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APPLICATION OF THE BUSINESS CASE TOOL

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SIXTH FRAMEWORK PROGRAMME

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Executive Summary

The BCT (Business Case Tool) developed in WP2.4 in CityMobil (see CityMobil deliverable D2.4.1 Generic Analysis Tool for Business Cases) has been used to assess the business cases for the cities and schemes analysed using the MARS model in CityMobil WP2.3. The results of this exercise are presented.

The BCT has performed as expected, and any variations due to known and accountable factors appear to be encompassed by a simple sensitivity analysis involving a worst case scenario made up from assuming a 20% reduction in demand and a 20% increase in costs.

For best results however, the exercise has shown that modifications are required to the BCT, in particular:

- to take account of a build period
- to allow for a vehicles, and perhaps an infrastructure refurbishment / replacement programme
- to recognise the effects of a growth in demand on the growth in numbers of vehicles required.

These changes will be implemented in the final version of the BCT which will be a public deliverable available at the end of the project.

1. Introduction

The CityMobil Business Case Tool (BCT) and accompanying User Guidelines were developed in CityMobil WP2.4 (see CityMobil deliverable D2.4.1 Generic Analysis Tool for Business Cases) and have been made available on the project web site for use by the partners and cities in the project.

The BCT has also been used to assess the business cases for the cities and schemes analysed using the MARS model in CityMobil WP2.3. The results of this exercise are the subject of this report.

2. The BCT

The BCT is a stand alone spreadsheet comprising a number of linked worksheets that take the user through a question and answer routine in order to develop the business case i.e. costs and benefits, of a new or proposed scheme. It has been applied in this exercise to the MARS model outputs for 4 proposed schemes in each of 4 cities.

The cities are: Gateshead (UK), Vienna (A), Trondheim (NO) and Madrid (E)

The schemes are:

- Personal Rapid Transit (PRT)
- Inner City Cybernetic Transport System (IC CTS)
- Cybernetic Transport System Feeder (CTS Feeder)
- Hi-Tech Buses (HTB)

In each case, the MARS model results have provided the length of the route, the number of stations/stops, the average fare, the peak and off-peak demand figures (passengers/hour) for a 16 hour/day operating period, the growth in demand over a 25 year period, and the number of buses needed in the HTB schemes.

For this exercise it has been assumed that all schemes operate for 365 days per year.

3. Application

In order to accommodate the particular requirements of the exercise, and to accommodate cross-site comparisons, the BCT has been adapted and applied in a specialised way.

Particular considerations are as follows:

- scheme benefits are made up from fare revenues only.
- costs of systems are in 2008 prices
- costs and benefits are computed using a discounted cash flow analysis performed over a 30 year period starting in 2009, using a 3% discount rate.

- scheme build is assumed to take place in 2009
- scheme operations and fare collection starts in 2010
- no land costs are incurred
- no infrastructure replacement costs are incurred
- PRT and CTS vehicles are refurbished at 1/3 their original cost after 10 and 20 years; HTBs (which can expect to do a much higher mileage) are refurbished at 1/3 cost after 5 years and replaced after 10 years.
- Residual values are zero at the end of the 30 years.

Note in particular that the method as applied here produces a Business Case in terms of cash flows made up from revenues and costs only. No real socio-economic benefits, such as valuations of time savings by users or of saved accidents and pollutants, are included. These are normally included in a full socio-economic assessment, and the additional benefits used to support the case for subsidising Public Transport schemes.

4. Costs and benefits of schemes

Generic costs, in 2008 prices, have been developed for the various schemes. These have been based on evidence taken from manufacturers and consultants, though it has to be admitted, the evidence is scarce. There are virtually no schemes in existence, so costs have been derived from a collection of data from a number of sources and manipulated to provide ‘reasonable’ estimates. Care has been taken to try and ensure they are realistic. But the results can, and must only be taken as, indicative.

PRT schemes
These require a dedicated guideway and small 4 or 5 seater (i.e. car sized) driverless vehicles. The guideway will very probably be elevated for all or part of its length, though the structure can be relatively light. Representative costs are reckoned to be:
Capital costs:

Cars cost 75 K€ each
Infrastructure costs 3.8 M€/km

Operating costs: Are made up from a base cost for 5km of track and 25 vehicles (including staff) plus additions for infrastructure per km and per vehicle, and for staff per km and per vehicle, which total to:

1,607 + 67.28(L-5) + 11.21(N-25) K€ per year

Where L is the length of single track guideway (in km) and N is the number of vehicles.

CTS schemes
These use 20 seater (i.e. mini-bus sized) driverless vehicles running on street. The vehicles are more expensive than for PRT but the guideway construction costs are substantially less, though a guidance system using eg buried cables or magnets is generally required. Representative costs are reckoned to be:
Capital costs:

Cars cost 271 K€ each
Infrastructure costs 717 K€/km

Operating costs: as above for PRT, but for a base cost for 5km of track and 10 vehicles, giving:

1,148 + 36.89(L-5) + 46.01(N-10) K€ per year

HTB schemes
The buses are driven by a driver and guided automatically on a dedicated guideway for all or part of their route (i.e. like a tram), but can also be driven as a conventional bus on normal streets. If the buses are electric, they may need a pantograph. Representative costs are reckoned to be:
Capital costs:

Buses cost 500 K€ each
Infrastructure costs 8 M€/km

Operating costs: as above for PRT, but for a base cost for 5km of track and 10 vehicles, giving:

2,350 + 49.26(L-5) + 263.54(N-10) K€ per year

The benefits are made up from fare revenues only. In all cases the benefit is therefore the product of the fare and the demand. The BCT has been modified for this exercise to recognise that revenue collection does not start until year 2.

The demand also determines the number (and hence cost) of vehicles needed. This is calculated automatically within the BCT for the CTS schemes. For the PRT schemes however, an average passenger loading of 2 is assumed for purposes of calculating the number of vehicles needed to cater for the peak hours. For the HTB schemes, the number of vehicles is as provided by the MARS model outputs plus an additional small number to allow for spares.

The BCT can accommodate growth in demand, which has been calculated from the MARS output data and reduced to an annual percentage for input to the BCT. However, for the exercise, special multipliers have been applied within the BCT for recognising the effects of growth in demand on the number of vehicles required, and for recognising the vehicle refurbishment and replacement programs.

5. Benefit Cost Ratio

Outputs from the BCT provide Present Values (PV) of capital costs, operational costs and benefits.

The Benefit Cost Ratio BCR = (PV Benefits-PV Costs)/PV Costs

A sensitivity analysis has been conducted by varying the demand and cost figures by +/- 20%.

For the PRT and CTS schemes, variations to the demand have been made to the peak and off-peak figures individually so that the effects of demand on the number of vehicles needed, is recognised. For the HTB schemes the corresponding variation in vehicle numbers must be made manually.

For the costs, it is assumed that the variation applies to both the capital and operational cost figures, and applies to staff (and, where required, drivers) as well as infrastructure and equipment costs.

6. Results

The results are summarised in the table below.

The PRT schemes show the highest vehicle speeds and lowest waiting and trip times. This is inherent in the BCT which assumes PRT vehicles have operational speeds of 30kph on a segregated guideway, while CTS vehicles, which run mixed with pedestrians on street have operational speeds limited to 15kph.

No comparable figures are available for the HTB schemes.

The results of a 'best vs. worst case' sensitivity analysis are shown for all the schemes analysed. These show the effects of a 'worst case' scenario made up from a 20% reduction in demand and a 20% increase in costs, compared with a 'best case' made up from a 20% increase in demand and a 20% decrease in costs.

For the Gateshead PRT scheme the effects on the BCR are to change it from 3.04 by -34% to + 48%.

Other sensitivity results for this particular scheme example, and arising from changes made to the BCT for the purposes of the exercise, are:

i) the effect of allowing for the growth in vehicle numbers required as a consequence of a 0.11% pa growth in demand is to reduce the BCR by 0.33%
ii) the effect of losing the year 1 revenue to allow for a 1 year build period is to reduce the BCR by 7.0%
iii) the effect of adding the vehicle refurbishment / replacement programme is to reduce the BCR by 7.2%
iv) the effect of making the vehicle refurbishment / replacement programme the same as for the HTB schemes would reduce the BCR by 20%
v) the effect of making the cost of the guideway the same as for the HTB schemes would reduce the BCR by 32%

It will be evident that all of these effects, individually, are encompassed by the best vs. worst case sensitivity analysis.

A particular result for the Gateshead HTB scheme is that reducing the capital costs/km of infrastructure to the same cost as for PRT (i.e. 3.8M€/km) increases the BCR from -0.16 to 0.25 i.e. to marginally positive.

Other special cases investigated show:
- for schemes with negative BCRs, the fare that would need to be charged to break even, i.e. to give a BCR=0 which occurs when PV Benefits = PV Costs. It is accepted that demand is influenced by fare level, so the result can only be indicative, but they are nevertheless of some interest.
- a special case included for HTB in Vienna where 35% of the required guideway already exists and so can be deducted from the capital costs.
- a special case for Madrid where the initial requirement was to purchase only 25% approx of the new buses needed, with the purchase of the remainder occurring in equal numbers in years 5 and 10.

7. Conclusions

The BCT has performed as expected, and any variations due to known and accountable factors appear to be encompassed by a simple sensitivity analysis involving a worst case scenario made up from assuming a 20% reduction in demand and a 20% increase in costs.

For best results however, the exercise has shown that modifications are required to the BCT, in particular:

- to take account of a build period
- to allow for a vehicles, and perhaps an infrastructure refurbishment / replacement programme
- to recognise the effects of a growth in demand on the growth in numbers of vehicles required.

With regard to the results for the particular cities:

Gateshead: the results look to be reasonable. The PRT scheme has the highest BCR, most probably because it attracts the highest demand and hence revenue. Both of the CTS schemes produce respectable BCRs suggesting they would not need subsidising. Only the HTB shows a negative BCR, but a relatively small increase in the fare from €3.15 to €3.75 would appear to be sufficient to achieve break even.

Trondheim: the results look reasonable in parts. The PRT and HTB schemes both have positive BCRs, with the PRT having a substantially higher figure. However, note the off-peak demand for PRT appears to be greater than the peak. There is insufficient demand to make an analysis of the IC CTS scheme worthwhile. The demand for the CTS Feeder is also very low and requires only 2 vehicles. It produces a negative BCR and is unlikely to be a viable scheme.

Vienna: very low fares (€0.3) for all schemes, relative to the other cities, mean relatively very low revenues which tend to be swamped in all cases by the costs so that the BCR = (B-C)/C tends to -C/C = -1. Break even, or better, looks to be possible with fares comparable with the other cities' schemes ie around 2€ for all but the HTB scheme. For the IC CTS scheme the demand is satisfied using only 5 vehicles, it may not be viable. The network length for the CTS Feeder looks high compared with the other schemes. For the HTB scheme, the off peak demand is greater than the peak

Madrid: the results look sensible. All except the HTB scheme produce positive BCRs. The demands for all schemes are relatively very high compared with the other cities, and require correspondingly larger numbers of vehicles. For the PRT, a 21.4m vehicle separation, at 30 kph, implies a 2.5 sec headway. This is unlikely to be viable.

Generally, the reason the HTB schemes perform badly, relatively, is very probably because of the high staff costs involved in providing drivers. The PRT and CTS schemes are driverless. They need operations and maintenance staff, but not drivers, and so save very substantially on operating costs.

It is perhaps something of a surprise that the PRT schemes seem to perform so well, and better than the CTS schemes in Gateshead and Trondheim. They are more expensive than the CTS, but it seems the higher demand, and consequently revenues, they attract is more than enough to outweigh the additional cost.

BCR Analysis	Summary of Results															
	Gateshead				**Vienna**				**Trondheim**				**Madrid (1)**			
	PRT	IC CTS	CTSFeede	HTB	PRT	IC CTS	CTSFeede	HTB	PRT	IC CTS	CTSFeede	HTB	PRT	IC CTS	CTSFeede	HTB
						(2)(4)		(4)	(4)		(2)		(3)			(4)
Route length (km)	20.7	20.7	22.8	50.9	11	11	110	34	18.5	ntr	22.8	25	42	42	90	143
no.stops	56	30	36	18	49	49	500	108	34		36	20	84	84	140	60
peak demand (pph)	5580	2188	2655	3273	744	283	2465	609	580		115	3091	27427	26882	17772	115782
off peak demand (pph)	3776	905	860	931	485	480	2262	984	1624		2	2445	11278	10718	3686	94492
annual demand (Mppy)	24.7	7.2	7.6	8.9	3.2	2.5	13.5	5.2	8		0.18	15.2	95.3	92.1	47.2	591
growth in demand (%pa)	0.11	0.31	0.7	0.2	0.02	0.02	0.1	0.04	0.8		0.7	0.44	-0.72	-0.71	1.19	-0.56
no. vehicles	406	36	43	30	55	5	40	73	43		2	35	1960	450	287	1800
av. veh speed (kph)	30.7	14.4	14.4	30	30.8	14.1	14.1	26	30.8		14	29	30.4	16.2	14.7	40.6
av trip time in pk (mins)	5.8	5.9	5.9	38.37	4.8	5.9	5.9	15	5.8		5.9	21.11	5.8	5.9	5.9	24.4
av waiting time in pk (mins)	1.4	3.1	3.1	4.81	1.4	3.1	3.1	0.6	1.4		3.1	4.07	1.4	3.1	3.1	5
av veh spacing (m)	51	575	530		200	2200	2750		430		11400	1450	21.4	93.3	313.6	
fare (€)	2.21	2.21	2.2	3.15	0.3	0.3	0.3	0.3	2.53		2.53	2.53	0.6	0.6	0.7	0.75
capital costs (€M)	123	29.3	34.6	453	47.7	9.8	94.6	381	75.4		17.2	255	351	190	195	3622
base year op costs (€M)	6.9	2.9	3.3	9.9	2.3	1.4	6.4	20.4	2.7		1.8	9.9	25.8	22.8	17	481
PV cost (€M)	263	88	102	652	95	37.5	224	792	130		53.6	455	872	649	539	13329
base year benefits €M)	54.6	15.8	16.8	27.9	0.96	0.75	4.05	1.56	20.1		0.45	38.5	57.2	55.2	33.1	443
PV benefit (€M)	1062	316	354	549	18.5	14.5	78.8	30.1	429		9.4	783	1001	968	743	7813
Business BCR	**3.04**	**2.58**	**2.48**	**-0.16**	**-0.81**	**-0.61**	**-0.65**	**-0.96**	**2.3**		**-0.82**	**0.72**	**0.15**	**0.49**	**0.38**	**-0.41**
Fare for breakeven (€) (7)				3.75	1.6	0.78	0.85	7.9			14.5					1.27
BCR Sensitivity analysis:																
-20% demand, + 20% cost	2	1.67	1.6	-0.4	-0.86	-0.74	-0.75	-0.97	1.24		-0.88	0.28	-0.11	0.25	0.08	-0.52
+20% demand, -20% cost	4.51	3.85	3.66	0.19	-0.72	-0.42	-0.5	-0.95	3.83		-0.74	1.33	0.51	0.83	0.81	-0.25
BCR special cases																
Special for Vienna (5)								-0.96								
Special for Madrid (6)																-0.39
track costs as HTB	2.04	0.32	0.32		-0.87	-0.88	-0.92		1.06		-0.96		-0.04	0.01	-0.38	

Notes
- (1) peaks last for 5 hrs in Madrid, 4 hrs in other cities, all have operating perods of 16 hrs /day
- (2) vehicle numbers probably too low for scheme to be viable
- (3) vehicle spacing of 21.4m at 30.4kph = 2.5 secs headway - is not viable
- (4) peak hour demand < off-peak !
- (5) 35% of required HTB guideway already exists, capital costs are reduced accordingly
- (6) initial need for 473 buses only, remainder purchased under old bus renewal programme in yrs 5 and 10
- (7) approx. fare required for BCR = 0 ie PV Benefits = PV Costs