Demand Responsive Public Transport for Australia: 2. Meeting the needs.[1]

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Abstract:

A conceptual discussion of the parameters of demand responsive public transport (DRPT) in a companion paper is elaborated here by the examination of a series of case studies. These case studies are of demand responsive transport services that have operated or are still operating in Australia. While they reveal the trade-Off between flexibility and efficiency in DRPT, they also suggest that in certain circumstances alternative and emerging technology (particularly in relation to vehicle size and communications) can reduce the compromises involved.

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1. INTRODUCTION

Public transport use in western countries has been declining since world war two. As cars and car travel have become steadily more affordable, their increased flexibility has eroded the market for public transport. One response to this situation has been the attempt to develop a more demand responsive form of public transport, to somehow combine the flexibility of the private car with the efficiencies of public transport.

In reality, the combination of these factors is in essence a trade-off. An earlier paper (D'Este, Taylor and Radbone, 1994) discussed the particular circumstances in which demand responsive transport would be most appropriate and the factors on which the compromise is made - timetable flexibility and route flexibility as well as the method of customer collection and quality factors. Such factors, it was argued should in principle be differentially valued by different market sectors. Commuters, young people, elderly people, the unemployed and home carers can have different demands, as can the same individual at different times, and these different travel demands can be catered for in different ways.

This paper examines several existing examples of demand responsive services that have been used in Australia. It has been written in cognisance of overseas developments but its emphasis is on a review of Australian experience, ancient and modern, and the lessons thus available. The paper looks at the issues of performance criteria and technology in the light of the Australian experience.

Demand responsive transport is frequently seen as a possibility for the future, but it should be realised that there are many examples of its operation, both in the past and currently. Taxis provide a ubiquitous example of demand responsive transport. Many council bus services operate on the demand responsive principle. Typically, a regular local shopping service will run a flexible route, with diversions and demand dependent on phone bookings and regular arrangements. The typical service will also have facilities for the disabled. Other community transport services are designed to connect with a conventional fixed route service, typically for elderly passengers in off-peak periods.

While very common, such services are not designed to be commercially viable. They typically exist using a bus funded from donations or a federal grant, which is driven by volunteer labour. Fares are a 'gold' coin donation at most. Following are some examples of demand responsive transport with a more ambitious remit. They provide useful lessons in dealing with the trade-offs of flexibility and efficiency.

2. CASE STUDIES

Dial -a-Bus, Adelaide

The Adelaide Dial-a-Bus experience of 1973 provided a spectacular example of the limitations of demand responsive transport using larger vehicles over a big area (Keal, Foley and Morris, 1974).

The concept of demand responsive transport was very popular in the early 1970s as it was seen as a possible answer to the dwindling appeal and poor financial position of conventional public transport. Public transport should be reformed to regain its previous financial self-reliance. Dial-a-Bus schemes were promoted to combine the benefits of personal freedom in the choice of when and where to travel, with the economic and environmental benefits of public transport subsidies and/or increasing reliance on the car.

Type of service	Many to many
Service area	260 km^2
Population served	623 000
Socio-economic characteristics	General
Operating characteristics	14 12-seat mini-buses; no route or timetable, area-wide.
Time of day	7 am to 9 pm, except Sundays

In 1971 the South Australian government initiated a study into the feasibility of such a scheme in the Adelaide metropolitan area. During the course of the study a private operator sought a licence to operate a service covering the entire metropolitan area, from 7am to 9pm each day except Sundays. This was approved, subject to the conditions that the CBD was not served and that hailing was not permitted. The operation was intended to be commercial and fares were set on a straight line distance basis. The fares themselves were higher than those applying on the conventional services. They were 30 cents for the first two miles and 10 cents for each subsequent mile, up to a maximum fare of one dollar - five dollars in current prices.

The operation covered the metropolitan area, excluding the then developing suburbs. Although the built-up area was well served by public transport, it was thought the dial-a-bus services would compensate for the lack of cross-suburban services. The aim was that within a half hour of calling a bus would arrive to take the caller anywhere within the defined area. Technology was, by modern standards though not necessarily the standards of the day, relatively crude, with information stored on cards and radioed to the operator.

Fears about whether twelve buses could cope led the government to trial the concept by contracting the company to service pensioners free of charge for two weeks. The trial had a lot of media attention and within minutes of opening it was apparent that the service could not cope with the demand. Phones were left off the hook to suppress demand and at about 11.30 on the first morning radio stations broadcast that the service was suspended for the rest of the day, to cope with bookings. Teething problems (such as a break down in radio communication) did not disguise the fact that for a free service at least, twelve buses were ludicrously inadequate.

The service lasted for six working days in total. By then it was obvious that the productivity of each bus could never provide a realistic service. The average number of calls serviced was two per hour per bus! It is unclear what the effect would have been if the intended fares had been charged. Obviously the demand would have been lower which would normally mean even lower productivity. On the other hand the demand was already far in excess of capacity, so this may not have mattered. Also if the fare structure had encouraged a higher proportion of shorter trips, then more trips could have been serviced.

Invicta Telebus - Croydon and Rowville, Victoria [2]

Type of service	Flexible route, zonal service
Service areas	c. 40 km [2]
Population served	
Operating characteristics	Flexible routes between fixed points. 10 buses, 22-39 passengers
Time of day	Monday to Saturday, 5am to 8pm

Telebus has been operating as a Public Transport Corporation (PTC) contracted service for the past fourteen years. It services shoppers, commuters and school students. The service began in Lilydale and Churnside Park and has since been extended to Rowville and North Croydon. These areas, all on the outskirts of Melbourne, are low density and characterised by narrow streets and at times hilly terrain, which makes the smaller buses of the Invicta service particularly suitable.

A key feature is that the stops are fixed rather than the route That is, the bus may approach a particular stop from a number of directions. Buses are scheduled to run within plus or minus five minutes of the published timetable. The peak hour service is however designed to link with trains at the Mooroolbark, Lilydale, Croydon and Ferntree Gully stations.

Normal PTC tickets apply to trips between bus stops. This revenue is forwarded to the PTC; customers are charged a surcharge if they want service to or from their door. [The actual charge depends on a number of factors: concessional status, time of day and the number of passengers to be picked up or dropped off.] The surcharge is retained by the

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[2] From information supplied by Mr Frank Mercuri, Croydon Bus Lines and Mr Hector McKenzie, Victorian Public Transport Corporation

bus company. Bookings can be made by telephone any time before the particular run begins. Alternatively, the bus can be hailed from the designated stops.

Translink - Shellharbour, NSW [3]

A flexible route bus service operated in Shellharbour, south of Wollongong for twelve months from 24 August 1992 until 27 August 1993. The formal evaluation of the Shellharbour experiment is yet to be released but from conversations with those involved and those who personally observed the experiment, several conclusions can be made. Essentially these are that while the service design features were successful, technical problems and a lack of marketing resulted in disappointing patronage.

Type of service	Flexible route, corridor service
Service area	24 km^2
Population served	47 000
Operating characteristics	Full-sized and 29 seat buses
Time of day	Weekdays, no night service

The scheme serviced an area of 24 km^2 and population of 47,000 with both full-sized and 29 seat buses. A base route was supplemented with set deviation loops which would be used if requested. All routes had fixed stops. Once radio communication was established, a phoned request for a bus to take deviation routes could be made as little as ten minutes before the bus reached the deviation point. Customers were told to expect the bus over a given five minute period.

Initially the exercise was designed to test state of the art technology such as a digital stop announcement system, automated timetable information, automated traffic light activation, real time table information and guaranteed transfers between services (Witherby, 1993, p.769). However, there were a number of technical problems brought about by the haste with which the scheme was implemented and its reliance on overseas technology. This tried the patience of the local operators and meant that most features were never introduced. Nevertheless the experiment appears to have demonstrated that demand responsive transport can operate successfully with relatively modest technology and that, if designed well, the technology can be enhanced later to provide a better and more efficient service.

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[3] This section has benefited from information provided by Mr Angus Witherby, University of New England and Ms Linda Madden, Shellharbour Municipality

The service itself operated on flexible routes - a fixed base route with deviations if required. The operating parameters required that 95 per cent of the population be within 200 metres of a bus stop. This compares with the NSW standard of 85 per cent within 400 metres of a bus route (Witherby, 1993, p.767). It was discovered that the better service could be met using the same size fleet, with no loss of running times. This was because the base route was shorter than the conventional fixed route. The deviations were only made when needed. This suggests that the total journey time would be shorter than it would be for a fixed route service, as walking time would be shorter with no loss of travelling time.

Transit Taxi - Hallett Cove, South Australia [4]

Hallett Cove is a housing estate in the outer southern suburbs of Adelaide. Although served by a railway station linking it to the CBD, the area has no local bus service at night. The idea of using taxis to meet the trains at night was developed as a cheaper alternative to the use of a conventional bus to distribute passengers. A taxi is contracted to meet every evening train arriving at the station hourly from the city. Passengers can normally step out of the train and into the waiting taxi. They are charged 50 cents to be taken to their home. The contract provides for backup vehicles if necessary.

Type of service	One to many (rail distributor); Zonal service
Service areas	c. 7 km ^{2}
Population served	12 343
Operating characteristics	Sedan taxi, fixed departure points and times only.
Time of day	Evening, off-peak, Monday-Saturday

Initially passengers could phone and be taken to the station as well but this service was discontinued through lack of use. Given that the service operated only at night, this is not surprising.

The service has now been running for two years and although it costs about $7 per passenger, it is considerably cheaper than the $18 that a conventional bus service would cost. Patronage has stabilised at about 15 passengers a night or 2.4 passengers a trip. As this represents over half the passengers alighting from the train who live in the service area, higher patronage could only result from higher patronage on the train.

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[4] This section has benefited from information provided by Mr Hugh Dixon, South Australian Passenger Transport Board.

Patronage of the service is commuters, at least for the early evening services. Female students find the service popular, particularly the fact that it delivers to the door. Late night services are more typically patronised by those returning from social evenings.

The annual contracts to run the service have been confined to the taxi industry. Because legislation applying until 30 June 1994 limited taxis to five passengers, this has meant that only small vehicles can be used. Although the contract requires a backup service within five minutes if one vehicle cannot cope this has proved difficult for the contractors, as there are no nearby taxi ranks.

Although political factors have caused the contract to be limited to taxis, there are practical reasons for limiting the size of the vehicle. Though there is evidence that there will typically be at least one couple travelling to the same destination when there are six or more customers, the service begins to take too long if there are more than six or so destinations. Given that the furthest point from the station is only 4.5 kilometres, a regular journey of about 15 minutes is about the limit of customer tolerance. This indicates an important practical consideration for services that have no route or timetable, at least for commuter services. Minibuses with thirteen seats or more would likely be impractical.

Because of the relative isolation of the area, the contract provides that the taxi be on hand throughout the evening, even though it is typically used for only fifteen minutes of every hour. It is highly likely that a lower contract price could be arranged if a local service supplier with a people mover such as a Tarago could be contracted, though some arrangements for a back-up service would still be necessary. TransAdelaide's one-person operation of the train precludes the selling of tickets on the train, but if this were possible (for example if conductors were reinstated), the service could be radioed ahead and a backup could be on hand if necessary.

Another limitation of the service is that it only operates at night, taking passengers from the station. While this is important, particularly for the security it provides, it does not provide the complete service. Passengers still have to find their own way to the station for their journey to the city.

Hub Shuttle - Happy Valley, South Australia [5]

Happy Valley is a relatively new suburb to the south of Adelaide. It has no train service and its links with the rest of Adelaide are generally circuitous. The Hub Shuttle is a similar service to that at Hallett Cove, in that taxis meet an arterial service and take passengers to their home, for a fee of 50 cents. In this case the arterial service is provided by an express bus.

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5 This section has benefited from information provided by Mr Hugh Dixon, South Australian Passenger Transport Board.

The area served is divided into two sectors, with one taxi designated each. [If there are too many passengers for one taxi and none for the other, then both taxis will serve the one area.] The service was designed to complement the Transit Link bus service established to link the Hub shopping centre with Adelaide. Transit Link is a high frequency limited stop service. But instead of operating in the evening, the service meets the afternoon peak services, from 4.30 pm to 7.00 pm.

Type of service	One to many, local area (bus distributor)
Service areas	8 km ^{2}
Population served	9 400
Operating characteristics	Taxi, fixed departure points and times only.
Time of day	Evening peak, Monday - Friday

The other interesting difference from the Hallett Cove service is that while Hallett Cove offers considerable opportunities for savings in contract costs, the Happy Valley service demonstrates the financial limits facing a demand responsive service with small vehicles. The taxi companies bidding for the contract used the Hallett Cove experience to make their offer at less than the waiting time rate of $19.50 per hour for each of the two vehicles. But instead of being used only fifteen minutes in every hour, the ten minute frequency of the Transit Link arrival means that the taxis are delivering passengers most of the time. A typical hour's work would involve driving 24 kilometres. Given running costs of 40 cents a kilometre and a driver's wage of $10 an hour, the total cost for the five hours of service per night would be almost $100. But even at a rate of $20 an hour, the forty or so passengers per night means that each passenger trip would cost about $2.50 - significantly more than the standard fare of $1.46 that passengers are charged to be carried from the city. Of course more passengers per trip would lower this figure, but each trip already averages three passengers. Raising this would lower the comfort level within the vehicle and threaten the ability of the shuttle to return in time to meet the next Transit Link service.

Taxi Transit - Mackay, Queensland [6]

Australian cities are designed for private motoring rather than public transport. Country towns such as Mackay are even less propitious for public transport given that parking is frequently free, roads are uncongested and a car is often necessary for travel outside the

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6 From information provided by Mr Max McBride, Mackay Taxis and Mr Neil Heath, Queensland Department of Transport

town. Mackay is attempting a new model of a demand responsive service using small vehicles, this time on arterial corridors rather than a localised area. [However the relatively small size of Mackay means that the area served would be considered 'local' in a capital city.]

Type of service	Many to few; corridor service
Service areas	c. 90 km ^{2} (most of which is not built up)
Population served	c. 25 000
Operating characteristics	Various; flexible route and timetable
Time of day	Business hours, plus Thursday night and Saturday morning

The service is operated by Mackay Taxis. It began February 1993 and serves the northern half of the town. It operates alongside a conventional bus service.

Although designed to take people from more distant suburbs to the centre of Mackay down arterial routes, it is demand responsive in two senses:

(1) although timetabled on an hourly basis during week days, the service only operates if requested to do so. Bookings - on a toll free number - must be made at least fifteen minutes before the service is due to start. One month after an expanded service began in April 1994, 40 per cent of the timetabled services were actually being run, and

(2) there are diversions from the arterial routes to allow a doorstop service.

Within the corridors, Mackay Taxis runs a many-to-many service, between passengers' homes and their downtown locations.

While the service is managed and promoted by a radio station, the service itself is delivered by owner-operator taxis. The size of the vehicle used depends on the demand. The Government requires the fee to be set above the comparable bus fare. It is set at about one third the taxi fare. The average number of passengers per trip is two, but because of poor utilisation of taxi capacity for conventional services, this is still considered profitable. [In 1992 Mackay Taxis calculated taxi seat capacity utilisation of 6.5 per cent during the day and 8.4 per cent during the night!] The service will run if only one person requests it. If there is only one passenger, the taxi is subsidised by the radio company.

The service is expanding and it is still early days but it needs to be pointed out that, as at May 1994, the numbers of passengers involved was still very low - about sixty per day, about 75 per cent of whom were female. This compares with the up to 100 a day using

the conventional bus service. [Note that the bus service is subsidised by over a dollar per passenger.] Mackay Taxis argues the inherent advantage of the use of smaller vehicles and points out that if the present bus patronage was combined with the taxi transit patronage then the present hourly services would average between five and seven passengers per trip. If maxi taxis were used (i.e about 10 seats) fares could be reduced significantly. Alternatively a more frequent service could be offered, which would again increase patronage.

Conclusions from the Case Studies

The earlier paper (D'Este, Taylor and Radbone, 1994) presented a conceptual diagram of the distinctions between transport modes in terms of route and timetable flexibility. Figure 1 uses this conceptual framework to compare the case studies, and thus helps to provide insights into some of the parameters of operational success for DRPT. It suggests that, apart from Adelaide Dial-a-Bus, the services have adopted a compromise position on the spectrum between mass transit and personal transport.

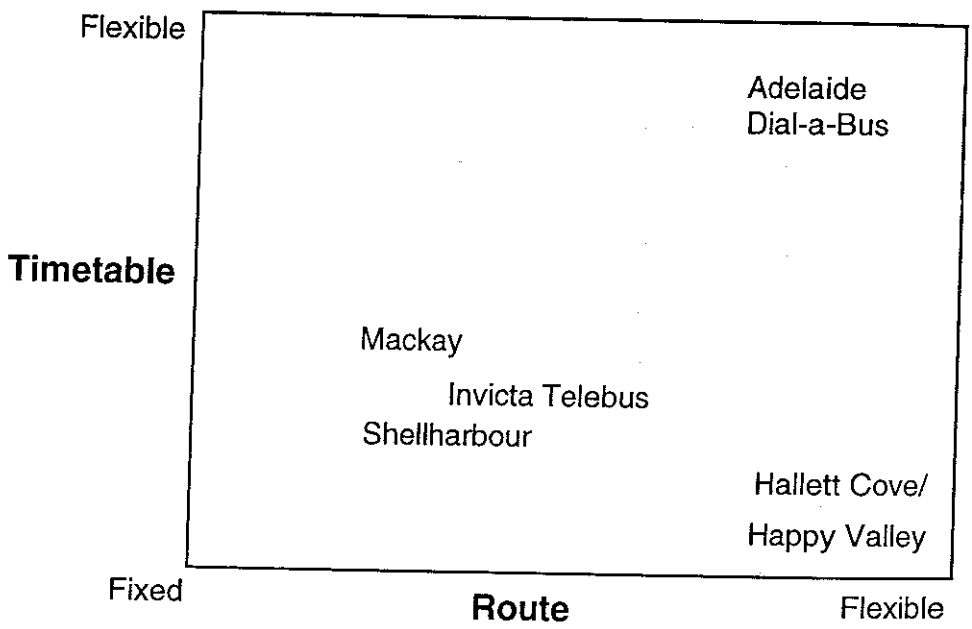

Figure 1 The case studies shown on a conceptual diagram of public transport services

The first and most important lesson from these case studies is that public transport can only achieve the efficiencies it does by grouping people's travel needs.

Removing the constraints of a timetable and route may provide personal flexibility, but it removes the whole *raison d' être* of public transport - its greater efficiency. Smaller vehicles overcome the diseconomies of personal flexibility, but only up to a point. Complete absence of route and timetable produces the economies - and the fares - of a

conventional taxi. To attempt such a service with a large vehicle, as attempted in Adelaide's Dial-a-Bus experiment, is absurd.

On the other hand compromises which trade-off efficiency and flexibility and which produce a more desirable service are possible. As noted, the use of smaller vehicles may counteract the diseconomies. Further, existing and emerging technology should allow better grouping of people's needs. Mackay Taxis' Raywood dispatch system has this capacity and it was also a feature of the Shellharbour experiment. However, in both cases the low levels of patronage allowed manual methods to be used.

The Shellharbour example suggested that fixed but demand-determined route deviations off a base route could provide a more convenient service with no loss of overall journey time. The Mackay service is significantly faster than the conventional bus service. But what it also has demonstrated is the critical importance of accounting for existing services when designing a demand responsive service. New areas, without a pre-existing service, offer the best prospects as they lack the fixed consumer habits. [This is especially if existing services are subsidised.] If there are existing conventional services, demand responsive services which complement these are the most likely to succeed.

Where the demand responsive service is in addition to that which already operates, it is still common to assume that such a service should be viable without a government subsidy. This is understandable particularly given the government's reluctance to spend more on public transport. If on the other hand, the demand responsive service exists instead of a more expensive conventional public transport service, some element of subsidy is justified. Hallett Cove's Taxi Transit can continue to operate despite a $7 passenger subsidy, because otherwise the government would feel obliged to provide a conventional bus, at a cost of $18 per passenger.

3. PERFORMANCE CRITERIA

Interestingly, the case studies have revealed little effort to pursue particular market types. The operations are defined by location and time rather than a particular sort of passenger. There are no services specifically catering for the elderly, or youth, for example, (although one notes Home and Community Care funding of community buses is confined to the target group of the program - those who without such support services would have to move prematurely into a hostel, nursing home or similar institution).

Having said that, to some extent time and location factors will inevitably shape the sorts of people who will use the service. For example, the Hallett Cove and Hub Shuttle services both cater for commuters, though one is a peak hour service and the other off-peak. But there are no specific efforts to cater to a particular sort of market. The Mackay, Shellharbour and the Lilydale services have been designed as a more viable form of general public transport, they will attract those who are suited to their particular combination of service parameters - elapsed trip time, frequency, reliability, and comfort.

alternative. In these terms most of the services have been successful. Fewer resources are needed in that the vehicles can be smaller (and hence running costs are lower) and because the service need only run when and where it is needed. But flexibility does have its costs and demand responsive public transport can never achieve the *potential* efficiencies of mass transit.

4. TECHNOLOGIES

The case studies demonstrate that the operations and technology of a DRPT service can take a variety of forms. However in all cases, by comparison to a fixed-route, fixed-schedule service, the operation of a DRPT service is complex since it must have the flexibility to adapt in real time, or at least over a short time frame, to the current needs of its clients. In particular, a DRPT service involves the exchange of information between the traveller and operator, and the technology that will enable the exchange to take place. Table 1 shows the sequence of steps, information and technologies involved in fulfilling a DRPT request from the initial desire to travel to the point at which the passenger boards the vehicle. By treating the case of a many-to-many service and a request for travel that is conveyed to the operator from a remote location, the table illustrates the most complex situation and incorporates all the major features involved in real time management of a DRPT service. In particular, it emphasises the central role of communications in a fully DR service.

A particular DRPT service will not include all these elements. The technology that is appropriate for a given service will depend on local conditions and the market segment that it is servicing.

Matching Technologies to Markets

This section of the paper examines the technological implications of providing DRPT services that cater for particular markets. Table 2 provides a summary overview of market segments and DRPT service characteristics. On the basis of this table and the case studies described previously the following features may be ascribed to various service types.

One-to-many Zonal Services

In operational and technological terms, a one-to-many zonal service (such as the Hallett Cove and Happy Valley services) is a very simple operation The timing of services from the trip origin is not demand responsive (*ad hoc* departures or timed to link with transit services), the trip requirements of individuals can be conveyed to the driver at the time of boarding the vehicle, the route can be determined by the driver on the basis of personal experience and the arrival time at the destination is flexible. This is a low technology DRPT service that could requires little or no communications infrastructure and minimal start-up cost. It can cater to the commuter market by providing a DR solution to the problem of dispersing commuters from a mass transit terminal.

Table 1 DRPT Information Exchange and Technologies

STEPS IN THE PASSENGER CHAIN	STEPS IN THE OPERATOR CHAIN	INFORMATION EXCHANGED	OPERATOR TECHNOLOGIES
Passenger Desire for Travel			
↓			
Contact DRPT Operator			• Telephone (Voice) • Telephone (Data) • Smart Bus stop • Teletext • Interactive TV
↘			
	Receive Travel Request	• Required Pickup Time • Pickup Location • Required Arrival Time • Destination	• Voice Communications • Data Communications • Bookings Database
	↓		
	Register Travel request		• Pen & Paper • Computer Keyboard • Direct Data Capture
	↓		
	Inform Passenger of Pickup Arrangements	• Pickup Time • Pickup Location	• Telephone (Human Voice) • Telephone (Computer) • Smart Bus stop • Teletext • Interactive TV
↙			
Passenger to Pickup Point			
↘			
	Select and Schedule Vehicle	• Vehicle Locations • Vehicle Schedules • Street Network • Passenger Requests	• Mobile Voice Comms • Mobile Data Comms • Vehicle Location System • Realtime GIS • Manual Scheduling • Automated Scheduling
	↓		
	Inform Driver	• Pickup Time • Pickup Location • Destination	• Mobile Voice Comms • Mobile Data Comms • Map Display
↙	↓		
Board Bus	Pickup Passenger		

Many-to-one Zonal Services

While this DRPT type is superficially similar to the one-to-many zonal service discussed above, in operational terms it is much more complex. The complexity arises from need to register and coordinate travel requests from dispersed travellers and in the case of commuter feedering, to coordinate arrival time at the destination. The full range of DR travel request and response technologies described in Table 1 may apply to this service type.

The overall complexity will depend on the combination of required response time and target market segment. For a service with long lead time (say bookings a day in advance) and unconstrained arrival time, a low technology solution can be adequate. Community buses are an example of this type of service and transport of the elderly to medical or shopping centres is an example target market. However for a service with short lead time (say real time booking) and constrained by arrival time (eg. to meet a mass transit service), there are significant demands on communications and organisation. Technologies such as mobile voice and data communications, vehicle location systems (such as GPS), and sophisticated on-line scheduling and routing software will be required. It follows that DR feeder services for the mass transit commuter market is a difficult and technological demanding format, with substantial start-up costs.

Many-to-many Corridor Services

Corridor services with DR diversions (such as the Lilydale and Shellharbour services) are an extension of conventional fixed-route fixed schedule services. This type of service is appropriate to teenagers, young adults and mobile older persons with irregular travel patterns. In some respects, a corridor service with DR diversions is less ambitious than a many-to-one service but in its most sophisticated form, the technological and communications demands are similar.

If diversions must be booked in advance, then it appears that a low technology operational is sustainable and can be successful (eg. Lilydale). However for real time diversions, the requirement to process travel requests, communicate with the driver and fly the bus route in real time, means that the operational technology must be much more sophisticated. For corridor services, the 'smart bus stop' (an electronic device that communicates a request for travel and responds with arrival details) appears to be a technology that can solve many of the problems associated with a real time DR corridor service. This technology is in use in Europe and is currently being investigated for inclusion in the Perth PPT (Personal Public Transport) project (Glazebrook, 1993). It appears that the appropriate technology and level of start-up cost of fixed and mobile infrastructure will be largely determined by the booking time, a service with advance bookings can be implemented cheaply with low technology while a real time response requires high technology and substantial investment.

Many-to-many Zonal Services

The Adelaide Dial-a-Bus experience demonstrates the inherent contradictions between personal flexibility and the grouping of travel needs. While such a service could be more feasible with cheaper and more efficient communications technology and if computers were used to group individuals' travel needs some compromises on travel time would be necessary and travel would always be more expensive than mass transit. This sort of service may well be suitable for the elderly at times of low demand (such as Sundays) and for the mobility handicapped.

The technology now exists to develop DRPT services that can respond in real time over a zone of the suburban region. However it could be reasonably argued that the taxi industry already has the fleet and installed communications infrastructure to cater for this market. Further development of this infrastructure may be needed for many-to-many multihiring. Taxi services have, after all, opted to cater for individual travel and personal flexibility rather than any large-scale grouping of travel needs.

5. CONCLUSIONS

The examples of demand responsive public transport here demonstrate that the concept is feasible. When one also considers the widespread use of demand responsive community transport, it is clear that a variety of different market sectors can make use of DRPT. Services such as the Invicta Telebus have been built with relatively low levels of technology. In principal we should be able to see shorter booking times, more real time information provided to customers and more efficient grouping of customers' travel needs using technology already widely available (Glazebrook, 1993). Of course, there are trade-offs. For instance the shorter the booking times, the less predictable the service is likely to be. However the Shellharbour experience warns us of the fragility of relying on advanced technologies, particularly when that technology is imported. Clearly also, high start-up costs make such projects difficult to establish outside the public sector, and here is a potential problem for service innovation given the present movements to privatisation and tendering of specific services.

On the other hand, one-to-many services and corridor services are relatively easy to establish with low levels of technology and what is more, the technology can be upgraded at a later point to enhance the service. Many to one services need cheap and widely available communication technology. The option of having numerous destinations increases complexity, though the Mackay Taxi Transit service shows it can be possible if the service operates within defined corridors.

Passenger transport will always involve trade-offs. Factors such as cost, convenience, reliability and comfort need to be juggled. But conventional public transport has situated itself for too long at one end of the spectrum, catering for the needs of an ever-diminishing proportion of the population. Demand responsive services can work in particular circumstances. And with intelligent use of existing and emerging technology the need for trade-offs can diminish. But what is also needed is the desire and capacity to

Table 2 Markets and Service Characteristics for DRPT

Market	Coverage	Category	Route	Level of organisation & communications	Vehicle Size	Start-up Cost	Potential for Success
Commuter							
- CBD	Many-to-one	Area	Door-to-terminal	High	Medium	High	Low
- Local	Many-to-Many	Corridor	Fixed with diversion	Medium	Medium	Medium	Possible
- Feeder to Transit	Many-to-one	Zonal	Door-to-terminal	High	Small	High	Low
- Feeder from Transit	One-to-many	Zonal	Terminal-to-door	Low	Small	Low	Good
Teenage/Young Adult							
- Local	Many-to-many	Corridor	Fixed with diversion	Medium	Medium	Medium	Possible
Elderly/Reduced Mobility							
- Local	Many-to-many	Zonal	Door-to-door	Medium	Medium	High	Possible
Unemployed/Carers etc							
- Local	Many-to-many	Corridor	Fixed with diversion	Medium	Medium	High	Possible

think laterally, perhaps by considering the spectrum of transport services and the appropriate matching of services to specific demands.

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