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COST AND SUBSIDY ISSUES IN URBAN PUBLIC TRANSPORT

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Abstract:

Over the next decade there is likely to be a growing demand for the extension of and quality improvements in urban public transport services. It is also likely that the already significant levels of deficit incurred by such services will further increase, heightening pressures for a reduction in services. It is suggested that a solution to this conflict will only be found by clearly identifying the social objectives to be met through the provision of such services. This will enable the costs of particular policies to be determined and provide a defensible and identifiable basis for the determination of fare and subsidy levels. An example of the type of cost analysis necessary is given in outline in the paper. Attention is drawn to a number of conclusions that are made possible by the analysis.

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INTRODUCTION

In response to energy conservation and quality of life issues, there has been a growing demand over the last decade for improved public transport services; this has frequently included arguments for reduced fare levels to attract patronage. Contemporaneously there has been a massive growth in the operating deficits of urban public transport services, creating significant pressures for major fare increases. These have not occurred to the extent necessary to remove the deficits, and a continuation of the situation has tended to be justified on the grounds of "public service obligations" in maintaining services.

The conflicts embodied in this situation will continue over the next decade, which is likely to see a much closer scrutiny of the social welfare implications of massive subsidisation of public transport systems, and of the social objectives that are served by these systems. It is likely that fare policies, in particular, will need to be designed to either more accurately reflect the cost of system operation, or to allow explicit statement of the objectives served by subsidisation. The claimed need for the discharging of "public service obligations" is seen by many to be an excuse for the maintenance of inefficient operating and managerial policies, and will increasingly be subjected to scrutiny.

The detailed cost analyses that will be necessary to support such a scrutiny have only infrequently been undertaken in the past or are not publicly available. This paper attempts to redress the balance by reporting an analysis that was undertaken into the costs of operation of the Melbourne suburban rail passenger system (O'Rourke, 1977). A particular problem confronting such an analysis is the choice of an appropriate cost allocation procedure. No one method is universally applicable, as a cost is measured by the value of the foregone opportunity implied in a decision; what is to be defined as a cost therefore depends on the decision. The paper outlines and justifies the choice of cost allocation methodologies and presents for the system as a whole, for peak and off-peak service and for each identifiable "route", both the "avoidable" cost and the "separate system" cost, as lower and upper bounds respectively.

PUBLIC TRANSPORT DEFICITS : OPERATIONAL LOSS OR PUBLIC SERVICE OBLIGATION?

While it is indisputable that in financial terms many public transport operations incur a substantial deficit, there

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is often argument as to how such a deficit should be interpreted. It can be viewed as an operating loss to be met out of general revenue while steps are taken to reverse the situation. Alternatively it may be viewed as a measure of the intangible but socially justified benefit conferred by the continued operation of the service. While neither view affects the detail of cost analyses, they do influence the purpose for which the analyses might be undertaken, and hence warrant a brief critical examination. It should be emphasised that this examination is at a conceptual level only; while the cost analysis reported is of the Vic Rail suburban passenger service, this is for example purposes only. The following discussion is purely general, and not directed explicitly at any particular system.

Deficit Financing

The practice of deficit financing, or meeting the operating deficit of (publicly owned) public transport services from general revenues, has been widely criticised. The psychological effects of this form of subsidisation on staff and public have been considered detrimental to the brand image of public transport and efficiency (Legris, 1971). As well, its practice delays the normalization of accounts and the finding of long-term solution. It has been argued (Glendinning and McKay, 1975) that overall unit operating costs tend to increase in sympathy with continued deficit financing unless the amount of subsidy is firmly related to cost efficiency and operating performance. In Australian experience this does not appear to have occurred. Unfortunately, no firm evidence detailing the ill-effects of deficit financing is available, but the proposition that X-efficiencies (e.g. motivation and morale) are adversely affected by the practice (Liebenstein, 1966) clearly indicates that adverse effects are likely.

The British approach is more inclined to specific revenue subsidies for specific services. Each service is examined to determine whether the required subsidy is worth the imputed benefit of continued operation. This form of subsidy is not provided as a lump sum payment to cover the entire deficit, but is directed towards the assessment of costs and the public service benefits of specific services (Beesley, 1973). This approach allows the prior determination of the justification for subsidies, but at the same time does not encourage the combination of inefficiencies leading to deficits. It also makes clear that only certain sections of the operation are regarded as justifying subsidisation and that other sections are therefore expected to cover operating costs.

Public Service Obligations : Justification for Subsidisation

If a Government-owned public transport operator had the same profit maximising objective as a private operator, it would in the long run retain only its profitable services and cease to provide non-profitable services unless it were paid

to maintain these by Government. The subsidy so paid, common in the contractual arrangements between many private contractors and Government Transport regulation authorities, could then be regarded as a measure of the social benefit available from continued operation of services that would be otherwise abandoned.

While it is not necessarily suggested that public transport authorities should operate in this way, it does have certain significant advantages. Most important of these is that the approach has the potential to make explicit the social welfare policies that Government feels it appropriate to pursue via indirect transport subsidisation. In reality of course, these are seldom clear. Nevertheless it is the task of the analyst to determine the magnitude of any such subsidy, whether based on stated policies and objectives or not, as part of an examination of the cost of providing particular services. Determination of whether or not the size of the subsidy is justified by the social objective at which it is directed can only be made when the nature of the objective itself is clear.

Objectives that are commonly espoused as justification for the maintenance of subsidy payments to public transport are varied. It is suggested that there are a number of underlying categories that encompass the range. These relate to

- Income redistribution
- Promotion/maintenance of growth
- Mobility for special interest groups
- Maintenance of "balanced" transport system to minimise social costs

and are briefly examined for relevance below.

It is commonly assumed that subsidies to public transport aid the lower income earner. There is little evidence to support this; indeed the reverse is more probably true. Dumble (1979)in an analysis of the subsidy issue in an Australian context indicates that there is a positive relationship between household income and public transport usage. Consequently, subsidisation tends to be regressive in that general revenue from taxes which may be regressive in their incidence are used to subsidise the travel of higher income groups.

Public transport systems have historically been a major influence on the development of Australian cities. Only since the rapid growth in car ownership starting in the 1950's has the dominantly radial form of cities enabled by fixed rail public transport systems been weakened, and a dispersion of residential and industrial location been possible. This has not always been viewed as a positive benefit, as indeed it may not be. The declining relative importance of the city centre has led CBD business interests, historically strongly associated with state governments, to promote public transport as a means of maintaining access to the CBD. While public transport carries the majority of

CBD commuters, it is simply not clear that the relative transport costs of mononucleic versus polynucleic cities are such as to justify transport policies supporting the former.

A common argument for support of public transport services is that for the young, handicapped, old, poor and others without private means of transportation, public transport is the only form of transportation available. To these groups it is an essential service without which access to employment, retail centres and social and recreational activities is denied. A role for public transport is therefore established and the price charged for the service must, if the objective is to be achieved, be limited to what any user can afford. A subsidy could therefore be justified if the revenues from the provision of the required public transport service do not cover costs.

This argument certainly has emotional appeal. Without exploring its validity in the Australian context, however, it can be simply stated that a first step in the formulation of such a policy must be the setting of minimum acceptable standards for the level of public transport service provided to the community. The <u>costs</u> of obtaining this standard can then be explicitly recognised and compared with the cost of alternative strategies for suitable welfare assistance.

There is a considerable body of opinion that road users are heavily subsidised, in that they do not pay the full cost of provision of road space (Ravallion, 1974), and that the marginal private cost of congested travel is necessarily less than the marginal social cost. This leads to an imbalance of mode usage; in the absence of suitable road pricing to reflect the marginal social cost of road use, a second-best argument is to reduce public transport fares by the same proportion as road user costs have been reduced de facto.

While this is an appealing argument, and one that may well underlie the reasons why fare increases to reduce public transport deficits are reluctantly made, there are a number of other aspects to consider. Firstly, it may be observed that road pricing in its true economic form is technically though probably not politically possible. From the standpoint of economic efficiency, setting both road and public transport user costs to approximate their marginal (social) costs is far superior to lowering public transport fares. A solution somewhere between the two, but closer to the former, may be to have a suboptimal form of road pricing administered on a cost-of-car-ownership basis and/or an increase in fuel taxes. Secondly, a history of suboptimal road pricing has its major impact through (perhaps severely) suboptimal urban form rather than simply through greater road usage, though this will follow. Inappropriate urban development will <u>not</u> be corrected by the lowering of public

transport fares, which is likely to have only limited impact in both the short and long term on mode usage.

Summary

It has been suggested above that many of the arguments used to justify the continued subsidisation of public transport services may be suspect. This should not be interpreted as a rejection of the need for subsidisation as an instrument of social policy. Rather it may be seen as an argument for the articulation of the objectives that are to be met in this way, so that they can be examined for relevance and whether they are best satisfied through public transport subsidisation.

Once the level of subsidy necessary to attain a particular set of objectives has been determined, the level of service offered to maintain equality between projected costs and subsidies plus projected revenues can be set. The motivation for implementation of managerial and operating improvements will be greater in this situation than under policies of deficit financing, where the bill is paid without querying how it arose.

An essential ingredient throughout this process is the isolation for particular systems of objective measures of actual cost and subsidy elements. This is necessary so that the actual costs of pursuing any particular objective can be examined. This is a complex process, as the nature of the information recorded by the operator may not always be that most appropriate for a cost analysis. An example analysis is summarised in the following, and reported elsewhere in far greater detail than possible here (O'Rourke, 1977).

A CASE STUDY : A COST ANALYSIS OF AN URBAN PUBLIC TRANSPORT SYSTEM

A methodological approach to cost analysis is illustrated by a case study of the costs of operation of Vic Rail's Melbourne suburban rail system.

Cost Allocation

One of the major problems of such an analysis is the allocation of costs to the various classes of use of the system; peak and off-peak travel on the various lines of the network. A useful discussion of the problem of cost allocation is given in Mohring (1976) and a typology of allocation procedures is contained in Dienemann and Iago (1976).

In this study, two approaches were used; the determination of "avoidable cost" and "separate system cost". These cost concepts are illustrated in Fig. 1, taken from Joy (1971). The avoidable cost of either service in a multiple service system is the cost escaped if the service is discontinued. As such it is the incremental common cost

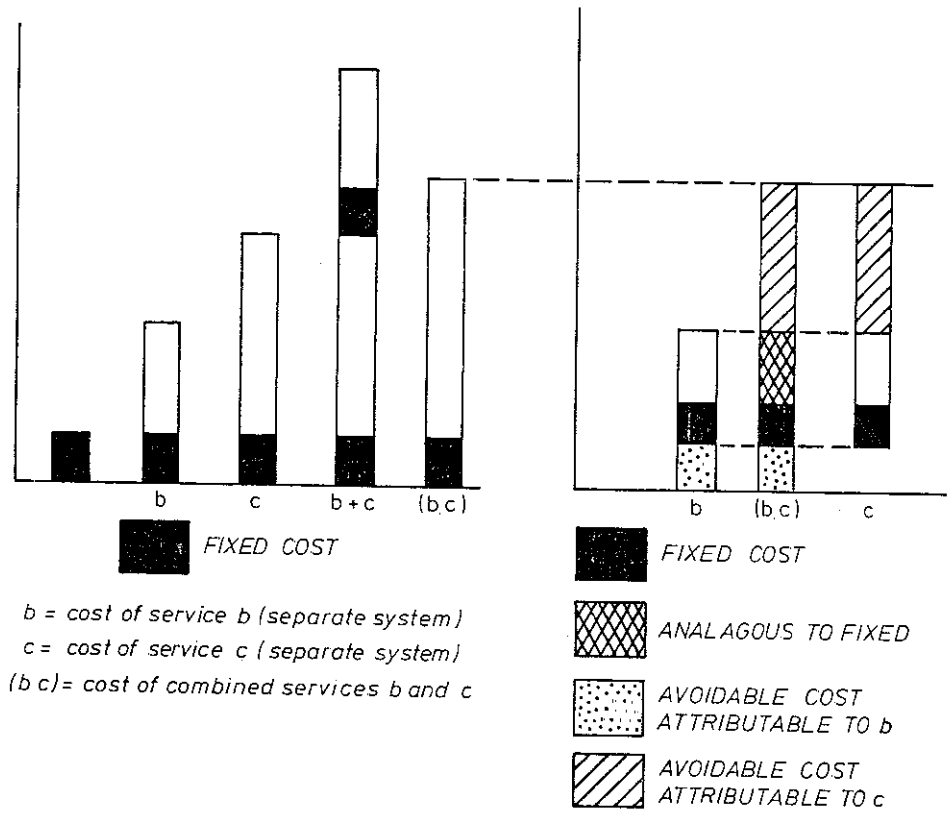

Fig. 1 Schematic of Cost Definitions

directly attributable to that service. Separate system costs are by definition the cost of operating single service systems. The separate system cost (b or c) and the avoidable cost provide limits to the estimate of the cost attributable to each service. For any two systems A and B (whether passenger (A)/freight (B); peak (A)/off-peak (B); route 1 (A)/route 2 (B)) the avoidable cost can be considered to be the lower limit of the estimated costs and the separate system cost the upper limit.

Using this "cost limits" approach the value judgements usually implicit in the choice of a cost allocation procedure are of reduced relevance. Accordingly the conclusions that can be drawn from the cost analysis are more objective, and less subject to criticisms as to the validity of the assumptions on which they are based.

Summary of the Cost Analysis

The data necessary for the analysis may be divided into two categories. The first consists of railway operating statistics which influence and vary with operating costs. These include

- passenger flows (though no origin-destination data was available for use in the study)
- train running statistics
- staff numbers and work activities.

The second consists of various cost tabulations drawn mainly from Victorian railway reports. Although not ideally suited to the purpose, they enabled reasonably accurate cost estimates to be determined.

As an indicator of the accuracy of the results obtained in this study an upper estimate of the separate system cost was also calculated. It is approximately 7 per cent greater than the "expected" values given in Table 1. Sources of possible error in the estimates were in the assumptions used for the allocation of

- maintenance of way charges, and
- maintenance of signal charges

on a percentage error basis, and

- station and signalling staff charges, and
- maintenance of way charges

on a percentage of total cost basis. Detailed investigation of staff activities, particularly in the main metropolitan centres would correct the former. The allocation of track maintenance charges is however extremely difficult as not even the design of track structure is directly related to maintenance requirements (O'Rourke, Mair and Doyle, 1978).

TABLE 1

SURBURBAN PASSENGER SYSTEM OPERATING COSTS & REVENUES

YEAR	AVOIDABLE COST		SEPARATE SYSTEM COST				SUBURBAN REVENUES	VICRAIL ESTIMATES	
			PROBABLE		UPPER			SUBURBAN LOSS RAILWAYS	COST ESTIMATE RAILWAYS
	INCLUDES PAYROLL TAX	EXCLUDES PAYROLL TAX	INCLUDES PAYROLL TAX	EXCLUDES PAYROLL TAX	INCLUDES PAYROLL TAX	EXCLUDES PAYROLL TAX			
1965-1966	20.6	20.2	26.9	26.4	28.4	27.9	20.3	-	-
1966-1967	21.0	20.7	27.6	27.2	28.7	28.2	22.3	-	-
1967-1968	22.0	21.6	29.1	28.6	30.6	30.0	22.6	-	-
1968-1969	22.8	22.4	30.3	29.7	31.9	31.3	23.0	6.0	29.0
1969-1970	24.3	23.9	32.8	31.9	34.3	33.7	24.2	6.3	30.5
1970-1971	26.3	25.8	34.8	34.2	36.6	36.0	24.0	8.9	32.9
1971-1972	28.2	27.5	37.8	36.9	40.0	39.0	26.8	8.4	35.2
1972-1973	32.5	31.6	43.7	42.6	46.1	44.9	27.2	14.8	42.0
1973-1974	39.3	38.0	53.0	51.3	56.0	54.2	27.2	-	-
1974-1975	50.3	48.4	68.5	65.9	72.3	69.6	28.4	-	-
1977-1978	-	-	-	-	-	-	49.0	51.6	100.6

N.B. ALL VALUES $MILLION

Suburban Passenger System

A summary of the results obtained over the period of the study is presented in Table 1. The Victorian Railways have also at times provided estimates of the loss caused by the operation of the suburban passenger system. These values have been added to the revenues for the applicable years to give the railway estimate of the operating cost.

The results are not surprising, but two features require comment. Firstly, until the late 1960's revenues from the suburban passenger service were greater than avoidable costs, if the Railways payroll tax payment is excluded. Yet no significant investment in maintaining the quality of the service was made during this period. Secondly, the cost estimates which the Victorian Railways have implicitly made are very close to our estimates of separate system cost. This implicit estimate of suburban railway costs may therefore be considered to include overheads and other charges which are not avoidable, and, as such, form an upper estimate of the costs attributable to the operation of urban public transport.

Peak/Off-Peak Charges

The avoidable cost results given in Table 1 were also used as a basis for the calculation of peak and off-peak costs, reported in Table 2.

Four alternative definitions of cost were used, as shown diagrammatically in Fig. 2, as the definition of peaking is dependent on the primary operating objective. For instance if the prime objective was to meet peak travel demands, in particular to the CBD, the peak period is best defined in terms of this demand and the costs allocatable to the peak period are the costs of meeting the total peak demand. The appropriate cost to compare with off-peak revenues is then the cost savings that would result if the off-peak services were not provided. Alternatively if the primary objective is the provision of a constant base level of public transport, the costs avoidable in the peak period are those caused by demands requiring a service greater than this level.

The results in Table 2 clearly indicate that

- peak services may require a greater percentage subsidy than off-peak services
- weekend services exhibit the largest percentage difference between costs and revenues.

The first result may be contrary to popular belief, but as it indicates that multi-income households making work trips to the CBD may be receiving a greater subsidy than other users, further immediate investigation is required. The second result gives a clear indication of the need to establish what minimum level of service must be provided for

TABLE 2

SUMMARY PEAK/OFF-PEAK COSTS 1974/1975

	COST ESTIMATES*		REVENUES	COSTS AS A PERCENTAGE OF REVENUES	
COST PERIOD	HIGHER	LOWER	$	HIGHER	LOWER
Off-Peak Avoidable	9.82	8.77	8.58	114	102
Peak System Costs	32.7	29.8	16.1	203	185
Peak Avoidable	16.35	14.5	8.07	203	180
Base Level Costs	33.9	32.1	20.3	167	158
Base Level (Exc. Weekends)	27.0	23.2	20.3	133	115
Weekends	8.74	6.95	3.69	237	188

*Two estimates have been made to take account of possible allocative inaccuracies

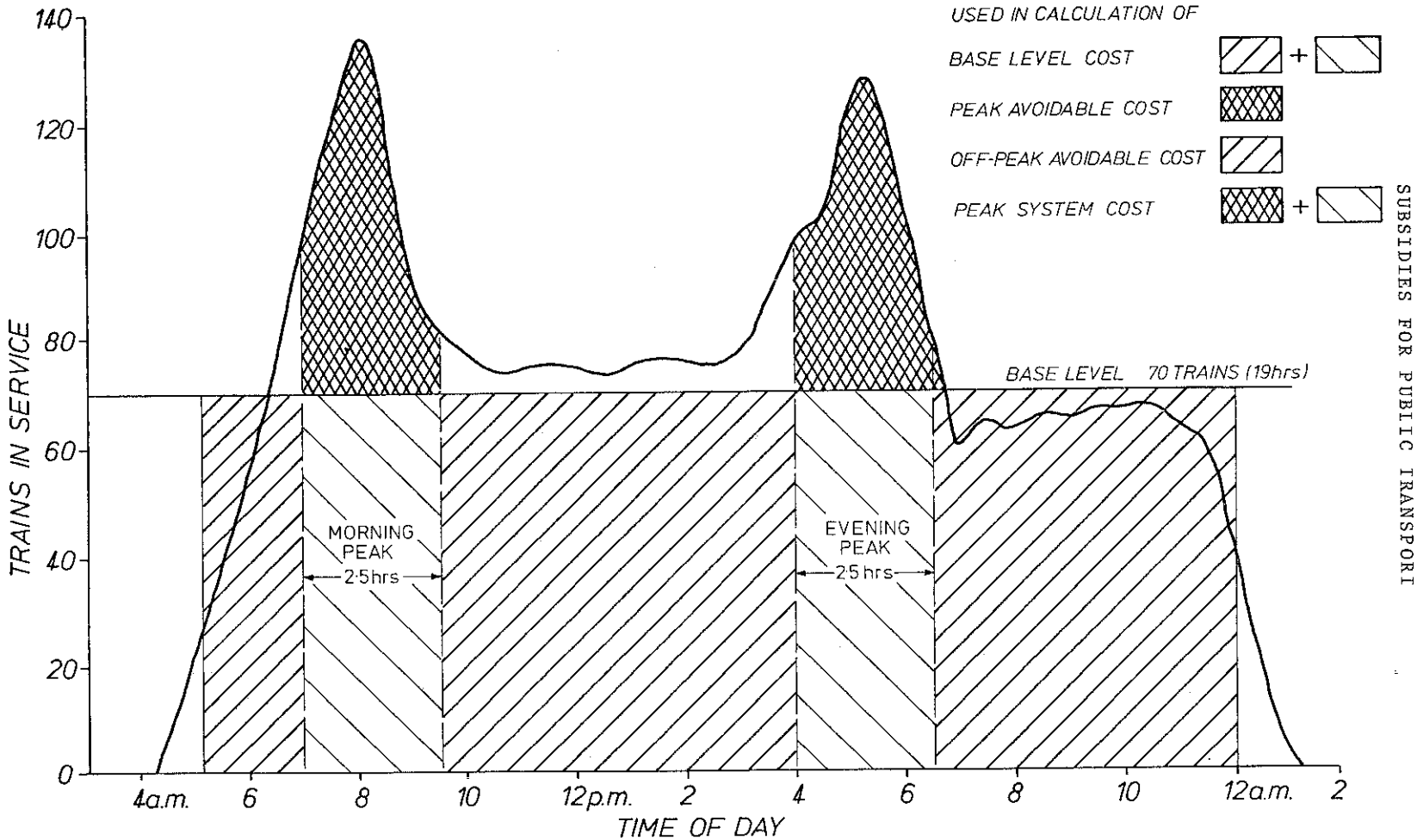

FIG.2. DEFINITIONS FOR PEAK/OFF PEAK CALCULATIONS

weekend services, given that use and revenue is so much lower during this period. A corollary is that there is also a need to determine what the most appropriate form of public transport service is for this period. It may well be that a radial service as provided in this example is inappropriate, and that rail operation could be replaced by more flexible bus services during the relevant periods.

Identifiable Route Sections

An examination of a schematic of the suburban network (Fig. 3) indicates that as the CBD termini are approached, separate routes are increasingly operated on common track, thus creating significant amounts of common/joint costs. The analysis of route costs which was performed was therefore directed towards the calculation of the costs incurred in "identifiable sections" of the network and not the costs of operating routes radiating from the central termini. These sections, illustrated in Fig. 3, are designated by the name of the last station in that section; e.g. the Ringwood section will include costs incurred in train operation from Camberwell to Ringwood, including station costs at Ringwood but excluding those at Camberwell. Train operating costs in inner sections are allocated according to passenger demand in outlying sections.

Even so, significant approximations were necessary in the allocation. For the purposes of this analysis the various cost categories were assumed to vary with five parameters. The first is train kilometres run in each section. Rollingstock maintenance, power costs and track maintenance were varied with this parameter. The second parameter, peak train kilometres, divides weekday crew costs, signalling costs and cleaning costs among the sections. The number of staff in each section is known, and station and signalling staff costs have been divided by the percentage of staff in each section to obtain sectional costs. Weekend crew costs in each section have been calculated by a weighted measure of train kilometres in each section on weekends. The fifth parameter was route length and maintenance charges for fences, crossings, power masts and fixtures were apportioned on this basis.

The results of the analysis are summarized in Table 3. The following observations are most pertinent:

(i) The financial position on every section analysed deteriorated over the study period

(ii) Sections exhibiting the best performance - Dandenong, Ringwood, Camberwell, are located in the eastern and southern suburbs.

(iii) Changes over the period. The Sandringham line which provided the second best result in 1965/66 vacated this position as revenues as a percentage of avoidable costs decreased to 56% of the 1965/66 value in 1973/74. Other sections fairing badly by this criterion were the Williamstown, Alamein, Newport and Broadmeadows lines. Sections performing

FIG.2 DEFINITIONS FOR PEAK/OFF PEAK CALCULATIONS

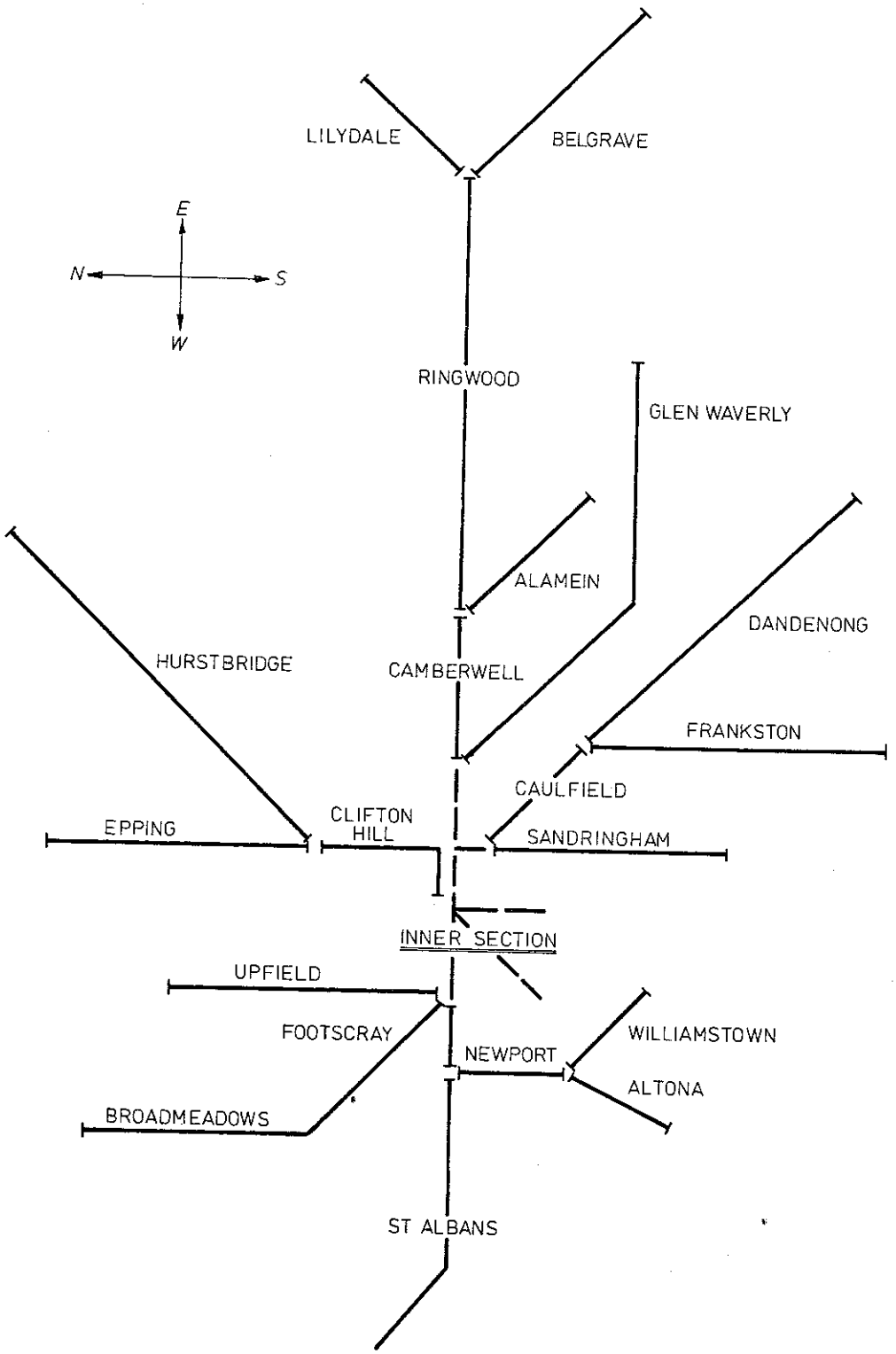

FIG. 3. SCHEMATIC OF VICRAIL SYSTEM - DISTRIBUTION NETWORK OF IDENTIFIABLE ROUTES

TABLE 3

REVENUES AND SECTIONAL AVOIDABLE COSTS

SECTION	1965/1966 REVENUE	COST	%	1974/1975 REVENUE	COST	%	% CHANGE
(1) St Albans	.793	.748	106.0	1.205	1.388	86.8	82
(2) Newport	.538	.489	110.0	.688	.935	73.6	67
(3) Williamstown	.183	.211	86.7	.217	.403	53.8	62
(4) Altona	.108	.156	69.2	.153	.283	54.1	78
(5) Footscray +(1) + (2) +(3) + (4)	1.885	1.719	109.7	2.648	3.251	81.5	74
(6) Epping	.797	1.072	74.3	1.334	2.039	65.4	88
(7) Hurstbridge	1.082	1.540	70.3	1.620	2.849	56.9	81
(8) Clifton Hill +(6) + (7)	2.137	2.799	76.3	3.252	5.341	60.9	80
(9) Broadmeadows	1.311	.966	135.7	1.666	1.868	89.2	66
(10) Upfield	.538	.816	65.9	.755	1.561	48.4	73
(11) Alamein	.286	.272	105.1	.301	.523	57.6	55
(12) Lilydale	.507	.524	96.8	.837	1.019	82.1	85
(13) Belgrave	.702	.684	102.6	1.049	1.335	78.6	77
(14) Ringwood	1.946	1.417	137.3	2.964	2.504	118.4	86
(15) Camberwell +(14)	2.353	1.682	139.9	3.533	3.280	107.7	77
(16) (15) + (11)+ (12) + (13)	3.848	3.162	121.7	5.720	6.080	94.1	77
(17) Glen Waverley	.930	.932	99.8	1.600	1.754	91.2	91
(18) Dandenong	1.851	1.415	130.8	2.744	2.699	101.7	78
(19) Frankston	2.749	2.336	117.7	3.620	4.465	81.1	69
(20) Caulfield +(18) + (19)	5.325	3.951	134.8	7.200	7.592	94.8	70
(20) Sandringham	1.311	.951	137.9	1.429	1.849	77.3	56

well were Waverley, Epping, Ringwood, Lilydale and Hurstbridge. The changes from 1965/66 to 1973/75 therefore seem independent of the initial financial position, but are indicative that in the inner and western suburbs the position is most crucial.

(iv) The low proportion of revenues earned by the Williamstown, Hurstbridge, Altona, Upfield and Alamein sections makes the investigation of alternative transport modes an attractive option. Brief calculations performed for the Williamstown section indicates the feasability of bus service operation as a feeder to Newport station.

CONCLUSIONS

The cost analysis that has been summarised is reported for example purposes only, hence the conclusions to be drawn from it are not centrally involved with a comparison of the cost and revenue figures estimated. Rather, the motivation for the analysis was to determine the nature and direction of the subsidy implied by the operating loss incurred.

Within the limits of accuracy of the analysis, a number of findings related to this objective emerge. The first and most important is that contrary to popular belief, peak period operation receives a significantly greater percentage subsidy than does off-peak operation. Other evidence suggests that users in this period are from higher income groups, indicating that this subsidisation is likely to be regressive in impact. That is, its effect is the opposite of what would be expected if normal social welfare objectives were being implicitly pursued in the financing of public transport.

A second and perhaps intuitively obvious result is the high relative cost of maintaining weekend services. The magnitude of the cost involved clearly indicates the need for an examination of the objectives being pursued in weekend service maintenance, and the operating strategy used to achieve them.

Both results underline the conclusions that the paper leads to. Firstly, it is argued that continued massive subsidisation of urban public transport demands the articulation of a clear set of welfare or policy objectives that subsidisation is designed to achieve. It is suggested that several objectives traditionally believed to be served by this practice are probably either inappropriate or may be better achieved by other means. "Public service obligations" cannot be cited as grounds for maintaining operating deficits unless the "obligations" are clearly identified, both in nature and quantity.

Secondly, the need for a careful analysis of the costs of operation and the market served is evident. This will indicate the extent to which particular (by now, clearly articulated) objectives are being met, and allow the

determination of the most appropriate fare and operating policies in this light. As an example, this analysis indicates that on social welfare grounds increased peak hour fares relative to off-peak are clearly warranted.

Thirdly, the need is established for an analysis of what base level of public transport service is needed by the community, and of how best to provide it. This in turn requires the coordination of modal operating policies to ensure the best combination of modes for particular demands. It is unlikely, for instance, that Melbourne weekend public transport needs have the same level of radial orientation that exists during the week. The provision of rail services may be inappropriate for this demand, and the considerable cost of maintaining a weekend service may be misdirected.

The summary implication is clear. There is nothing in the past decade to indicate that in the coming decade there will emerge a reversal in the financial fortunes of public transport, but it is clear that public transport must play a much greater role than it has. In order to provide a service that is efficient both economically and operationally, it is necessary to continually reappraise performance in light of clearly stated policy objectives. The claim of "public service obligation" should not be used as justification for continuing inappropriate policies without careful scrutiny of the nature of the obligations, the relevance of the operating policies employed and the cost-efficiency of the management of the system.

REFERENCES

Beesley, M.E. (1973). Urban Iransport : Studies in Econ Policy, (Butterworth & Co)

Dienemam, D.F., and Lago, A.M. (1976). User Iaxes and Allocation of United States Airport and Airway System Costs, Journal of Iransport Economic and Policy V3 p178-94.

Dumble, P.I. (1979). Urban Public Iransport Deficits in Australia, Australian Road Research Board Research Report, No. ARR99.

Glendinning, J.G., and McKay, G. (1975). "Implications of the Relationship between Investment and Maintenance, U.I.T.P. 41st International Congress, Nice, Paper Sa.

Joy, S. (1971). Pricing and Investment Policy in Railway Freight Services, Journal of Transport Economic and Policy, V(s) 3.

Legris, R. (1971). "Measuring and Improving Productivity in Urban Passenger Surface Iransport", U.I.I.P. 39th International Congress, Rome, Report No. 5

Liebenstein, H. (1966). Allocative Efficiency vs X-Efficiency, American Economic Review, V(56)p392-413.

Mohring, H. (1976). Transportation Economics. Ballinger Publishing Co., Mass., U.S.A.

O'Rourke, M.D. (1977). An Analysis of the Operating Costs of the Melbourne Suburban Railway Network, M.Eng.Sc. Thesis, Department of Civil Engineering, University of Melbourne.

O'Rourke, M.D., Mair, R.I. and Doyle, N.F. (1978). Towards the Design of Rail Track for Heavy Axle Loads, Inst. of Eng. Heavy Haul Railway Conference, Perth,W.A.

Ravallion, M. (1974). Transport Use and Social Costs: An Estimate of Subsidies by Mode of Travel Public Policy Research Paper No. 1, Dept. of Architecture, University of Sydney.