction of advanced technologies (e.g. PRT, CTS, dual-mode, high-tech buses, etc.) into the transport environment. The concepts, methods and tools developed will then be validated and demonstrated in a number of different European cities under different circumstances.

Tools for cities and operators have been developed to analyse transport requirements and potential impacts. The business case analysis tool described in this document is aimed at assessing the economic viability of a range of specific applications and solutions and is to be used by planners and decision-makers for the evaluation of potential future applications.

This User Guidelines document describes the main inputs and outputs to the business case analysis tool (which is available in spreadsheet form as an accompaniment to this document) in relation to the seven screens that make up the user interface for the model and the two that present the results. As an aid to the reader, inputs into the model required from the user are indicated in green and outputs generated by the model are indicated in dark grey.

In the following an overview of the business case analysis tool is given including all the main screens of the model for data entry and display, furthermore a detailed key is provided, explaining the characteristics and sources of the data to be entered or displayed, followed by a description of the user interface. In many cases guidance is provided on suitable sources of information or on appropriate values for the various parameters, such as system costs.

Note that while the tool has been developed to be comprehensive, it can easily be used in a first pass with incomplete and unrefined data to get an initial and rough idea of the business case. In addition the business case analysis can be carried out as an iterative process, with opportunities to modify or refine the inputs provided at four points in the process. Consequently, if the CityMobil option has a low ranking initially compared to the other systems considered, the opportunity is provided to refine the data and system description in order to try and improve the result. This will in turn help to determine the optimal system operating characteristics to be taken forward for a full design.

A2 BUSINESS CASE MODEL

A2.1 Overview

Figure A1 below shows an overview of the business case analysis tool model.

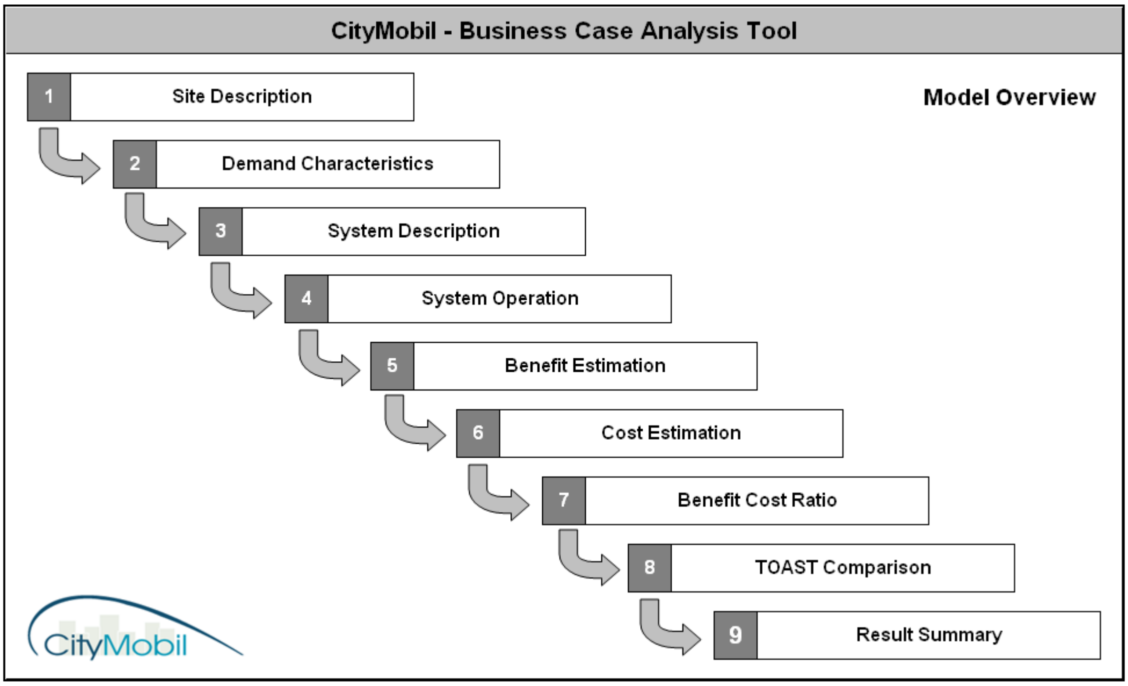


Figure A1: Spreadsheet Model - Model Overview

As the figure above indicates, the user interface for the business case analysis tool consists of a spreadsheet with 7 individual screens for data entry and 2 for the display of results. These screens include the following:

- Screen 1: Site Description
- Screen 2: Demand Characteristics
- Screen 3: System Description
- Screen 4: System Operation
- Screen 5: Cost Estimation
- Screen 6: Benefit Estimation
- Screen 7: Benefit Cost Ratio
- Screen 8: TOAST Comparison
- Screen 9: Results Summary

A2.2 Model Key

Figure A2 below shows the key for the business case analysis tool. It defines the characteristics and source of the data to be entered or to be displayed in the spreadsheet model, together with an indication if any guidance is available.

CityMobil - Business Case Analysis Tool

Key

Type of information		Data Source		User Guidance	
Description :	Answer in free text	**?** :	User input	**G** :	Guidance available
From list :	Choose from list	**=** :	Calculated	**-** :	No guidance
7-point-scale :	Rate on scale	**⇨** :	Previous value	**n/a** :	Not applicable
Yes/ No :	Answer Yes/ No	**Cells for model input and output**			
# :	Number of items	[green cell]		:	User input
[Unit] :	Unit for value	[dark grey cell]		:	Model Output

Figure A2: Spreadsheet Model - Model Key

As shown in figure 2, the Model Key, for each data entry or display cell 3 characteristics are given, *type of information*, *data source*, and *user guidance*. *Types of information* include a description, choosing an item from a given list, rating on a 7-point-scale, yes/ no, number of items, and specific units. *Data sources* are either user input, calculation by the model, or a value previously entered/ calculated. *User guidance* indicates whether or not guidance is available, or if it is not applicable here. Furthermore, as an aid to the reader, cells for user input are coloured green, and cells for model output are dark grey. In the following section all 9 main screens of the user interface will be described including information on model input and output for each screen. In addition where guidance is provided, the respective screens showing this information are also presented.

A2.3 User Interface

A2.3.1 Screen 1: Site Description

Figure A3 below shows a screenshot of the user interface for site description.

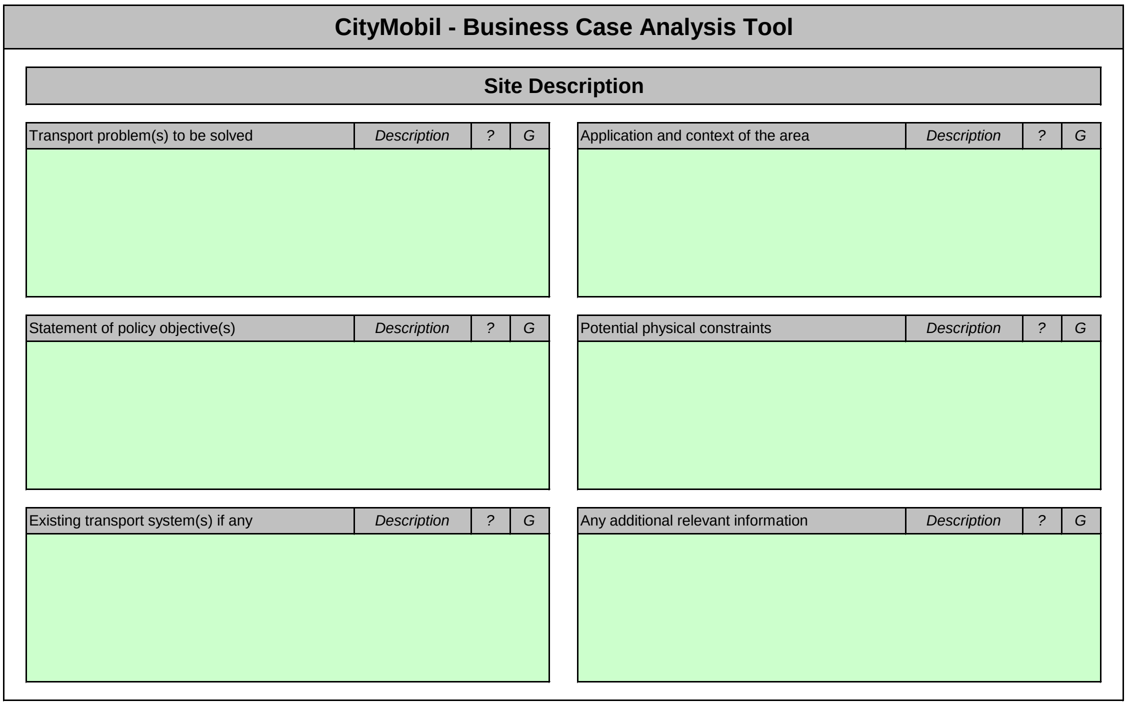


Figure A3: User Interface - Site Description

There is no model output on this screen, the information to be entered includes the following:

- State the transport problem(s) to be solved by the new transport option(s) which are being considered.
- State the policy objective(s) that apply to the site and the transport option(s) which are being considered.
- Brief description of the transport system option(s) that are currently being operated on the sites, if any.
- Brief description of the context of the proposed system applications on the site (e.g. land-use, facilities, etc.)
- Brief description of physical constraints (e.g. building, landscape, etc.) that could effect the transport options.
- Brief description of any additional information, which is relevant to the transport option considered, if any.

Figure A4 below shows the screenshot for the guidance for site description.

CityMobil - Business Case Analysis Tool

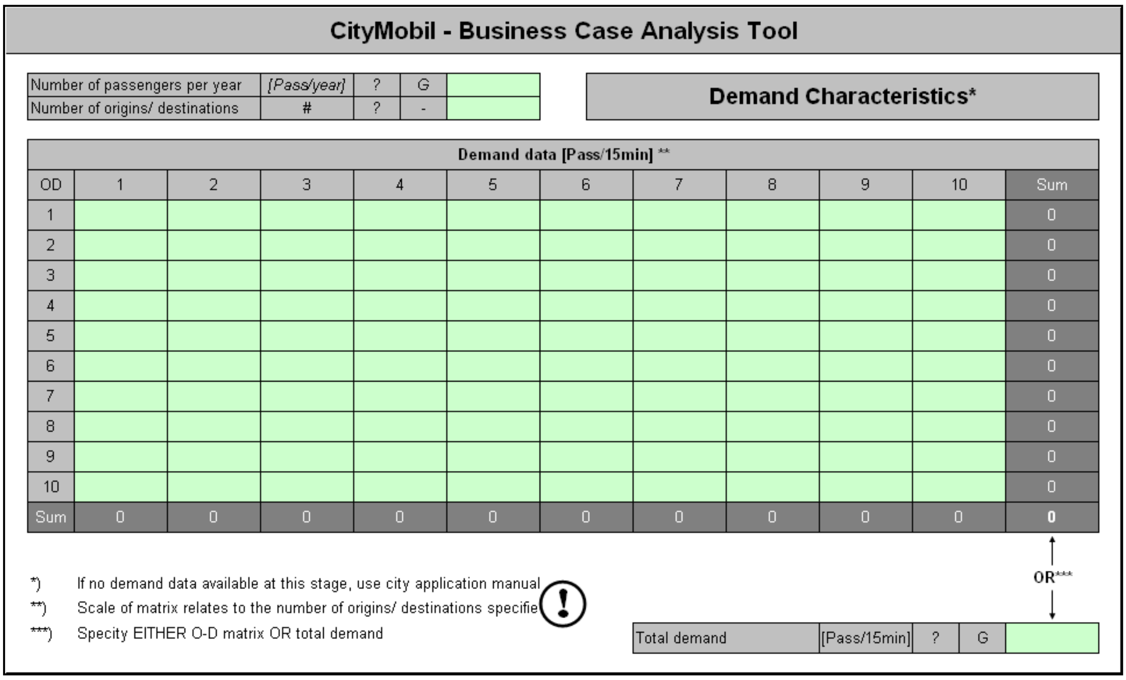
Guidance for Site Description

Transport problem(s) to be solved	Application and context of the area
Describe the identified transport related problems that are to be addressed by the new or upgraded transport systems considered for the site, e.g. - Congestion - New facilities - Increased demand - Environmental - Social exclusion	Describe the site where the new or upgraded transport system is considered and the context of the application, this information includes e.g. - Land use system - Topography - Size of area - Role/ function in region - Transport in region
Statement of policy objective(s)	**Potential physical constraints**
Describe the national/ regional/ local policy objective, which have an effect on the new or upgraded transport systems considered for the site, e.g. - Economic development - Urban regeneration - Sustainability - Demand management - Improve public transport	Describe any potential physical constraints on the site that could affect the new or upgraded transport system that is considered for the site, e.g. - Need for bridges/ tunnels - Distances between buildings - Landscape/ topography - Vehicle/ pedestrian traffic - Existing transport infrastructure
Existing transport system(s) if any	**Any additional relevant information**
If there are any existing transport systems on the site where the new or upgraded transport system is considered, desribe systems, including e.g. - Transport mode/ vehicle - Number of vehicles - Length of track/ network - Number of stops - Depot/ other facilities	If there is any additional information relevant to the site and the new or upgraded transport system that is considered for it, describe this in detail

Figure A4: User Interface - Guidance for Site Description

A2.3.2 Screen 2: Demand Characteristics

Figure A5 below shows a screenshot of the user interface for demand characteristics.



CityMobil - Business Case Analysis Tool

Number of passengers per year	[Pass/year]	?	G	
Number of origins/ destinations	#	?	-	

Demand Characteristics*

Demand data [Pass/15min] **

OD	1	2	3	4	5	6	7	8	9	10	Sum
1											0
2											0
3											0
4											0
5											0
6											0
7											0
8											0
9											0
10											0
Sum	0	0	0	0	0	0	0	0	0	0	0

OR***

*) If no demand data available at this stage, use city application manual
**) Scale of matrix relates to the number of origins/ destinations specifie
***) Specity EITHER O-D matrix OR total demand

Total demand	[Pass/15min]	?	G	

Figure A5: User Interface - Demand Characteristics

The information to be entered includes the following:

- Number of passengers per year
- Number of origins/ destinations.

- Demand data* as O-D matrix (if known).

OR

- Total demand (if no detailed data available).

*) If no demand data is available and further advice is needed, see the CityMobil City Application Manual (currently under preparation).

A2.3.3 Screen 3: System Description

Figure A6 below shows a screenshot of the user interface for system description.

CityMobil - Business Case Analysis Tool

System Description				CityMobil System	Conventional Alternative System
Transport mode/ vehicle	*From list*	?	G		
Type of guideway	*From list*	?	G		
Length of guideway	*[m]*	?	-		
Depot required	*Yes/ No*	?	-		
Other facilities	*Description*	?	-		
Comply with policy objectives	*7-point-scale*	?	-		
Identification of risks/ barriers	*Description*	?	G		
Severity of risk/ barriers	*7-point-scale*	?	-		
Minimise risks/ barriers	*Description*	?	G		
Additional Information	*Description*	?	-		

Figure A6: User Interface - System Description

The information to be entered includes the following:

- Transport mode/ vehicle considered (options are: PRT, cybercars, train, metro, tram/ LRT, and conventional bus).
- Type of guideway to be used (options are: conventional road infrastructure, PRT guide way, light rail, heavy rail).
- Length of the chosen guideway in [m], to be estimated from the initial system design for each option considered.
- Additional facilities required for each option, if any. Type of facilities user defined (e.g. depot, battery charging facility, etc.).
- Compliance of each option with the policy objectives as described in the previous screen, rate on 7-point scale,
- Identification of potential risks or barriers for each option (e.g. technology, legal, certification, user acceptance, etc.).
- Severity of the risks/ barriers that have been identified for each option as above, if any, to be rated on 7-point scale.
- Brief description of any measures to minimise the impact of potential risks/ barriers as described above, if any.

Figure A7 below shows the screenshot for the guidance for site description.

CityMobil - Business Case Analysis Tool

Guidance for System Description

		Transport Mode/ Vehicle					
		Bus	Tram/ LRT	Metro	Rail	PRT	CTS
Type of Guideway	Existing road	※					
	Existing road + guidance						※
	Separate lane/ guideway					※	
	Light rail		※	※			
	Heavy rail				※		

		Minimise Risks/ Barriers
Risks/ Barriers	Institutional/ political	Provide evidence for the economic viability, safety and reliability of the system based on the experience with existing syster
	Technical/ operational	Carry out careful system design in order to address all technical and operational issues at an early stage to provide solutior
	Financial/ commercial	Results from the economic analysis of system options can address this, otherwise investigate additional funding opportunit
	Societal/ acceptability	Carry out market research to identify user perceptions and requirements and market education to inform the key stakehold
	Legal/ certification	On private sites legal and certification issues are easier to overcome, additionally identify and address safety issues early c

Figure A7: Guidance for System Description

A2.3.4 Screen 4: System Operation

Figure A8 below shows a screenshot of the user interface for system operation.

CityMobil - Business Case Analysis Tool

System Operation*				CityMobil System	Conventional Alternative System
Transport mode/ vehicle	From list	⇨	n/a	<SYSTEM 1.1>	<SYSTEM 1.2>
Average vehicle speeds	[km/hr]	?	-		
Average trip times	[min]	?	-		
Average waiting times	[min]	?	-		
Number of vehicles	#	=	n/a		
Passengers per vehicle	[Pass/veh]	=	n/a		
Number of stops	#	=	n/a		
Number of vehicles	#	?	-		
Passengers per vehicle	[Pass/veh]	?	-		
Number of stops	#	?	-		
Average vehicle speeds	[km/hr]	=	n/a		
Average trip times	[min]	=	n/a		
Average waiting times	[min]	=	n/a		

*) Specify EITHER performance (speed, trip time, waiting time) OR system characteristics (number and size of vehicles, number of stops)

Figure A8: User Interface - System Operation

On this screen EITHER the system performance parameters (speed, trip time and waiting time) have to be specified and the model will determine the system characteristics (number of vehicles, passengers per vehicle and number of stop) based on this, or the other way around, depending on the background for the project.

Input (output):

- Average vehicle speeds [km/hr]
- Average trip times [min]
- Average waiting time [min]

Output (input):

- Number of vehicles [#]
- Passengers per vehicle [Pass/veh]
- Number of stops [#]

A2.3.5 Screen 5: Benefit Estimation

Figure A9 below shows a screenshot of the user interface for benefit estimation.

CityMobil - Business Case Analysis Tool

Benefit Estimation					CityMobil System	Conventional Alternative System
System Revenue	Fare per passenger	[EUR/Pass]	?	-		
	Number of passengers	[Pass/year]	⇨	n/a	0	0
	Total Fare	[EUR/year]	=	n/a	0	0
	Subsidies	[EUR/year]	?	-		
	Other system revenue	[EUR/year]	?	-		
	Σ System Revenues	[EUR/year]	=	n/a	**0**	**0**
System Benefits*	User time savings	[EUR/year]	?	-		
	System reliability	[EUR/year]	?	-		
	System punctuality	[EUR/year]	?	-		
	Image/ attractiveness	[EUR/year]	?	-		
	Sustainability impacts	[EUR/year]	?	-		
	Saved operating costs	[EUR/year]	?	-		
	Accident savings	[EUR/year]	?	-		
	Saved pollutants	[EUR/year]	?	-		
	Jobs generated	[EUR/year]	?	-		
	Non-user benefits	[EUR/year]	?	-		
	Other system benefits	[EUR/year]	?	-		
	Σ System Benefits	[EUR/year]	=	n/a	**0**	**0**

*) If not possible to monetise leave blank and apply rating on 7-point scale as part of TOAST comparison instead

Figure A9: User Interface - Benefit Estimation

There is no model output on this screen of the model, the information to be entered includes the following:

- System Revenues:
  - Fare Level [EUR/Year]
  - Subsidies [EUR/Year]
  - Other System Revenue [EUR/Year]
- System Benefits*:
  - User Time Savings [EUR/Year]
  - System Reliability [EUR/Year]
  - System Punctuality [EUR/Year]
  - Image/ Attractiveness [EUR/Year]
  - Sustainability Impacts [EUR/Year]
  - Saved Operating Costs [EUR/Year]
  - Accident Savings [EUR/Year]
  - Saved Pollutants [EUR/Year]
  - Jobs Generated [EUR/Year]
  - Non-user Benefits [EUR/Year]
  - Other System Benefits [EUR/Year]

*) If not possible to monetise at this stage, apply rating on 7-point scale as part of the TOAST (Transport Options Appraisal Summary Table) Comparison (see Screen 8 below).

A2.3.6 Screen 6: Cost Estimation

Figure A10 below shows a screenshot of the user interface for benefit estimation.

CityMobil - Business Case Analysis Tool

Cost Estimation					CityMobil System	Conventional Transport System
Capital Costs	Cost of guideway per m	[EUR/m]	?	G		
	Length of guideway	[m]	⇨	n/a	0	0
	Total cost of guideway	[EUR]	=	n/a	0	0
	Cost per vehicle	[EUR/vehicle]	?	G		
	Number of vehicles	#	⇨	n/a	0	0
	Total cost of vehicles	[EUR]	=	n/a	0	0
	Cost per stop	[EUR/stop]	?	G		
	Number of stops	#	⇨	n/a	0	0
	Total cost of stops	[EUR]	=	n/a	0	0
	Cost of depot	[EUR]	?	G		
	Cost of other facilities	[EUR]	?	-		
	Other capital costs	[EUR]	?	-		
	Σ Capital Costs	[EUR]	=	n/a	**0**	**0**
Operating Costs	Operating costs per m	[EUR/m]	?	G		
	Length of guideway	[m]	⇨	n/a	0	0
	Total perating costs	[EUR]	=	n/a	0	0
	Other operating costs	[EUR]	?	-		
	Σ Operating Costs	[EUR]	=	n/a	**0**	**0**

Figure A10: User Interface - Cost Estimation

There is no model output on this screen of the model, the information to be entered includes the following points:

- Capital Costs*:
  - Guideway [EUR]
  - Vehicles [EUR]
  - Stops/ Stations [EUR]
  - Facilities [EUR]
  - Other Capital Costs [EUR]

- Operating Costs*:

*) If not known, for each cost category a range of values will be given, based on the transport system/ type of vehicle chosen.

Guidance is available directly from the spreadsheet tool on the costs of different systems.

Figure A11 below shows the screenshot for the guidance for cost estimation.

CityMobil - Business Case Analysis Tool

Guidance for Cost Estimation

		Capital and Operating Costs				
		Bus	Tram/ LRT	Metro	Rail	PRT/ CTS
Capital costs	Cost of guideway [EUR/m]	10-45	4,000-15,000	72,500-220,000	7,500-30,000	1000-7000
	Cost per vehicle [EUR/vehicle]	160,000-270,000	1,000,000-3,000,000	9,000,000	15,000,000	50,000-300,000
	Cost per stop [EUR/stop]	5,500	18,000	3,000,000	6,000,000-15,000,000	50,000-1,500,000
	Cost of depot [EUR]	6,500,000	650,000-4,200,000	750,000-1,000,000	750,000-1,000,000	6,500,000
Operating costs [EUR/m]		275-4,750	275-4,750	3,000-6,500	375-1,800	150-5,000

Figure A11: Guidance for Cost Estimation

A2.3.7 Screen 7: Benefit Cost Ratio

Figure A12 below shows a screenshot of the user interface for benefit cost ratio.

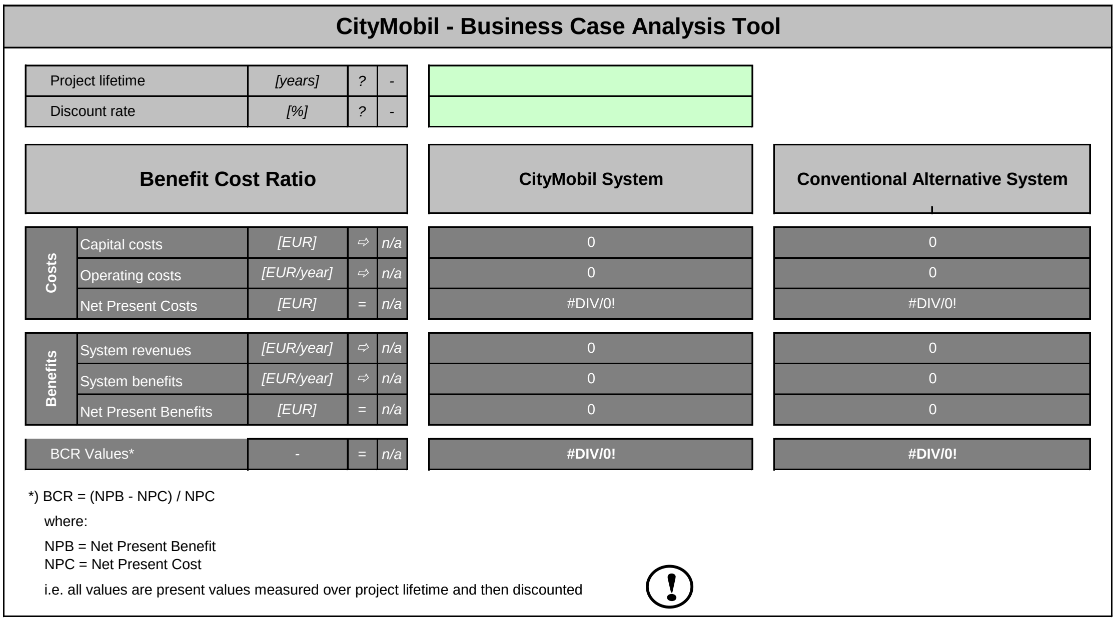


Figure A12: User Interface - Benefit Cost Ratio

On this screen the Benefit Cost Ratio (BCR) will be calculated based on the data entered on previous screens for system costs and benefits. All values are present values, measured over project lifetime and then discounted, therefore the accounting period and the discount rate have to be defined.

The information to be entered includes the following points:

- Project lifetime
- Discount rate

The information to be displayed includes the following points:

- Capital Costs
- Operating Costs
- Net Present Costs

- System Revenue
- System Benefits
- Net Present Benefits

- Benefit Cost Ratio

A2.3.8 Screen 8: TOAST Comparison

Figure A13 below shows a screenshot of the user interface for TOAST comparison.

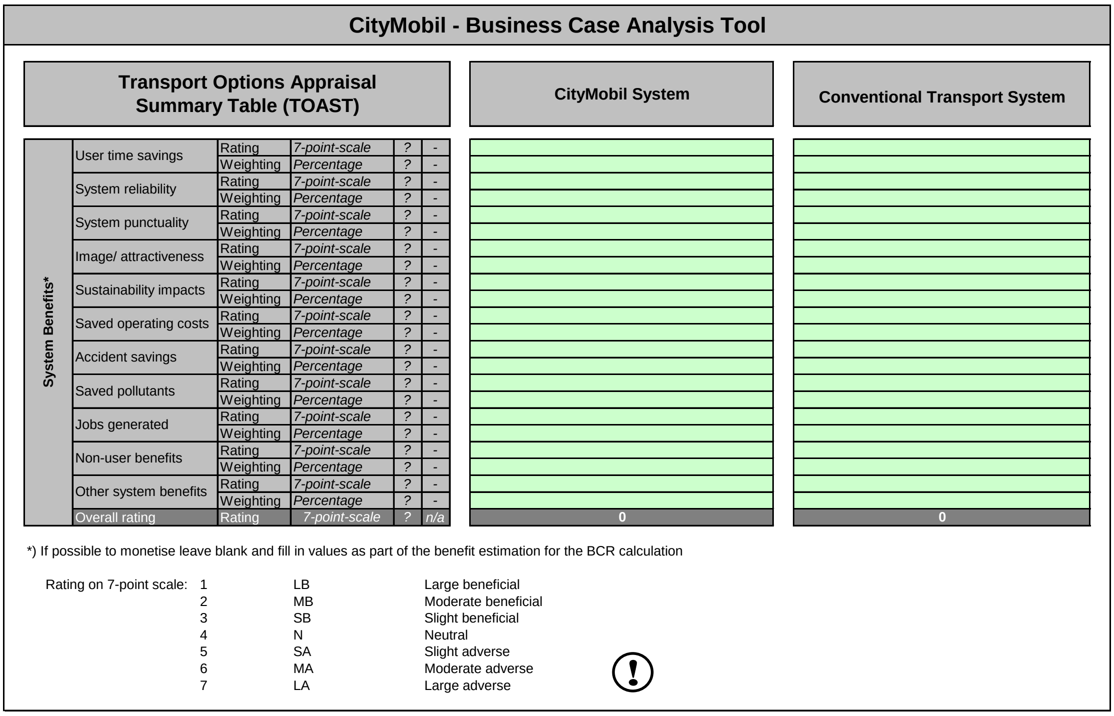


Figure A13: User Interface - TOAST Comparison

On this screen the average TOAST (Transport Options Appraisal Summary Table) ratings will be calculated based on the data entered here.

All ratings are to be entered on a 7-point scale. These ratings are part of the TOAST methodology and include the following descriptions:

1	LB	Large Beneficial
2	MB	Moderate Beneficial
3	SB	Slight Beneficial
4	N	Neutral
5	SA	Slight Adverse
6	MA	Moderate Adverse
7	LA	Large Adverse

The information to be entered covers the following benefit categories:

- System Benefits*
  - User Time Savings [EUR/Year]
  - System Reliability [EUR/Year]
  - System Punctuality [EUR/Year]
  - Image/ Attractiveness [EUR/Year]
  - Sustainability Impacts [EUR/Year]
  - Saved Operating Costs [EUR/Year]
  - Accident Savings [EUR/Year]
  - Saved Pollutants [EUR/Year]
  - Jobs Generated [EUR/Year]
  - Non-user Benefits [EUR/Year]
  - Other System Benefits [EUR/Year]

For each benefit category a weighting parameter in the range 0 – 100 % can optionally be given in order to give higher/ lower importance to some or all of the benefit categories. Where benefit categories have been assigned money values, they should be included within the benefit-cost ratio and left blank in the TOAST. Weights within the TOAST for these attributes will then be set to zero. Appropriate ratings and weights can be based on the professional judgment of the user, or dedicated surveys of relevant stakeholders. An example of the process of obtaining weights can be found in D5.1.2. As a default, the field can be left blank which is equivalent to giving equal weights to all attributes.

*) If possible to monetise enter values on the 'Benefit Estimation' screen in order to include the data for the calculation of benefit cost ratios.

The information to be displayed includes the following points:

- Overall TOAST Rating

The overall rating is derived from calculating the normalised sum of the products of each rating and its weighting.

A2.3.9 Screen 9: Result Summary

Figure A14 below shows a screenshot of the user interface for result summary.

CityMobil - Business Case Analysis Tool					
Result Summary				**CityMobil System**	**Conventional Transport System**
Transport mode/ vehicle	*From list*	➪	*n/a*	0	0
Number of vehicles	*#*	➪	*n/a*	0	0
Passengers per vehicle	*[Pass/veh]*	➪	*n/a*	0	0
Type of guideway	*From list*	➪	*n/a*	0	0
Length of guideway	*[m]*	➪	*n/a*	0	0
Number of stops	*#*	➪	*n/a*	0	0
Average vehicle speeds	*[km/hr]*	➪	*n/a*	0	0
Average trip times	*[min]*	➪	*n/a*	0	0
Average waiting times	*[min]*	➪	*n/a*	0	0
BCR value	-	➪	*n/a*	#DIV/0!	#DIV/0!
TOAST rating	*7-point-scale*	➪	*n/a*	#REF!	#REF!

Figure A14: User Interface - Result Summary

There is no model input on this screen of the model, the information to be displayed includes the following points:

- Transport Mode/ Vehicle
- Number of Vehicles
- Passengers per Vehicle
- Type of Guideway
- Length of Guideway
- Number of Stops
- Average Vehicle Speeds
- Average Trip Times
- Average Waiting Time
- Benefit Cost Ratio
- TOAST Rating

This last screen allows a direct comparison of the system options analysed, including system description, performance parameters, operating characteristics, benefit cost ratio (only economic analysis) and the TOAST rating (including a qualitative assessment of other system benefits).

A3 Summary

The main outputs of this business case analysis tool enable a direct comparison of the system options analysed, including system description, performance parameters, operating characteristics, economic analysis and the qualitative assessment of other system benefits. Unquantifiable benefits The results facilitate a judgement of value for money.

The spreadsheet model is a high level analysis tool to compare conventional transport options to more advanced systems (i.e. the CityMobil solutions), covering a variety of less tangible benefits. This will enable planners and decision-makers to develop a transport and business case for these systems.

Two particular features of the tool are designed to assist the user:

iii) The tool contains 'simulations' of PRT and CTS systems so that the user can specify a system either in terms of user needs eg required performance characteristics such as average, minimum, and maximum in-vehicle travel times and waiting times; or in terms of system design parameters such as the size of vehicles (passenger carrying capacity) and the number and speed of vehicles required for the operation. The simulations also facilitate testing of a range of 'what if' questions so that effects of changing demand, network length or vehicle carrying capacity can be easily answered;

iv) The tool provides guidance on a range of information and parameters taken from real life examples, such as data on the costs of different systems.

The tool has been developed to be comprehensive, but it can easily be used in a first pass with incomplete and unrefined data to get an initial and rough idea of the business case. In addition the model can be used as an iterative process through varying and refining the values for a number of different model inputs in order to assess the effects of these alterations on the overall BCR and TOAST results. This will help to determine the optimal system operating characteristics to be taken forward for a full design.

APPENDIX B. GLOSSARY OF ABBREVIATIONS

ADAS	Advanced Driver Assistance System
AGT	Automated Guideway Transit
BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
Civils	Civil engineering works
CTS	Cybernetic Transport System
CVHS	Cooperative Vehicle Highway System
DfT	Department for Transport in the UK
EU	European Union
LRT	Light Rail Transit
NPB	Net Present Benefit
NPC	Net Present Cost
O-D	Origin - Destination
Pass	passengers
Pax	passengers
PRT	Personal Rapid Transit
TOAST	Technology Options Appraisal Summary Table
ULTra	The trade name of the PRT system implemented by ATS Ltd at Heathrow Airport
VfM	value for money
WT	waiting time