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MULTIPLE HIRE ALTERNATIVES FOR AUSTRALIAN TAXI CABS

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ABSTRACT:

Multiple hire, as opposed to single hire of taxi cabs is a concept often propounded by the community as desirable, yet seldom acknowledged by the taxi industry as practicable. Multiple hire is frequently claimed to have the following potential impacts:

- *an easing of existing under-supply of taxi-cab services, where and when this occurs;*
- *a decrease in the cost of travel by taxi-cab thereby both improving the potential to satisfy latent demand and reducing the cost to those currently using taxi-cab transport;*
- *an increase in vehicle occupancy, with consequent benefits of reduced congestion, increased efficiency and so on.*

This paper reports an investigation of the general desirability of introducing multiple hire of taxi-cabs to Australian cities.

MULTIPLE HIRE OF TAXI-CABS*

INTRODUCTION

Multiple hire, as opposed to single hire use of taxi cabs is a concept often propounded by the community as desirable, yet seldom acknowledged by the industry as practicable. The multiple hire mode of service is, with one exception, catered for only minimally in Australian cities. The exception is in Canberra where, since December 1975 it has been permissible for taxis to operate a multi-rate fare system, specifically designed to allow multiple hire from all taxi ranks.

Multiple hire is often claimed to have the following potential impacts:

- an easing of existing under-supply of taxi-cab service, where and when this occurs;
- a decrease in the cost of travel by taxi-cab, thereby both improving the potential to satisfy latent demand and reducing the cost to those currently using taxi cab transport;
- an increase in vehicle occupancy, with possible consequent benefits of reduced congestion, increased efficiency and so on.

This last claimed advantage of increased vehicle occupancy is, however, the principal contentious issue raised by cab owners, drivers and companies whenever the question of multiple hire is raised. Understandably, cab operators will not be satisfied with any decrease in revenue resulting from innovatory action. The critical, but unknown, factor therefore concerns the initial relationship exhibited between demand and cost. On the one hand, the lower user-cost of multiple hire may encourage an increase in demand sufficient to offset the decrease in revenue. On the other hand, no or little change in demand may be recorded, and net revenue to the industry may fall.

This paper reports on an investigation of the general desirability of introducing multiple hire of taxi cabs to Australian cities.

The paper commences with a discussion of overseas and Australian experience of formal arrangements for multiple hire. Alternative fare sytems are also introduced and briefly discussed in terms of their application in different places.

Specific possibilities for multiple hire service in Australian cities are then investigated. The general conclusions of this phase are that:

- a general multiple hire service for an entire metropolitan area is probably not feasible since it cannot be expected that the demand for service in excess of current demand, will be sufficient to ensure large-scale matching of trips (whether such matching is arranged in advance or in an impromptu manner as requests for service are received by telephone or hail);

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* Based on part of a 1976 study for the S.A. Department of Transport, this paper is published by permission of the Director General of Transport (S.A.). Special thanks are expressed to John Hutchinson .

- a meter-based fare system for multiple hire is operationally feasible only for one-to-one or one-to-many travel. Even then, it is nigh impossible to determine a rate of discount to apply to multiple hire fares which provides sufficient revenue to the cab driver to encourage him to always offer the service, yet provides sufficient guaranteed cost savings to passengers to encourage them to always want the service;

- a zone-based fare system for multiple hire, whilst being eminently suitable on theoretical grounds, is probably too complex to be implemented on a large scale. Its suitability for small-scale multiple hire schemes, however, seems clear.

The final part of the paper contains a description of a number of small-scale multiple hire schemes suitable for pilot study. These may be placed in one of four categories:

- those serving activity centres;

- those performing a feeder/distribution function;

- those catering to cross-town demand for travel;

- those extending hours of operation of existing public transport.

AN OVERVIEW: THE ALTERNATIVES AND SOME EXPERIENCE

Australian Experience

In most Australian cities, multiple hire of taxi cab is permitted, but only to a very limited degree and in a manner specified in the respective regulations. In some cases, a cab-driver must ask permission of the first passenger (hirer) before accepting a multiple hire request from any potential passenger. In other cases, a cab may be multiple hired at any time at the express request of the principal hirer or when given permission by a duly authorised officer. The cab driver is (in this case) not permitted to ask passengers whether they will consent to multiple hire.

The fare charged each hirer must typically not exceed 75% of the fare recorded on the meter at the drop-off point. Alternatively, the fare for each hirer must not exceed 75% of the fare corresponding to the shortest route which would have been taken had the hire been exclusive to that passenger.

In Canberra, where multiple hire is specifically provided for, the Department of the Capital Territory allows multiple hiring from any taxi cab rank, together with the following fare schedule (as at June 1976):

Flagfall	35¢	
Booking Fee	25¢	
Rate 1:	Single hire 6.00 a.m. to midnight Monday to Friday	22¢/km
Rate 2:	Single hire midnight to 6.00 a.m. and on Saturday, Sunday and public holidays	25¢/km
Rate 3:	Multiple hire 6.00 a.m. to midnight, Monday to Friday	16.5¢/km
Rate 4:	Multiple hire midnight to 6.00 a.m. and on Saturday Sunday and public holidays	19¢/km

Rates 3 and 4 are 75% exactly of the corresponding Rates 1 and 2. It is illegal for a driver to multiple hire from any point unless the taxi is fitted with a meter which can register the appropriate (Rates 3 and 4) charge. With multiple hire, the meter is operated on Rate 3 or 4 depending on the time of day, and the meter is left on until the last fare has been dropped. The fare charged at each drop is that shown on the meter at the time of the drop.

The multi-tariff system is understood to be operating well, if in a limited way. Due to lack of demand, multiple hire is occurring from only three places: one at Canberra airport rank, one at the major rank in Civic and one at the major rank in Phillip town centre. No corresponding occupancy or revenue data is available, but it could be said that the multiple hiring rate of 75% is often generous to the operators.

About 35% of hirings in Canberra are from ranks, so that a natural limit on the level of multiple hire is set. It is debatable whether there would be any value in widening the scope of the scheme to allow multiple hire for the remaining 65% of hirings.

Fare Systems

At this point, it is perhaps appropriate to briefly introduce the issues involved in the setting and regulation of taxi cab fares. Indeed, it may be asked whether any form of regulation is necessary at all. On the one hand, the essentially competitive nature of the taxi market would seem to ensure the existence of a fare-structure both stable and uniform over the entire market. Further, economies of scale are relatively small, and there is therefore little chance that an owner of several cabs would find it economically feasible to charge less than the fare required by a single cab owner.

On the other hand, there may be sufficient justification for fares regulation solely in order to avoid a confused and confusing situation where a passenger may never be certain of the rate at which the fare will be assessed, even if such confusion were to arise out of relatively small deviations in rates. In any case, whatever the justification for fares regulation, it does exist and most likely will continue to exist. We are therefore in a position to propound a general principle that trips of equal quality and length be uniformly priced.

In setting fare levels within a specified fare system, however, exceptions to this general rule may be justified. For example, trips to a major city airport often result in cabs having to 'dead-head' back to the city. Trips to some areas might be considered hazardous by drivers. The money available for expenditure on personal transport by the poor is limited. In each case, fares could, justifiably perhaps, be set differently to the prevailing level for trips of similar length elsewhere or for different classes of passengers (1).

Criteria which should be considered in determining a fare system are:

- the system should be simple, fraud-proof and cheaply administered;
- it should be so as to discourage circuitous driving;
- it should be readily adaptable to increases in costs generally;
- it should allow fare levels to be high during periods of high variable cost, or during periods of high demand (relative to supply);
- it should encourage an "appropriate" supply of cabs in response to the demand for cab services.

Meter based fares: Taxi fares in Australian cities are calculated by *meters* largely according to a prescribed *rate per km*. A simple and important advantage of this system is that the passenger sees the total amount for which he is liable. Taxi industry spokesmen maintain that passengers are generally happier to pay their fares on the basis of such a visible continual reckoning rather than the statement of the driver that "..... the prescribed flat fare is ....." or on the driver's calculation of the appropriate proportion of the accrued meter reading (in the case of multiple hire, for example).

Zone fare system: An alternative fare-calculating system is based on defined *zone-to-zone* charges. Many cities in the U.S.A. appear to use this method to define fare levels for their taxi systems. A recent American study (Webster et al, 1974) produced the results presented in Table 1. Over 20% of all cities surveyed were found to have zone-based fare systems. In Madison, Wisconsin, for example, a zone fare system operates alongside a meter-based fare system. The zone fares are less than the meter fares for equivalent-length journeys, but zone taxis can stop en route to pick up other passengers travelling the same general direction. Meter taxis are faster and offer a single-hire service only. For a trip

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1 which is, of course, the current situation with respect to bus train, tram and air travel, where students and pensioners receive travel concessions subsidized by government.

of length 12 km the meter fare is US$3.90 whilst the zone fare is US$1.20(1). Presumably, the average occupancy for zone taxis is around 3, to ensure a comparable rate of return to each driver. There is no quantitative information relating to the degree of success of the dual system, although it appears that the respective operators see no direct competition between the two services. The implication is that two markets are being tapped, and that multiple hire system serves a hitherto *latent* demand (or else, is tapping existing use of public transport).

The truth (or otherwise) of this implication is important. Existing operators will be far more interested in catering to a new market than in experimenting with service to the existing market, and understandably so. Certainly in Canberra, however, the multiple hire operation appears to ease pressures on a few high demand situations by consolidating trips which are made already. It could be argued, though, that excluding all but taxi rank hirings from the multiple-ride facility (as is done in Canberra) severely constrains the satisfaction of the demand for trips which are not presently made (by taxi).

It might be concluded that the *indications* are that wide-scale multiple hire would diminish little the existing satisfied demand for taxi travel, and may encourage a substantial increase in satisfaction of hitherto latent demand.

TABLE 1: TAXI CAB FARE SYSTEMS IN 80 U.S. COMMUNITIES SEPTEMBER, 1973 (a)

Fare System	Population 100,000 or more	Population under 100,000	Total
	Number of Communities		
Meter rates	152	422	574
Zone rates	8	156	164
Flat rates	0	69	69
Total	160	647	807
	Percent of Communities		
Meter rates	95.0	65.2	71.1
Zone rates	5.0	24.1	20.3
Flat rates	0.0	10.7	8.6
Total	100.0	100.0	100.0

(a) Source: International Taxicab Association cited in Webster et al (1974).

The Madison situation of *parallel* zone and meter-based fare structure appears rare. In Arlington (Virginia), an experimental shared taxi service was implemented in February 1975 for operation in conjunction with the regular single fare

1 as at 1974.

taxi service. A ten zone fare system was calculated by dividing the taximeter fares between geographical centroids of the zones by a hypothesized average load factor of 1.8. The existing average load factor for exclusive ride services was about 1.2, and a substantial incentive was therefore considered to exist for drivers to match destinations of riders. A 25¢ surcharge applies during peak periods to compensate for additional costs (relating to congestion) incurred by cab operators. The Arlington experiment is being carried out by two of the largest taxi companies there, controlling over 50% of the country's 470 taxi cabs. Multiple hire related services offered by the companies are several. Subscription rates for regular travel can be negotiated between prospective riders and the two companies, and commuter and shopper multiple hire services are operated during peak hours and midday hours respectively. As reported by Kirby and Miller (1975), the service was neither promoted publicly, nor very successful during its first months of operation.

In Darwin, Australia, a limited zone fare system is understood to have operated up to 1973. Since then, metered charges have been made to passengers. The earlier system actually defined point-to-point rather than zone-to-zone fares and was probably feasible because of Darwin's very small city population (about 37,000 in 1973). In contrast, the populations of Arlington and Madison, whose zone fare systems were described above, are 174,000 and 170,000 respectively. Many other smaller centres in the United States are believed to have zone-based fare structures. For at least 22 in Wisconsin alone, this is certainly the case (see Fachar and Beimborn, 1974) the various populations ranging from 7,000 to 50,000 and up (see also Table 1).

This experience suggests that zone fare systems are workable in areas of small size only, and where the system is part of a multiple hire service, demand must be relatively high already or become so. For major Australian cities it might be argued that a zone fare system would be complicated and confusing, and if introduced as part of a multiple hire service, would not generate sufficient revenue in many parts of the city because of low demand. If certain zone fares were increased to take account of this low demand, the saving to riders might probably be zero or negligible (or even negative!)

One way however, of operating either a multiple hire service or a zone-fare system (or both) might be to restrict it to one part only of the metropolitan area. A proper assessment of the feasibility of such an operation would seem to require a detailed knowledge of both spatial and temporal demand for personal transport in general, and taxi cab transport in particular. None-the-less, later parts of this paper suggest schemes for implementation of multiple hire taxi services over limited areas and limited periods of time as pilot studies designed to explore the viability of such schemes.

Conclusion: In conclusion the claimed relative features of each of the meter-based and zone-based fare systems may be summarised as follows (Kirby and Miller, 1975):

Meter-based

- Meter-based fares can approximate more closely the marginal costs of providing the services in that they take the time duration of the current journey into account.
- Meter-based fares more closely reflect the distance-related costs of the journey.
- Meter-based fares can cater for time spent waiting by a cab driver when requested by the passenger.
- Meter-based fares are not susceptible to manipulation by geographically isolated 'political' or pressure groups of the community.

Zone-based

- A zone-based system negates incentive for the driver to take unsuspecting passengers by deviously lengthy routes or to manoeuvre artificial delays in order to increase fares.
- A zone system obviates the capital cost of meters.
- Passengers are more readily able to judge the cost of travel before the journey's commencement.
- The need to adapt meters in the event of altered fare levels is a particularly inefficient task, from the point of view of operators.
- A zone system can take account of a high degree of dead-heading along certain corridors.
- Zone systems can be closely tailored to the needs of multiple hire services.
- Zone systems can be designed to benefit geographically-concentrated disadvantaged groups.

Various features are given attention in the sequel.

SPECIFIC ALTERNATIVES FOR AUSTRALIAN CITIES

Introduction

In this section, we expand the general discussions presented above, in order to identify those aspects of multiple

hire service which we consider may warrant implementation. Our investigations suggest the testing of several different schemes simultaneously, rather than to recommend the large scale implementation of one ostensibly polychrestic innovative scheme.

The recommendation for a "trial-and-error" approach stems partly from a general absence of knowledge about taxi-based transporation services. Also, it is possible to be more selective in the distribution of benefits, by choosing for implementation or testing a number of projects, each of which may have a different objective.

Alternative hire structures are many. Figure 1 shows some of the different feasible structures which may be considered for implementation and at least ten may be deduced from a study of Figure 1 alone. The left-hand box lists modes of operation which will be familiar to those with an interest in so-called "demand activated" transportation systems. Thus, many-to-many and one-to-many mean that the vehicle providing the service will pick up passengers from any origin points or only one origin point respectively, and drop off passengers at (virtually) any destination point they wish. Whether, in the case of taxis, the origins may be anywhere in the service area, or only at taxi ranks, is expressed by the entries in the right hand area. Single or exclusive hire is possible with only the one-to-one mode of operation. Multiple hire is possible in any mode.

Restrictions may also be placed on the spatial variation of origins and destinations for the one trip. For example, all origins and destinations for the one multiple hire trip might be required to be within the one defined area.

Alternative fare systems are shown in Figure 2. Those represented there are by no means all that are possible. For example, a fare system based on a single flat rate is not generally appropriate for the sorts of trips made by taxi. This would only be a reasonable proposition if the scatter of trip lengths around the most frequent value and the difference between the most frequent and mean values were small, which is not believed to be so for taxi travel.

Various hire and fare system alternatives are analysed below. Systems are chosen for analysis on the basis of their main features (for example, multiple hire or zone-based fares). No attempt is made to cover all possible alternatives. These have been indicated already to be large in number.

Meter-based Multiple Hire

One-to-many: This system constitutes part of the current operation of taxi services in Canberra, where multiple hire

FIGURE 1: ALTERNATIVE HIRE STRUCTURES

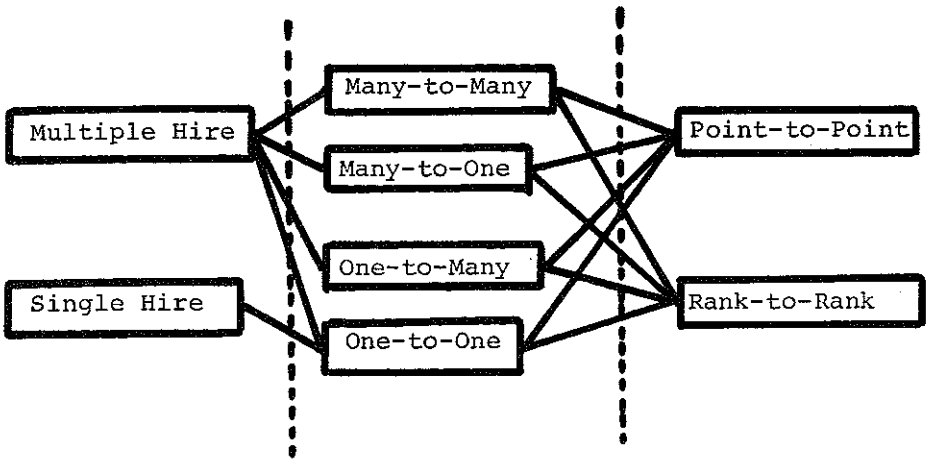
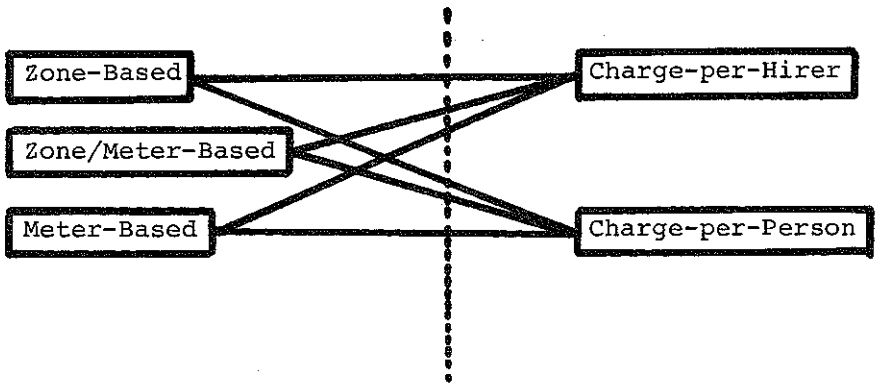


FIGURE 2: ALTERNATIVE FARE STRUCTURES



pickups are allowed only from *taxi-ranks* and the fare is charged to each *hirer*. The complete meter-based fare system was described in Section 2 above, but the feature which concerns us here is that the multiple hire charge per hirer is calculated by meter as 75% of the single hire fare by the actual route taken. Criticism has been directed at the apparent generosity to cab operators of these rates, and the questions arise:

> What discounted rate is appropriate for multiple hire, and what effects does this hire and fare system have on the behaviour of operators and passengers?

In Appendix B, an analysis is made of these questions. There are two significant conclusions to be drawn from the analysis.

Firstly, it is clear that for discounted rates as high as that prevailing in Canberra, the cab driver will generally do well out of double hire and almost always do extremely well out of triple (or higher) hire.

Secondly, given that passengers have the right to refuse multiple hire, it can be seen that each passenger is subject to considerable mental strain before he can sensibly agree to travel on a multiple-hire trip. Therefore, it is not surprising that the multiple-hire market is apparently rather limited (as discussed earlier in this chapter). In fact those three areas where it is successful (in Canberra) comprise major trunk routes for transport services in general and taxi services in particular. Here, multiple-hire passengers' destinations are invariably distributed closely about the end of the trunk route. This can be readily predicted from our analysis (see Appendix B). Passengers will in general agree to multiple-hire only when all passengers' routes closely coincide, (as they do along trunk routes) and low costs are assured.

These effects can certainly be mitigated to an extent, and the attractiveness of multiple-hire alternative increased by increasing the rate of discount. But a dilemma arises: the smaller is the number of passengers, the less willing is the cab-driver to multiple hire for a given group of passengers with destinations along the same corridor; a greater spread of destinations is required to maintain the driver's revenue at a sufficiently high level. A decrease in the rate of discount may be compensated by higher cab occupancy, but this means that the onus is on the driver to assemble a sufficiently large group of passengers with sufficiently dispersed destinations to maintain his revenue at a satisfactory level.

Clearly, an appropriate value for the discount rate is as much dependent on the desired trip-making patterns of potential cab-travellers as it is on cab-drivers' willingness to cater to these desires, and vice-versa. What must be concluded is that because of the "feed-back" processes involved, it is not possible to set a theoretically definitive discount

value. It would have to be continually redefined in the hope that some equilibrium point would be reached eventually.

It may be found difficult to reconcile the apparent (though limited) success of the Canberra multiple-hire system with our earlier inference that multiple-hire and single-hire services cater to largely distinct markets. In other words, a multiple-hire service should be expected to serve a demand which remains effectively latent when offered 'conventional' single-hire taxi-cab services. Remember that this is, in fact, a claimed benefit of a multiple-hire cab scheme. What appears to be occurring in Canberra, however, is a straight forward consolidation of existing trips where and when cab supply is low and drivers and passengers are assured of satisfactory returns and reductions in costs respectively.

Unless latent demand is for trips which are closely matched in terms of origin and destination, costs are unlikely to be sufficiently low to allow satisfaction of this demand. Apart from this, the satisfaction of latent demand would seem to require at least point-to-point service; multiple-hiring in Canberra is presently allowed only from taxi-ranks.

In summary, we believe that multiple-hire service of the sort currently operational in Canberra can be successful only in the consolidation of trips already made along trunk routes. Both the concept of a discounted meter-based rate and that of taxi-rank oriented multiple-hire service are not appropriate to the objectives of multiple-hire, one-to-many, taxi-cab service.

Many-to-One and Many-to-Many: Using much the same analysis as above, it can be shown that a discounted meter-based fare structure is equally inappropriate for operation of the modes of service described by the terms many-to-one and many-to-many multiple-hire. But not only is it not possible to set a theoretically definitive discounted value as before. Two other problems of many-to-many operations concern, firstly, the difficulty of calculating individual fares from a single meter when passengers are continually boarding and alighting and, secondly, the need to curb any overt enthusiasm of drivers in picking up additional passengers such that the itinerations needed to deliver each passenger to his destination might outweigh the advantages originally seen by the passenger in deciding to share. This last problem is important, yet not so marked in the earlier one-to-many situation where each passenger conceivably knows the itinerations to be undergone before the journey is commenced. Nor is it so marked in the many-to-one situation, since the longest the first passenger could have to wait is the time required to pick up the remaining three (say) passengers who are travelling to the one destination.

Even supposing these problems to be solvable, the practicability of a many-to-many multiple-hire cab service must remain uncertain. There are two issues. Firstly, the service could not depend to any great extent on telephoned bookings, because of the currently relatively low level of

household telephone ownership in Australia. In the U.S.A., where many-to-many cab operations are reportedly successful, this is apparently not a problem (1). In Australia, in 1975, *average* household telephone ownership stood at just under 60%, with telephone ownership for households which might most justifiably be described as "transport disadvantaged" being considerably less (2). It appears likely that the effectiveness of a many-to-many service (in catering in particular to latent demand) will be poor unless, co-incidentally with its implementation, an improvement in telephone ownership can occur. A many-to-many service need not, of course, be totally dependent on the level of household telephone penetration if street-hail and rank-hiring remained attributes of the service.

The second issue, referred to earlier, partly concerns the likelihood that cabs providing the service can pick up sufficient passengers en route to ensure a satisfactory return to the driver, given that fares are discounted from their normal single-hire rates. It also concerns the likelihood that the service will be capable of satisfactorily serving all demand for travel. In other words, will both supply and demand be appropriate to the successful operation of the service? This could be determined through practical experiment; whereby a multiple-hire many-to-many service would be set up, a fare-charging mechanism specified, and the operation monitored to see if a satisfactory equilibrium point could be reached.

The alternative to practical experimentation involves the construction of a *model* of cab operation. Such a model would allow for alternative specifications of style of operation and nature and extent of demand, to determine those combinations critical to the satisfactory performance of a many-to-many cab service. Note, however, that the model would not be required to estimate demand *per se;* rather particular levels of demand would be calculated as those required for viable operation at particular levels of service, and vice versa.

The next step would be to postulate a range for the level of demand most likely to hold in practice. This range could then be used to define the associated type of service most suitable for implementation. Our expectation is that a many-to-many service defined in this way could be unattractive either to the cab industry, because of insufficient return, or to the user population, because of low level of service.

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1 In the USA telephone exchange services per 100 population are 37. In Australia the figure is 25, the implication being that household telephone ownership in the USA is much higher than in Australia.
Source: Siemens "International Telephone Statistics" 1974.

2 See Appendix A

In conclusion, we do not see the implementation of a large-scale multiple-hire service as being a sensible innovation. Rather, it would be preferable to introduce different types of multiple-hire service implemented on a small scale, to provide a relatively cheap program for monitoring and testing. In this way, attention may be given to selected aspects of multiple-hire and to the way in which the community reacts to those aspects.

Zone-based Fares

One of the principal detractions of meter-based fares for multiple-hire is the nigh impossibility, for many-to-one and many-to-many service, of sharing fares equitably between all passengers. Fares based on a zonal system, however, suffer no such disadvantage, since the fare for each passenger is assessed *as he enters the taxicab*.

Other claimed positive attributes for zone-based structures have been listed already, including:

- zone-based charging obviates the need for the capital and other costs associated with meters;
- a zone-based structure discourages behaviour fraudulent to passengers;
- a zone-based structure can take account of drivers' reluctance to serve certain routes;
- a zone-based structure can be drawn up so as to benefit disadvantaged but geographically concentrated target groups;
- zone-based charging may mean that the cab owner finds difficulty in maintaining proper control over revenues.

Fraudulent Behaviour: It may be said that, to an unknown extent, some cab-drivers take advantage of passengers unfamiliar with a city, in that the route taken (and charges made) do not truly reflect the requirements of the trip. If this sort of behaviour were practised it could be effectively and immediately stopped by the implementation of a zone-fare structure for both multiple and single-hire.

Unpopular Routes: There may be broad routes (or times of day) where average revenue to the driver falls considerably in comparison with the metropolitan average. Understandably, drivers would be unwilling to service these routes (or these times) as much as they do other more productive routes. A zone-fare pitched at a higher level for these trips specifically would encourage drivers to provide more service, in that their average revenue would approach more closely (or equal) the metropolitan average. There is a complication, in that a higher user charge may lead to a fall in demand, so that

the increase in revenue which might be expected, if other things were equal, will be compensated somewhat by a co-incident fall in demand. It is not possible to estimate the extent of this effect.

Geographically Concentrated Groups: To subsidise taxi usage by geographically concentrated disadvantaged groups is probably not possible, simply because of the difficulty of identifying such groups. Certainly areas can be delineated, which *tend to contain* above-average numbers of disadvantaged persons. But such areas are by no means completely homogeneous in their population content, and any general measure intended to benefit the disadvantaged residents must simultaneously benefit those whose needs are less.

What may be possible, however, is to identify large institutions whose clientele and visitors are predominantly the sorts of people to whom cheaper taxi fares could be directed. For example, a large geriatric centre could be defined as a separate zone, and all fares to and from that zone set at an artificially low level.

There remains the problem, however, of relieving the cab operators of the subsidy burden, and transferring it to the government. It suffices to state here that zone fares cannot sensibly be used to benefit geographically concentrated groups, not because the concept itself is inconsistent, but because:

- such groups are very difficult, if not impossible, to define; and
- it is difficult to design this scheme in such a way that it is the government which provides the intrinsic subsidy and not the cab operators.

Owner Control of Revenues: There is one major apparent disadvantage of a zone-based fare system which we have not yet discussed. We have recognised that zone-charging discourages drivers from defrauding passengers. But the incentive provided to the driver by a meter to deal honestly with the *cab owner* is absent. A passenger will generally quickly chastise the driver of a metered cab if the meter is not running during the trip, and the cab owner is therefore provided with a good physical record of revenue earned during the driver's shift. It is therefore a straight-forward task to check that the money handed over by the driver at the end of his shift tallies with that amount shown on the meter.

This safeguard does not necessarily exist within a zone-fare structure, and it is not difficult to see that the structure as so far defined will be therefore of very little interest to cab owners. We do not mean to imply, by this, that dishonesty is rife within the cab industry. Rather, we recognise the important need in any operation for controls on fair-dealing.

Can the problem be circumvented? Certainly it would not arise at all if all cab driving were done by cab owners, but this is obviously out of the question. The solution would probably lie in the introduction of a ticketing system, similar to that operated on buses. Passengers would be "encouraged" to ask for tickets, and the taxi owner's reckoning of tickets sold, would provide him with an almost perfect physical record of revenue.

Complexity: A further disadvantage would appear to relate to the necessary complexity of a zone-fare structure, in that the number of different fares struck would equal at least half the square of the number of zones. Earlier in the paper, the zone-fare system in Arlington, Virginia was discussed. Here ten zones were found necessary to cover an area of some 70 sq. km. containing over 170,000 persons, or about 2,400 per sq. km. In Adelaide, for example, the metropolitan area is over 550 sq. km. and contains about 820,000 persons or 1,490 per sq. km. On comparison, it would seem that between 50 and 80 zones would be needed to cover the Adelaide metropolitan area, resulting in the need to strike between 1,250 and 3,250 different fares! This is certainly not an impossible task, but the practical difficulties involved in assessing individual fares would seem, at first sight, to be immense.

On the other hand, given that the driver can identify the origin and destination zones of his passengers, there is no reason why, for example, a simple electronic device could not be constructed to provide a visual display of the appropriate fare. The device could resemble a small pocket calculator; zone numbers would be punched in and the fare displayed in the same way that an electronic calculator displays its results.

Despite the apparent ultimate feasibility of operating a city-wide zone-fare system for multiple-hire, it is probable that acceptance of zone-fares will be the more readily forthcoming, the simpler is the proposed system. In other words, it is probably sensible to introduce zone-fares on a limited basis only, in conjunction with multiple hire schemes confined to specific areas (both geographic and operational).

SUGGESTED MULTIPLE-HIRE SERVICES FOR AUSTRALIAN CITIES

Summary of preceeding Discussion

Thus far, the discussion seems to point to the following conclusions:

- A general multiple-hire service for an entire metropolitan area is probably not feasible since it cannot be expected that the demand for service, additional to current demand, will be sufficient to ensure large-scale matching of trips (whether such matching is arranged in advance or in an impromptu manner as requests for service are received by telephone or hail).

- A meter-based fare system for multiple-hire is operationally feasible only for one-to-one or one-to-many travel. Even then, it is nigh impossible to determine a rate of discount to apply to multiple-hire fares which provides sufficient revenue to the cab-driver to encourage him to always offer the service, yet provides sufficient guaranteed cost savings to passengers to encourage them to always want the service.

- A zone-based fare system for multiple-hire, whilst being eminently suitable on theoretical grounds, is probably too complex to be implemented on a large scale. Its suitability for small-scale multiple-hire schemes, however, seems clear.

Further, it is desirable that proposed innovations be implemented as small pilot studies, designed to test distinct aspects of multiple-hire service.

Consequently, our investigations suggest the definition of certain small-scale schemes which we suggest are suitable for pilot study. These suggested pilot studies may be placed in one of four categories:

- those serving activity centres;
- those performing a feeder/distribution function;
- those catering to cross-town demand for travel;
- those extending hours of operation of existing public transport.

Each is discussed below.

Activity Centre Services

Commuter Services: A multiple-hire taxi-cab service may be directed to the alleviation of traffic congestion associated with the journey to work, in the sense that it can offer a reasonable alternative to present private car users (not bus users). It is important to make this distinction, since we believe that public transport union concurrence may be a critical factor in allowing the implementation of a commuter service.

Overseas experience has been that there appears to be no direct competition between bus and multiple-hire taxi services. In Australia, for trips of the distance typically travelled by commuters, taxi travel costs under a multiple-hire scheme would most likely be higher than by bus, yet less than by private car, even if multiple-hire taxi fares were only (say) 25% of the single-hire rate. For a present bus passenger to transfer to taxi travel, a significant increase in cost would be involved, so that it may be

contended that any transfer is far more likely to occur from the relatively expensive private car to the cheaper multiple-hire taxi (1).

In the light of the apparent and expected lack of success of car-pooling schemes (MacLean 1977), it may be thought that a multiple-hire cab service might suffer from a similar fate. There is, however, sufficient differences between the two modes of operation to suggest that this need not be the case.

By reducing the number of possibilities for individual trips, a cab scheme could well find sufficient demand to warrant the extra administrative effort required on the part of companies to match demand. One way to drastically reduce the number of possibilities is to simply limit the number of origin points serviced by the scheme. We envisage here that a relatively small number of cab ranks be designated as commuter pick-up points (being used also as drop-off points for the work-to-home journey). These pick-up points would be serviced by cabs during morning and evening peak hours, and act as pedestrian/cab or car/cab interchanges, as the case may be. Fares would be set in a manner analogous to a zone-fare structure, and at a level which encourages drivers to collect a near-full complement of passengers before setting off.

There need be no fixed and regular agreement on the part of passengers, but the cab company or companies providing the service must guarantee to have cabs at the pick-up points during the advertised hours. Further, to encourage public transport unions' acquiescence, publicity could be aimed largely at present private car travellers.

Certainly there are problems in the implementation of a cab commuter service. For example:

- suitable sites for pick-up points may be difficult to find (car parking space may be necessary);
- suitable destinations may be fairly restricted (e.g. CBD, industrial centres) in order to avoid delay to passengers awaiting departure;
- shelter may be needed, during inclement weather, for riders transferring to cabs.

Such problems should not, however, be insurmountable. For example, a regional shopping centre may be happy to allocate car-parking space to the scheme in return for the extra custom it could expect to receive from users of the commuter service.

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1 There are other factors involved here of course. These relate to comfort, convenience, travel time, privacy and so on.

Shopper Services: A multiple-hire cab system may be used to service large retail shopping centres. The fact that these suburban shopping centres depend for their custom so much on private vehicle transport is evidenced by the very extensive provisions for car parking which must be made. Even so, there are, conceivably, many people who find it difficult, if not impossible, to shop at these centres because of unavailable public transport or lack of car-ownership. There are at least two ways in which taxi-cabs could be very sensibly used to supplement the transport modes currently available to shoppers. One involves the running of a route taxi service and the other, the running of a pre-bookable multiple-hire cab service.

A shopper service is understood to exist in Arlington, Virginia (see Kirby 1975). There, to summon a cab at the home end of the trip, a passenger is required to call two hours in advance of his or her desired pick-up time. This facilitates matching of trips. The cab company (one of two) guarantees pick-up within 30 minutes of the requested time, and will call back the passenger a few minutes before the cab is due to arrive. This action both frees the customer from having to watch for the cab's arrival over long periods and also aims at reducing the number of "no-shows". Four activity centres (one health, one health/shopping and two shopping) are served in this way. At the centres, cabs are available for the return trip from designated stands at least every hour on the hour. Each cab waits until it has three passengers going in the same direction, or for 15 minutes after the first passenger boards, whichever occurs first.

We do see some differences being desirable in Australian applications. Initially, at least, demand for travel to the shopping centres could be served just once in the morning (say around 10 a.m.) and once in the afternoon (say about 2 p.m.). This would allow all demand to be concentrated near these two times, so easing any growing pains the service might suffer through too dispersed a demand pattern (both geographically and in time). A similar restriction could be maintained on the home journey service.

Fares could be charged according to a zone system, although this is difficult to specify precisely. A separate zoning could be defined for each centre, or use could be made of a zoning defined for the whole metropolitan area. Alternatively, provided demand turned out to be not too geographically dispersed, a single flat fare could be levied.

There is one drawback to the service as defined here, which may be significant for many urban areas in Australia. This relates to the incidence of household telephone ownership. As discussed earlier, this averages 60% in Australia, with the figure being considerably less for some areas. Since the

shopper service described above depends completely on telephoned bookings, it would probably be necessary to provide an alternative system to serve areas of low telephone ownership (1). Such a system might be satisfactorily developed using fixed route taxis.

Just as a pre-arranged shopper service might be provided twice each day, so might a set of routes be serviced twice each day. The routes would meander somewhat as they gradually converged to the centre, so that maximum coverage could be given. Should a cab obtain a full complement of passengers, another cab could be summoned by radio to take over the servicing of the route whilst the first would then proceed directly to the centre.

There are many variations which might be made to the service concept defined here. These could be sorted out in planning discussions held with companies interested in providing the service. Perhaps a major requirement, however, is the need to avoid competition with scheduled bus services; publicity should be given to the service but must be directed at car users and at those who do not travel to shopping centres at all through lack of appropriate transport.

Feeder Services

In planning public transport routes, a common standard pursued in Australia is that more than 90% of urban residents should be situated within 400m or 500m of a public transport service. Even if this aim is achieved ultimately, there will still be times when, because of off-peak low service frequencies, travellers will prefer to begin their journey on a route or service quite distant from that closest to them. In other cases there will be numbers of people living in areas on the fringes of those classed as 'urban', whose access to regular public transport will be severely limited. Another example occurs when a major traffic generator is served by a public transport terminal situated more than a reasonable walking distance away.

In all these situations, and others, the concept of *feeder* services is often propounded as appropriate for the transport needs of the people concerned. These sorts of services, provided by buses, are operated in Australia, but their number is limited by the expense involved relative to the number of passengers which might be carried. There is a clear case, in situations of low demand, for feeder services to be provided by taxi-cabs.

It is difficult to specify precisely areas where cab-operated feeder services would be suitable. There are certainly cases where the distance to the nearest public transport route for residents is greater than the desired

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1 The allocation of taxi stands for the homeward journey would provide some level of service for those not on the 'phone provided that the shoppers could reach the centre by some other means.

400-500m. This is even more likely during off-peak times when some service frequencies are so low as to be of negligible significance. Also, the distance between outer suburban public transport terminals is often substantial and persons living at these extremities may well be more than 500m (or reasonable walking distance) from the bus route.

In both these situations, feeder cab services could be operated. But the identification of relevant locations or areas must come from further study. The basic mechanism for operating feeder services would be like that described below, where hire of cabs is considered for extending hours of operation of existing bus routes.

Cross-town Public Transport

A feature of public transport networks is the proliferation of radial routes with relatively few cross-town routes. This relates to, in part, the low density of demand assumed to exist for cross-town journeys. As one moves further out from the city centre the radial routes are further apart and cross-town movement becomes exceedingly difficult without a private motor vehicle.

To provide sufficient cross-town public transport by bus is rather costly and given the relatively low residential densities of Australian cities, costs are unlikely to be recouped via public transport fares. It is also not appropriate to use bus services to ascertain the level of demand because of the inflexibility of this mode of transport. Based on the comparative costs of running buses and taxis (1), and the greater flexibility of taxi services, it seems logical to run a route taxi on low demand routes where a public transport service is required.

Levels of demand for new cross-town public transport routes provided by route taxis cannot be simply predicted. This of course is one reason for using taxis, a more flexible means of transport, to experiment with cross-town public transport. Because of the inadequate information on demand levels and also the newness of the concept of fixed route taxis, a pilot project running for say an initial six months would seem an appropriate point of departure.

Some guidelines are now given for operating a cross-town cab service.

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1 Taxi services can be 2-3 times cheaper to operate than bus services, principally because of differing wage rates.

MULTIPLE HIRE OF TAXI-CABS

Choose a specific route on which to operate a route taxi: Any one of a number of potential routes could be suggested. The important criteria are:

- no effective public transport currently exists;
- demand is 'expected' to be at an appropriate level;
- important community facilities will be connected with residential areas.

Decide upon desired headways and hours of operation: One of the advantages of fixed route taxis is that because taxis operate at much lower costs than buses, and seat only five passengers, it may be financially possible to run a service on attractively short headways. Clearly the level of service is improved as headways are reduced. However a compromise must be made to ensure adequate patronage. Until better information on demand levels were available it would be virtually impossible to determine the appropriate headways. This would have to be one of the tasks of the pilot study. The flexibility of cab operations makes such a learning-by-doing process feasible. For example, if demand is higher than anticipated additional taxi-cabs could be radioed in to assist. If demand is less than anticipated taxi-cabs can be taken off fixed route service.

In the experimental stage it is desirable to offer a high frequency service even if this is initially at a loss because people may be discouraged from using the service at all if long headways occur. Short headways avoid the necessity for scheduled services which run to a fixed timetable.

The appropriate hours of operation are again difficult to determine when there is no knowledge of anticipated demand. They may initially be determined by the funds allocated to the pilot study.

Negotiate a hiring rate with a taxi company: Once the route has been decided upon and the frequency of service determined a hiring rate for the taxi-cab plus driver can be negotiated. In the experimental stage it may be easier to approach just one cab company. However if more general use is envisaged it may be appropriate to call for tenders from various taxi companies or owner-drivers to offer the specified service(s).

The hiring rate negotiated is likely to be in the vicinity of the total hourly revenue the taxi-cab could be expected to earn in normal operations. This may be in the vicinity of $5.00 to $7.00 per hour (1976 dollars) for Australian taxi operations, plus a premium for lost flexibility, lost tips etc.

Determine a fare and mode of operation: In the picking-up and dropping-off of passengers and the collection of fares, fixed route taxis can operate in exactly the same manner as buses. The route can be divided into sections and the passengers pay a fare in accordance with the number of sections travelled. Identical rates to bus rates could be charged and collected by the taxi driver who would issue passengers with the appropriate tickets. However as the fares charged on buses are not set at a level to cover costs but have been kept down as a matter of policy, such a similar fare will invariably imply a subsidy to the users of the service. The choice of fare will depend on the attitude towards subsidising such a service, as well as predictions of the elasticity of demand.

We would suggest that where there are no clear external benefits from such a subsidy (such as a reduction in traffic congestion) and where the service is not specifically directed towards the more needy sections of the community a subsidy is undesirable.

There may be no need to provide taxi stops; instead the taxicabs could be hailed anywhere along the route. The route taxi would need to bear an appropriate sign to distinguish it from the normal exclusive ride taxicabs.

In summary, it is quite clear that conclusive answers to the questions which must be asked in relation to the operation of fixed-route taxis cannot be obtained without a pilot study. We definitely think that there is sufficient *a priori* evidence to recommend the formulation and implementation of a pilot study on the operation of fixed-route taxicabs.

Extending the Hours of Public Transport Operation

A final illustration of a suitable pilot study is the use of fixed-route taxicabs instead of the operation of off-peak low-demand bus services. In this case, route-taxis could be expected to cope adequately with the demand on a particular route and their introduction could improve the public transport coverage at minimal cost.

The actual choice of route on which to experiment with route taxis is somewhat arbitrary. It would be desirable to run a route taxi where demand is currently suppressed to some extent. As suggested with all our recommendations it is desirable that a pilot project be run for some months to gather information and test various features of the service.

The service could operate in an identical manner to other route taxi operations as described earlier. That is, the taxi would bear a route taxi sign with an indication of the route along which it was travelling. Passengers could alight and disembark anywhere along the route and pay a designated zone based fare. This fare may or may not be

equivalent to the bus fare for the same trip. For whatever fare is decided upon it may be necessary to subsidise the service to fully cover the costs of operation.

We recommend that fixed route taxis be used, initially on an experimental basis to extend the public transport network operating during low-demand off-peak hours. Such a competitive use of taxis may well meet with significant opposition from affected parties. And although very considerable cost savings would be possible and a higher level of service could be offered (as taxis could operate at a higher average speed) expansion of the service may not be politically feasible.

CONCLUSION

Our general analysis of multiple-hire taxi service has highlighted the limitations as well as the strengths of multiple-hire operations for Australia's low density cities. The main role for multiple-hire taxi, particularly as a means to provide improved mobility to non private car users, appears to be through small scale schemes, designed to serve markets not viable for fixed route high cost public transport services. For small scale operations zone fares may offer the most appropriate fare structure.

The main options for multiple-hire appears to be in the following situations:

- fixed route cross town jitney operation to service particular activity centres;
- feeder routes for public transport, to extend the reach of public transport and to provide a more intensive service;
- evening services and other low demand situations;
- demand responsive operation to service selected activity centres, within restricted hours.

The options can best be tested through pilot schemes, which can enable a proper identification of demand and costs. Continual monitoring of these schemes would be required.

APPENDIX A: TELEPHONE AVAILABILITY

Telephone availability, or the lack of it, is a principal determinant of a person's ability to make use of cab services, whatever their nature. For the present Australian cab industry, much work derives from bookings and presumably, most of this initially from telephone calls. If it is the case, as seems likely, that the sorts of persons to whom innovative cab services would be beneficial are at present often not telephone owners, then it seems equally likely that the effectiveness of improved cab services will be poor unless a co-incident improvement in telephone ownership can occur.

Ideally, it would be valuable to have some idea of both present and projected levels of household telephone ownership within the Australian cities, in terms of:

- geographic location;
- socio-economic grouping.

Information of this sort is, surprisingly, sparse.

The Australian Telecommunications Commission appears reluctant to release its estimates of household 'phone ownership by detailed location. The Australian average is, however, about 60% (1). The Commission has forecast that by the year 2000, the number of telephones per dwelling will increase from about .6 to 1.1 (2) and it is believed by 1980, household telephone penetration will have risen to about 70% overall in Australia, with individual areas ranging up to 90-100%.

Variation of household telephone ownership across socio-economic groups is uncertain. For 1974/75 an indication is available (See Table A.1). In particular, in 1974 some 56% of households with annual incomes below $6,000 possessed a telephone service, illustrating the relatively high penetration amongst lower income groups. These services represented 73% of all telephone services (3).

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1 *Telecom 2000*, Australian Telecommunications Commission, p. 133

2 Ibid p. 113. This does not mean, of course, that every household will then have a telephone.

3 Ibid p. 133.

Pensioners are entitled to a subsidy of 33% of the rental cost of a telephone service and over 500,000 pensioner concessions are currently in force, Australia-wide, representing nearly 25% of all telephone services ; there are a little over one million pensions paid currently in Australia to the aged invalids and widows, so that the level of 'phone ownership within this group appears to be satisfactorily high compared with other households. Thus, the ability of the pensioner group in particular, to book a taxi by telephone whilst not as good as may be desirable, appears to be almost comparable to that of the community at large. And further, if we accept the conclusion of the Australian Telecommunications Commission it seems likely that subsidies of the pensioner concession type will eventually be extended to other disadvantaged groups whose members would otherwise be unable to subscribe.

In summary, it appears that within five years, about 70% of all Australian households will possess a telephone service. Disadvantaged groups are likely to be more strongly represented than at present in the telephone owning group, but the extent to which telephone owners will coincide with those who are potential taxi-cab users is largely unknown. What effect the actual situation will have on the success of innovative cab services can therefore be determined only by trial implementation of those services.

TABLE A.1: HOUSEHOLD TELEPHONE OWNERSHIP, AUSTRALIA 1975

Category	Class	% with phone	% in class
Socio-economic	Upper	78	17
	Middle	65	45
	Lower	49	39
Personal Income	$6000	56	73
	$6000-$9000	63	17
	$9000	85	10
Food and household expenditure	$20	55	24
	$20-29	58	30
	$30-39	64	26
	$40	69	21
All households surveyed		59	100

Source: McNair Anderson Prime Prospects Report 1974/75: Survey of Telephones in Households by Categories. (Quoted in *Telecom 2000*, Australian Telecommunications Commission 1975).