The Economics of Applying IVHS to Public Transport: a cost-benefit analysis of the Shellharbour Demand Responsive Bus Trial Project.

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Abstract:

There is much debate concerning the applicability of IVHS to public transport improvements. In particular, Computerised Public Transport Management Systems (CPTMS) are being seen by many as the answer to some of the traditional problems associated with public transport — the main one being flexibility for use. CPTMS was trialed in a one year project on the urban fringes of Wollongong, taking the form of a demand responsive bus service.

The flexibility of the service came from its ability to allow on-demand route diversions from a trunk route, offering real time passenger and control centre information, and 20 minute prior telephone booking. This paper details a cost-benefit analysis of the service. Two scenarios are evaluated — the high technology approach adopted by the project, and a low technology alternative which operated for most of the trial period because of technical problems.

In both scenarios, significant capital outlays greatly outweigh any benefit to bus users. The study does raise some questions on how to value the intangible community benefits which could not be included in the formal cost-benefit analysis, such as goodwill towards the service and the flexibility it offers. Also, in light of the technical difficulties encountered in the CPTMS trial in Shellharbour, the paper discusses possible alternate solutions to providing a more flexible form of public transport.

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1. INTRODUCTION

Traditional forms of public transport have several drawbacks which make the car more attractive form of transport. Three of the main disadvantages are as follows.

1. Public transport usually does not deliver a person directly from their trip origin destination as the routes are not flexible. Some other form of transport (usually foo is needed at either end of the trip.

2. Often more than one mode of public transport is required to reach a destination, an it is transfer times between modes which adversely affect the time competitivene of public transport trips.

3. Thirdly, public transport runs to fixed timetables, meaning there is limited flexibilit for consumers in the choice of departure times.

In Shellharbour, an urban fringe area just south of Wollongong, a trial project wa conducted over the period August 1992 to August 1993 which attempted to addres these problems to a limited degree with the aid of a form of IVHS technology. Thi paper reports on the experiences during the trial period and the outcomes of the trial with particular reference to the economics of operating such a service.

2. BACKGROUND

The Shellharbour Municipality is a rapidly growing, low density urban fringe area. I was because of this growth that a need was initially perceived for a more flexible form of public transport than existing linehaul bus and heavy rail services. Many of the new subdivisions did not have a large enough population to support a fixed route public transport service, so the idea of a bus system with flexible routes was proposed. It was envisaged that such a system would also provide more accessible services to the traditionally transport disadvantaged groups in the area.

Shellharbour Council arranged for a one year trial project to be jointly funded by the German and Australian Governments using a German Computerised Public Transport Management System (CPTMS). The project involved the collaboration of two local bus operators. As part of the project, they gave their bus services within the Shellharbour Municipality a common name (Translink), operated a joint booking office and control centre, bought a midi-bus each which was painted in Translink livery and put large Translink stickers on their existing fleet that operated in the Shellharbour area. At the same time, with the help of the Department of Transport, they restructured their routes, ensuring that they met minimum service requirements specified under the 1990 Passenger Transport Act.

The result was the addition of one extra route, and some innovative changes to the three other routes in the Municipality, with the four routes forming the Translink network. While these four routes had a regular linehaul route and timetable, they also had a series of demand loops which would only be used if someone made a booking to be picked up or set down on that loop. The demand loops had designated bus stops as on a normal route (though they were painted in Translink livery) and were placed in areas not well served by the linehaul route. The system was timetabled in such a way as to allow the buses to divert onto 60% of the demand loops on any one run. The addition of the two midi-buses also meant that frequencies could be increased on the two routes with midi-buses on them because of lower operating costs.

The second innovative part of the project was that the whole booking and route diversion system was fully computerised, with on-board computers being linked by radio-wave to the computer booking system at the control centre. This transfer of data via radio waves is very new to Australia, and unfortunately problems getting this system operational were a constant source of frustration for the trial project.

An extensive radio, newspaper and letterbox drop campaign told people of the new service, its routes, and how it operated. The four Translink routes could be used as a normal bus service by people on linehaul sections of the route, while people living on demand loops could book a service to make a diversion to them (regular bookings could also be made). The midi-buses painted in Translink livery and the Translink bus stops also helped make the public aware of the service, with the telephone booking number emblazoned on the buses.

When a person called the booking service, all they needed to tell the operator was their address, their destination, and what time they wished to reach their destination. The operator would put these details into the computer and the computer could tell which was the closest stop to their address, and what time a bus could divert to the stop given the desired time they wished to reach their destination. Passengers would be given a five minute time window in which the bus would appear at the stop closest to them. This was necessary because some flexibility was required in the timetable to account for differing numbers of demand diversions being made. As soon as the booking was made, this information was automatically transferred to the onboard computers. A display screen in the bus told the driver when to divert onto a demand loop and how many people to expect. The system allowed people to book a service as near as 20 minutes before they wished to be picked up.

The on-board computers also meant that both passengers and the control centre always knew exactly where the buses were on their routes. An on-board passenger information system electronically displayed the name of the next stop to passengers. The CPTMS also allowed for traffic light actuation, though the RTA was only willing to give the buses an advantage on a couple of unimportant traffic lights in the Municipality.

Thus, it can be seen that the new service had several advantages over traditional forms of public transport. Firstly, the addition of demand loops and a simple booking service made the service far more accessible to residents. Secondly, transfer times between modes were minimised via information available to the onboard computers — timetables were adhered to because at any time the control centre knew where the buses were, and could respond quickly to any problems. The midi-buses allowed increased frequencies, adding to the convenience of using public transport in a traditionally low density, low frequency environment. The only downside to this form of public tran was that some extra time had to be built into the timetable in order to cater for demand loop diversions off the main route. This added some extra in-vehicle time normal linehaul trip.

Despite these plans and visions for the project, the reality of what happened somewhat different.

3. BRIEF OPERATIONAL ASSESSMENT

The CPTMS technology already referred to was not fully implemented until the months of the trial, and then only on some of the buses. While the computer boo system worked well from the beginning, there was trouble with installation, licen and communicating with the onboard computers. As a result, throughout most o trial period, hand radio communications were used to transmit booking informa directly to the drivers before the start of each run. Such a system allowed for book up to one hour before travel.

Despite these problems, the performance of the service as it operated was extensi monitored over the trial period. A series of surveys, including an on-board survey, user survey and a survey of demand loop users, as well as collection of data f booking and ticketing systems, were used to make a financial and operatio assessment of the project, and a social and economic cost-benefit analysis of service. These data are used in this paper to focus on the economic costs and benefit the project. Firstly though, a brief summary of other findings is presented.

Figure 1 shows the total weekly patronage on the Shellharbour routes of each opera from 1991 to the end of the monitoring project in August 1993. It also shows patronage trend for the four Translink routes over the length of the trial project. Des the introduction of demand responsive services and a new route, there seems to be li discernible change in patronage for either operator beyond a general growth trend wh was evident even before Translink. However, the on-board survey indicated that th was some additional travel by previous bus users whose accessibility to the service been enhanced. Small amounts of mode switching and induced travel were a observed. Traditionally transport disadvantaged groups such as elderly and mothers young children were the main additional users.

When looking at individual routes, the two routes with dedicated midi-buses proved be the most successful at attracting both additional patrons and praise from the patrons for the more individual, personal service such buses offered. Since the proj both operators have purchased additional midi-buses, suggesting that the use of smaller vehicles was one of the more useful outcomes of the project.

The level of demand loop bookings was not sufficient to warrant a continuation of t demand responsive system beyond the completion of the trial. However, some dema stops were used quite extensively, and subsequent to the completion of the trial t operators used this information to restructure their routes.

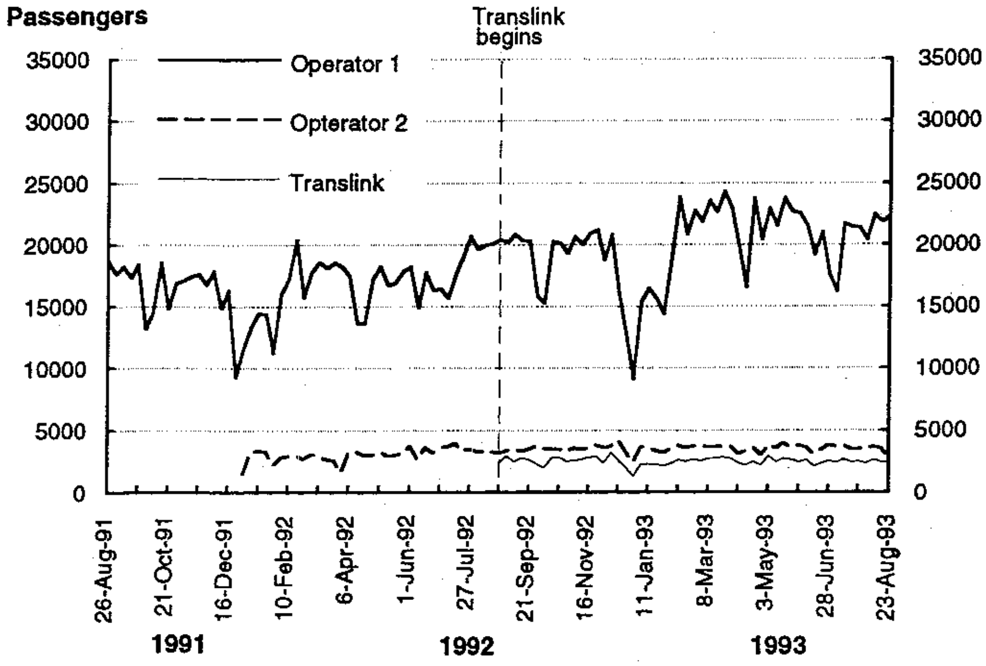

Figure 1 Total weekly patronage for Shellharbour routes of each operator

This paper now focuses on the economics of operating a demand responsive system such as that trailed in Shellharbour. In doing so, the weaknesses of cost-benefit analysis in accounting for social costs and benefits is highlighted.

4. COST-BENEFIT ANALYSIS

The task of assessing the economic costs and benefits of a trial project with government support is complicated by the need to provide a realistic set of costs. That is, those that would be incurred by an investor who decided to set up a similar system without government assistance, rather than the full set as incurred in this project. In order to overcome this problem, the costs of two different scenarios will be presented. One scenario will include all the costs incurred by the project as it operated (excepting independent monitoring costs and grant administration costs which would not normally be incurred). This will give an indication of the true costs of this particular pilot project, including the costs of the technology used, even though the government met most of the expenses and the project had many and costly teething problems. This option will be referred to as the *high technology* option. The second scenario is a *low technology* option using the lessons learnt from this pilot project, where the operators run a similar service, but with the use of manual short-wave radio communications instead of state-of-the-art radio wave data transfer and computer control. This scenario reflects the situation which operated for about half of the monitoring period, and also represents what is perhaps a more reasonable investment possibility for a private bus operator.

In this section, the economic benefit of Translink to bus users is calculated using changes in fare costs, patronage levels, access and egress time to and from bus stops, waiting time, and travel time. Then the costs of operating the project are calculat Costs include capital investments in new buses, computer and radio equipment and ne bus stops and signage, operating costs associated with running the buses, renting a operating the Translink Office, and the costs of informing the public about the servic As already mentioned, a high and a low technology scenario will be used in the costi of the project.

The life of the capital investment in this project is assumed to be twelve years. It i generally accepted that the life of a standard size bus is fifteen years, so the midi-buse bought for this project are assumed to last twelve years as smaller vehicles are generall less durable. Thus, the costs and benefits of the project are calculated over the twelv year period from August 1992 when Translink began to August 2004 when the usefu life of most of the hardware involved in the project will end.

Data used in this section are sourced primarily from the on-board survey of approximately 500 Translink users, particularly the information they provided about the trip they were making and how they made that particular trip prior to Translink. Some additional data came from ticketing systems of the operators. A non-user survey conducted just after the on-board surveys found no previous users who were disenfranchised to the extent that they no longer used the service. Thus it is believed that the on-board survey results are not biased by failing to capture previous users who no longer use the service.

Net benefit calculations

The economic benefits to the community of Translink services can be measured in terms of time and cost savings to current passengers of Translink compared with the times and costs of the same trip before Translink. Travel time savings can be achieved by decreased distance to a bus stop, less waiting time at a bus stop, and shorter trip lengths. The calculations involve comparing both the costs and levels of bus use before and after the introduction of Translink

Valuing time

One of the major benefits associated with the demand responsive public transport service trialed in Shellharbour was its improved convenience and greater flexibility. Compared with the previous fixed route service, it ran more frequently, had more potential stops, and could be booked on demand with information as to when and where the bus would arrive. These and other features of the new service had the potential to reduce travel times (where travel time is time measured from the trip origin to destination) compared to the old fixed-route service. In terms of time savings, benefits could take the form of reduced access and egress times to and from bus stops (out of vehicle time), reduced waiting times at bus stops (waiting time), and reduced time spent travelling in the actual vehicle (in vehicle time).

In order to include time savings in a cost-benefit analysis it is necessary to put a value on people's time. There are a set of readily accepted values of time used for these purposes (see Waters, 1992 for a good summary). The standard accepted value of time for in-vehicle time is $7 an hour for commute trips, $4 for non-commute. Studies have confirmed that people dislike getting to and from a bus stop more than actually travelling on a bus, so out of vehicle time is valued at twice as much as in vehicle time. The time people least prefer is that of waiting at the bus stop, so waiting time is valued at 3 times as much as in-vehicle time.

For people who used a travel mode other than bus prior to Translink for their surveyed trip, only in vehicle time is used for their previous trips. Only public transport has the extra costs of out of vehicle and wait time. For example, if a person used a car for the trip before Translink, they could step straight into their car at home, and drive directly to their destination, with no access, egress or wait time. The same is true if a person rode a bicycle, walked, travelled as a car passenger or used community transport from their home.

Actual monetary costs

Increased levels of Translink service had the potential to increase patronage by mode switching as well as induced travel and additional travel by existing users. Thus, calculating costs for the year prior to Translink necessitates calculating the costs for people who previously used other modes of transport. Travel times were dealt with above, but there is also the actual cost incurred by using a particular mode of transport to consider. For example, the bus fare is the only cost other than time that is incurred by bus passengers. This is the same for people who travel by taxi. Community transport, walking, riding a bike and travelling as a car passenger are often perceived to be free of actual monetary costs. However, travelling in a private car incurs fuel and operating costs. The 1992 NSW standard used to value the perceived cost of operating a car is 14¢ a kilometre (this is the cost which people perceive as being incurred when they use their car; it generally only includes the price of fuel plus a small amount of maintenance). From the survey we know the distance of the car trip, so operating costs can also be calculated for car drivers. Perceived rather than actual costs are used in the cost-benefit analysis as an attempt to incorporate social costs and benefits rather than true economic ones.

Calculating costs before and after Translink

Increased numbers of trips, and decreased costs per trip since the introduction of Translink are the main factors which drive the net benefit calculation. Initially, the total costs, comprising actual monetary costs and values of time spent travelling (as explained above), were calculated for the sample for the year prior to Translink (26 August 1991 to 25 August 1992) and the year of the Translink pilot (26 August 1992 to 25 August 1993). These costs were then scaled up from the sample costs to the population of bus users. This can be achieved because the survey collected data on the number of trips which were undertaken by the sample in the year prior to Translink and in the year with Translink. From the ticketing information it is possible to find out the total population of Translink users.

For each respondent, we know which mode they used to make the surveyed trip prior to Translink. We also know the times and costs associated with each trip, and the frequency with which they made that particular trip prior to Translink. Having appli values of time to the time component of the trip, and added the actual monetary cost these calculations, it is necessary to multiply the resultant cost per trip of the sample the frequency with which trips were undertaken. Instead of multiplying the costs by t number of trips made by the sample, the number of trips has to be scaled up to that the population (which is all Translink users) before the multiplication can take place provide a total cost for the year prior to Translink. This total cost is summed for a respondents to arrive the costs associated with travel prior to Translink. Scaling th sample up to the population was on the basis of the probability of a person bein sampled given their travel frequency before and with Translink.

A similar process is used for cost calculations during the Translink period, though thes are simplified since only one mode is used.

Net benefit with Translink

Figure 2 shows the net benefit derived from the Translink service by current bus users The demand curve for bus services is derived by assuming a linear demand, with tw known demand points before and after Translink. The average price per trip before an with Translink was calculated by dividing the total annual cost for all Translink user by the total number of trips undertaken per annum. The total trips per annum ar derived from ticketing data.

In order to calculate the net benefit it is necessary to calculate the consumer surplus to current passengers prior to Translink and their consumer surplus with Translink Consumer surplus is the area below the demand curve and above the cost incurred Consumer surplus for a single person can be defined as the maximum cost a consumer is willing to incur for a given amount of travel, less the amount they actually pay. To calculate surplus for all Translink passengers, it is necessary to know how many trips they undertook prior to Translink and how many they undertook with Translink. Those figures are plotted on the x-axis. On the y-axis is the average cost per trip. This was calculated by dividing the total cost for the year (calculated earlier) by the total trips (from the scaled up trip data) to give an average cost per trip for Translink passengers before and with Translink. Figure 2 indicates that more trips have been undertaken by current Translink travellers since the introduction of Translink, and it also shows that the average cost per trip has fallen by approximately 7% or 24¢ a trip.

Thus, the net benefit accrued to passengers because of Translink is shown in Figure 2 as:

Consumer Surplus with Translink (ADE) – Consumer Surplus before Translink (ABC)

= CBDE = 115,833 x 0.24 + 0.5 x 18018 x 0.24

= $29,926 for the first year of Translink operation.

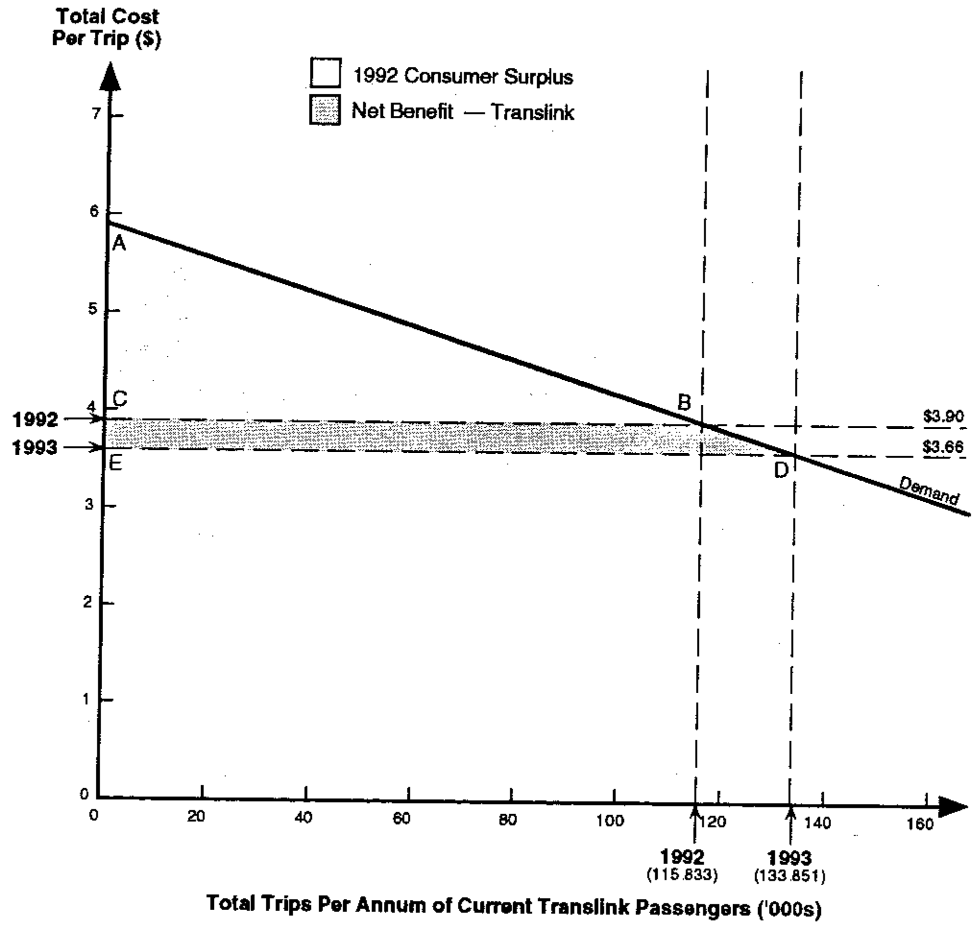

Figure 2 **Consumer surplus with and without Translink**

The population of the Shellharbour Municipality has been growing at approximately 2% per annum in recent years, so this figure was scaled up by two percent each year for the potential twelve year life of the project (life of the capital) as shown in Table 1, with the sum of all the years equalling the total net benefit for the 'potential' life of the project (net present value). It should be stressed that these benefit figures almost certainly underestimate the benefits which might have accrued had there been some continuity to the type of service offered during the trial project, and it there was some recognised means of incorporating some of the intangible social benefits associated with such public transport improvements.

Cost calculations

The Shellharbour Transport Project aimed to use German computer technology to provide real time passenger information and a booking system which would enable trunk route services to be diverted onto predetermined route diversions on demand (with a minimum 20 minute pre-booking time). Teething problems with the computer technology and radio wave data transfer delayed the full introduction of this system until the last few weeks of the project. In the interim, several other techniques were used to supply on-demand services. Firstly, day-before booking was used so that driver could be given lists of diversions before they started in the morning. Later in th project, same-day booking was instituted using manual, hand-held radio communicatio between the booking office and the drivers, informing drivers of booked diversion before each run. Only in the last few weeks did the on-board computers automaticall display the required diversions to the bus driver as bookings came in, allowing 2 minutes-before booking. As explained earlier, given the range of technologies used i the project at various stages, and the need for costs to reflect those which would b incurred in a non-pilot project, it has been decided to calculate costings for two differen scenarios: a high technology scenario, and a low technology scenario.

Table 1 Net benefit calculations for 'life' of Translink

Year	Calculation	Amount
Year 1	\$29,926.08 x 1 02^{0}	\$29,926
Year 2	\$29,926.08 x 1.02^{1}	\$30,525
Year 3	\$29,926.08 x 1.02^{2}	\$31,135
Year 4	\$29,926.08 x 1.02^{3}	\$31,758
Year 5	\$29,926.08 x 1.02^{4}	\$32,393
Year 6	\$29,926.08 x 1.02^{5}	\$33,041
Year 7	\$29,926.08 x 1 02^{6}	\$33,702
Year 8	\$29,926.08 x 1.02^{7}	\$34,376
Year 9	\$29,926.08 x 1 02^{8}	\$35,063
Year 10	\$29,926.08 x 1.02^{9}	\$35,764
Year 11	\$29,926.08 x 1.02^{10}	\$36,480
Year 12	\$29,926.08 x 1.02^{11}	\$37,209
Total (NPV)		**\$401,137**

Costing the project is further complicated by the fact that only one new route was implemented. While two midi-buses were purchased as part of the project, one replaced a conventional bus running the same service without diversions. Thus, since this bus was not necessary to the project, its purchase cost has not been used in the cost calculations. Similarly, the operating costs for that bus are not included since these would have been incurred by the operator without Translink.

High technology scenario

Table 2 lists the costs, in broad categories, of the low and high technology cost scenarios. The high technology option is far more expensive for two main reasons. The first is the cost of the computer hardware, on-board computers, state-of-the-art communications technology and their installation. The second is that such a capital investment requires a control centre/office with specialist staff. Neither of these costs are incurred by the low technology option for which the main cost is the operation of the route service.

Table 2 **Total cost of each scenario for year 1**

High Technology Option	1992 Cost	Low Technology Option	1992 Cost
CAPITAL COSTS (one-off)		CAPITAL COSTS (one-off)	
IBIS Units for buses	$179,940	Midi Bus	$115,000
Midi Bus	$115,000	Bus Stop Signs and Information	$47,258
Vehicle and Radio Equipment	$53,986	Signage on Vehicles	$3,000
Bus Stop Signs and Information	$47,259		
Control Centre Hardware	$40,682		
Office Fit-out	$13,720		
On-Board Fitting of Computers	$9,344		
Signage on Vehicles	$3,000		
Revolution Counters	$1,745		
Technicians Equipment	$754		
One Translink Sign	$168		
OPERATING COSTS (annual)		OPERATING COSTS (annual)	
Operations Centre Staff	$74,433	Bus Operating Cost	$55,608
Bus Operating Cost (total)	$55,608	Telephone	$2,533
Driver costs	*$43,536*	Public Relations	$1,500
Fuel, Oil, Tyres	*$7,920*	Office Expenses	$1,431
Repairs/Maintenance	*$2,535*	Contingency	$1,000
Fleet overheads	*$1,620*		
Salary (technician)	$42,340		
Office Rent	$35,000		
Communication Fees	$13,000		
Radio Communication	$9,994		
Additional Pilot-Related Costs (annualised)	$7,901*		
Public Relations	$5,079**		
Telephone	$2,533		
Office Expenses	$1,431		
Consumables	$1,270		
Superannuation	$1,250		
Electricity	$801		
Computer Repairs/Maintenance	$73		

* Not necessarily incurred by an operator
** These costs could occur disproportionately in the first year of operation

Low technology scenario

The low technology scenario is a 'bare-bones' approach to achieving similar features and performance to the high technology approach without the large capital cost of the computer technology. It involves using short wave, hand-held radio communications between the person taking bookings and the bus driver before each run.

Such a system allows hour-before booking services, but no real-time passenger information. Given the low levels of demand for booking services experienced in the trial area, such a system could have been run from the operator's existing offices by one of the currently employed office staff, using perhaps 1/5 of their time. This negates the need for a separately staffed control centre and office. It also does not require on-board computers and high technology communications, making it a much less expensive option.

Costs of each scenario

Table 2 summarises the costs of each scenario in the first year of operation using the broad headings used in Shellharbour Municipal Council's accounts. Many of the costs related to problems with radio technology and other teething problems involved in the pilot project, and are included in the "Additional Pilot-Related Costs" category of the high technology scenario. The high technology approach also employs a technician to install and operate the computer equipment. The low technology approach has a smaller public relations budget since the experiences in Shellharbour should lead to better targeting of funds. There is also $1,000 set aside annually for contingencies in the low technology scenario as all projects are bound to run into added avoidable costs. For the low technology scenario, the only extra costs to the office are assumed to be expenses such as additional stationery.

In order to simplify the method of reporting the costs of the project, all costs will be kept in 1992 dollars. Never-the-less, some calculations are required to obtain costs over the life of the project, and Table 3 breaks down the costs summarised in Table 2 into a number of categories according to how each cost needs to be treated over time. The table is designed to give an impression of the magnitude of costs involved in each year of operation.

The first category (annualised bus cost) deals with the capital cost of the midi-bus purchased for the project. It is assumed to have a working life of twelve years, with a residual value at the end of the 12 years of 15% of the purchase price (in 1992 dollars). With this information, the average capital cost of the bus per annum is calculated at an assumed real long term interest rate of 8% (sensitivity testing was performed but it made little difference to the result and is thus not included) using the following formula:

Average Capital Cost per annum (ACC) = (A - B) x Amortisation factor

where: A = vehicle purchase price
B = residual value of bus after 12 years

$$\text{Amortisation factor} = \frac{\text{interest rate}}{1 - \dfrac{1}{(1 + \text{interest rate})^{\text{years}}}}$$

Thus,

ACC = ($115,000 - $17,250) x 0.1327 = $12,971 per annum.

This cost is the same for both the high and low technology options. It has been assumed that the operators purchase a new bus in both scenarios because the Shellharbour trial project involved the addition of a new route. This may not always be the case in future ventures, thus the costs even for the low technology scenario could be significantly reduced if no additional vehicles were required.

The second category in Table 3 (Other capital costs - annualised) includes all other capital costs associated with the project, and these are listed in Table 2. These capital costs are assumed to have a life of twelve years also, but with no residual value at the end of the project. The same formula as above is used to annualise their costs, with zero residual value.

The third category (Annual operating costs) deals with the costs of running the project for any given year. The items included in the operating costs are listed in Table 2, though repair and maintenance costs for buses and for computer hardware are included in the next category, Total variable costs. The costs included in the operating costs are assumed to remain constant (in 1992 dollars) for the life of the project. Included in this category are some costs, such as public relations expenditure, which will occur predominantly in the first year of the project, but have been annualised for statistical purposes.

The final category (total variable costs) deals with those costs which will change over time despite being measured in constant dollars. It is assumed that as the hardware ages, the costs to repair and maintain it will rise at 10% a year. Table 3 reports the repair and maintenance costs for year one only.

Table 3 Costs in the first year of operation (annualised for capital costs)-1992 dollars

High Technology Option	Cost	Low Technology Option	Cost
Annualised bus cost	$12,971	Annualised bus cost	$12,971
Other capital costs - annualised	$46,524	Other capital costs - annualised	$6,669
Annual operating costs	$248,108	Annual operating costs	$59,540
Total variable costs (year 1)	$2,608	Total variable costs (year 1)	$2,535
TOTAL	**$310,211**	**TOTAL**	**$81,715**

In Table 4 all the annual costs listed in the previous table have been scaled up to give the costs over the 12 year potential life of the project. The bottom line of the table represents the total costs incurred by the high and low technology scenarios for the 12 year life assumed for this project. These are the costs which are used in the cost-benefit analysis.

Table 4 Cost over an assumed 12 year life of the capital

High Technology Option	Cost	Low Technology Option	Cost
Annualised bus cost *12	$155,657	Annualised bus cost *12	$155,657
Other capital costs annualised*12	$558,288	Other capital costs annualised*12	$80,028
Annual operating costs*12	$2,977,296	Annual operating costs*12	$714,480
Total variable costs (whole 12 years)	$55,769	Total variable costs (whole 12 years)	$54,209
TOTAL	**$3,747,010**	**TOTAL**	**$1,004,374**

Cost-benefit result

We can now look at the economic costs and benefits of the Shellharbour project had it run for the full life of its capital under two scenarios — the high technology scenario which was the aim of the project, and the low technology approach which was operational for the main part of the project. Tables 5 and 6 bring together the net benefits to consumers as calculated in Table 1 with the costs calculated under the two scenarios as discussed in this section.

Although the benefit-cost ratio of the low technology scenario is slightly higher than that for the high technology scenario, the benefit-cost ratio for both scenarios is well below one. This means that the project, in economic and partly social terms (disregarding any intangible benefit), does not break even.

Table 5 High technology scenario in $1992 (brackets mean negative benefits)

Year	Net Benefits	Costs	Total Benefits	Benefit/Cost Ratio
1	$29,926	$310,211	($280,285)	0 096
2	$30,525	$310,472	($279,947)	0.098
3	$31,135	$310,759	($279,624)	0 100
4	$31,758	$311,074	($279,316)	0 102
5	$32,393	$311,421	($279,028)	0 104
6	$33,041	$311,803	($278,762)	0 106
7	$33,702	$312,223	($278,521)	0.108
8	$34,376	$312,685	($278,309)	0.101
9	$35,063	$313,193	($278,130)	0.112
10	$35,764	$313,753	($277,9896)	0.114
11	$36,480	$314,367	($277,887)	0.116
12	$37,209	$315,044	($277,835)	0.118
Total	**401,137**	**$3,747,005**	**($3,345,634)**	**0.1**

Table 6 Low technology scenario in $1992 (brackets mean negative benefits)

Year	Net Benefits	Costs	Total Benefits	Benefit/Cost Ratio
1	$29,926	$81,715	($51,789)	0.366
2	$30,525	$81,969	($51,444)	0.372
3	$31,135	$82,247	($51,112)	0.379
4	$31,758	$82,554	($50,796)	0.386
5	$32,393	$82,891	($50,498)	0.391
6	$33,041	$83,263	($50,222	0.397
7	$33,702	$83,671	($49,969)	0.403
8	$34,376	$84,120	($49,744)	0.409
9	$35,063	$84,614	($49,551)	0.414
10	$35,764	$85,157	($49,393)	0.420
11	$36,480	$85,755	($49,275)	0.425
12	$37,209	$86,413	($49,204)	0.431
Total	**401,137**	**$1,004,369**	**($602,998)**	**0.4**

The social benefit of providing a more convenient service to the public is included in these calculations, however the intangible benefit of feelings of goodwill regarding bus services is not included. In addition, the extra value of inducing a trip, or making travel easier for most of the municipality cannot be truly quantified in terms of what it does for personal quality of life. Cost-benefit analysis also does not place different values on increasing the mobility of different groups in the community. This project had particular benefit to a small group of transport disadvantaged, but giving them greater mobility is given no extra weight than someone who could easily use a car for the same trip. It is up to governments to make decisions on whether economic losses evident in this result are worth the social gains. This theme is developed further by Battellino (1994).

For such transport reforms it is difficult to calculate, measure or balance all relevant factors for policy makers. Often such projects offer social advantages, but considerable economic costs. There is obviously a need for a method which successfully combines the social and economic costs and benefits of projects in seamless decision-making framework. Giving more weight to increased mobility for the transport disadvantaged when calculating benefits of a project would perhaps be a good starting point.

6. CONCLUSIONS

The trial was not a financial success for the operators, nor a measurable economic success for the community (in either low or high technology guise). This raises the question as to what type of service would be cost-effective enough to be useful. Such a demand responsive system should not be ignored because some important lessons have been learnt from this project which may make the path to success a little clearer. The lessons for operators are many. For example if an operator wishes to implement such a system, costs can be minimised by applying the demand responsive idea to existing services using existing vehicles and office and communication facilities. The only additional costs that need be incurred are those related to promotion of the changed service. In this way, an average urban operator could serve more people without incurring significant extra costs.

IVHS will almost certainly have a role to play in public transport in the future, but the tasks it performs need to be better defined and more useful than in this project. The costs were simply too high for a system which was essentially used as a computerised booking system. This does not mean that the demand responsive concept per se is bad. Indeed, if its benefits could be measured in social terms, it could be measured a success. Demand responsive public transport may well have a niche to fill in our public transport system, and this theme is developed in Battellino (1994).

ACKNOWLEDGMENTS

We wish to thank the two bus operators involved in the trial, John J. Hill and Rutty's, for their openness and cooperation throughout the trial, and Shellharbour Municipal Council supplying the cost data.

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