The Future of Urban Passenger Transport: A Delphi Survey

Occasional Paper

This paper describes a small-scale Delphi survey of participants in a BTE workshop, held to discuss the Future of Urban Passenger Transport in Australia. The survey was not central to the workshop, but rather the workshop provided a convenient focus and venue for such a survey to be mounted.

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FOREWORD

This paper describes a small-scale Delphi survey of participants in a BTE workshop, held to discuss the Future of Urban Passenger Transport in Australia. The survey was not central to the workshop, but rather the workshop provided a convenient focus and venue for such a survey to be mounted.

The survey was mounted to explore the use of a 'collective wisdom' approach to the development of future scenarios in transport and to the review of feasible directions for development.

Increased statistical power in forecasting and evaluation techniques applied to transport often appears to serve mainly to indicate a greater degree of uncertainty. Past trends are no longer necessarily useful indicators of future developments; the criteria for optimality are often unclear. In these circumstances it seemed that an expert panel view may prove useful. It was to explore the methods of obtaining such a view, rather than necessarily to obtain the view per se, that this survey was conducted.

The exercise has proven useful both in demonstrating the technique and in arriving at some interesting views on the urban public transport industry. With respect to these latter, of course, as reported they merely reflect the survey responses and are not necessarily the views of the BTE.

Following the experiment reported in this paper, the technique is presently undergoing a low-key trial within the Department of Transport Australia in support of other forecasting approaches.

The survey was undertaken by Mr D. Scorpecci, with assistance from Mr M. Wood.

M. J. HUTCHINSON
Assistant Director
Special Studies

Bureau of Transport Economics
Canberra
April 1982

CONTENTS

TABLES

FIGURES

CHAPTER 1—INTRODUCTION

ORIGINS AND SCOPE OF STUDY

This Delphi survey was conducted in conjunction with the Bureau of Transport Economics Workshop on the Future of Urban Public Transport in Australia. The workshop, which formed part of the BTE's Transport Outlook Series, was held in Canberra on 12-13 May 1981. Selected results were reported in the Workshop Summary Report published in June 1981 (BTE 1981).

The purpose of the survey was twofold:

- to examine views on a range of topics dealing with urban passenger transport, and to analyse how these views were modified as the workshop and the Delphi survey progressed; and
- to test the Delphi survey as an analytical tool that may be useful in research work which involves handling uncertain future events.

This report encompasses both these aspects. First, it reports on the outcome of the survey, analyses the movements from one round to the next, and draws conclusions on possible future outcomes based on this analysis. Second, it reports on the methodological aspects of the survey, including comments on the procedures used, the analytical tools employed and suggestions on ways of improving the application of the Delphi technique.

Finally, this report concentrates largely on the survey's final results. For further information on round by round movements in participants' views refer to BTE Reference Paper No 28 (BTE 1982 forthcoming).

SUMMARY AND CONCLUSIONS

Every Delphi survey aims to glean some better understanding of the future. This survey has focussed on urban public transport, but has encompassed a range of relevant topics and issues.

By the end of Round 4 (the final round) of the Delphi survey, the participants had had several opportunities to reconsider their views to take into account new perspectives and to weigh additional information. The results represent a collective view of how the future of urban public transport may shape up.

Energy

Rising fuel prices (and there is uncertainty as to the magnitude of the increases) are not expected to have any great effect on urban private car travel to 1990. Of the various uses, business travel will be least affected.

It is probably just as well that this is the case, for public transport has been judged to be a relatively poor alternative to the private car. Its capacity to act as an alternative is expected to improve, but only slightly, by 1990.

A similar position is expected for public transport's capacity to undertake a 'fall back system' role to the private car.

Australia should plan for the price of fuel being about 52 cents per litre in 1990 and about 67 cents in 2000 (in 1981 constant prices).

Air pollution

The level of air pollution in Australia's major cities has been judged overall to be acceptable in 1981, and to remain so by 1990.

Of the measures available to help *reduce* pollution levels, two stood out in the amount of support they received. The first (and most favoured), was the encouragement of advanced engine technology, and the second the discouragement of private vehicle ownership and usage in inner urban areas.

However, most participants considered that at present greater effort should be directed towards developing engines which are more fuel efficient rather than necessarily less polluting.

Travel demand

Demand for rail travel in the next 10 years will remain almost static, while demand in bus and tram travel is expected to increase by about 8 per cent in the same period.

Of the measures suggested in the survey to stimulate demand only two, the improvement to the delivery of public transport and restrictions on the use of private vehicles were believed to have even a moderate effect on demand.

The Central Business Districts were seen to have a 'moderate' level of importance in the future, and public transport has an important role to play in ensuring their vitality. However, it is quite *unimportant* that a low fares policy be adopted for public transport in fulfilling this role.

Transport supply

The following technological measures have a better than even chance of being introduced in the next ten years to facilitate the provision of transport to meet expected demand (in order of likelihood):

- automated traffic control systems;
- control systems in scheduling;
- new urban road developments; and
- full electrification of railways.

Public transport deficit

Public transport system deficits are expected to show an overall increase of about 5 per cent (in real terms) in the next five years. There will be some chance that public transport's public service obligations will be explicitly recognised by governments, with specific funding provided for these.

Transport organisation

There may be a slight increase in the proportion of bus services provided by private operators.

The institutional structure of public transport in the next 10 years will change with a tendency for the ownership and operation of systems to become more decentralised and for planning to move slightly towards greater centralisation. Regulation and co-ordination functions will become substantially more centralised than they are at present.

Concerning paratransit, there is only a slight chance of organisational obstacles to expansion being removed, but even if they are, paratransit will have only a small impact on urban public transport.

Participants considered, on average, that the fare box contribution towards the operating costs of buses and trams, and rail, should be 69 and 65 per cent respectively. The present position is shown in Appendix IV.

THE DELPHI SURVEY AS A RESEARCH TOOL

As well as covering issues of interest to the workshop the exercise provided an opportunity to examine the Delphi technique as a research tool. This was a secondary aim of the project and the survey was not structured in such a way as to allow definitive comments to be made on the Delphi's worth in research. The following summary is provided as guidance to other researchers who may wish to employ the technique.

Once participants decided on their expertise level in the first round, there was little inclination for them to be altered.

Final results weighted by the level of expertise of respondents were indistinguishable from unweighted results. This suggests that experts and non-experts were equally distributed throughout the range of answers.

An 'elite' sub-group of respondents (ie those with above average expertise) yielded results which were only slightly different from those of the non-experts. The differences were not statistically significant.

A review of past Delphi surveys showed that while they were able to provide some accurate forecasts there was no empirical evidence to suggest that such surveys were any better (or, for that matter, any worse) than more conventional methods.

In the BTE's survey, 35 of the 42 questions showed an increase in agreement among respondents between Rounds 1 and 4.

CHAPTER 2—THE DELPHI TECHNIQUE AND THE BTE SURVEY

BACKGROUND

Every person, and every organisation, needs to delve into the future at some time. The means available to do this are many and varied. Some choose to make 'guesstimates' based on perceptions of how the world will develop, others employ sophisticated econometrics and complex computer programs to compute the future based on past and present trends. Some may simply employ a psychic or an astrologer.

In ancient Greece the leaders of the city states had a much easier time; they simply consulted the oracle at Delphi. There, the priests, in their infinite wisdom and knowledge, would provide guidance by 'seeing' the future.

In fact the Delphic Oracle was a well organised and quite successful confidence trick, as during the month long waiting period imposed on those who sought advice, an elaborate intelligence game was conducted to enable the priests to give 'good' answers (Encyclopaedia Britannica 1971). Often the priests went to the trouble of sending messengers to gather information to ensure that their forecasts, even if eventually not totally correct, contained enough accurate information to be impressive.

The modern day Delphi method no longer resorts to this process of stealth to make its predictions. However, it still carries on the tradition of utilising available information in order to make reasoned predictions of the likely future.

The basic format of a Delphi survey was developed by staff of the RAND Corporation in the USA (Helmer 1966). A questionnaire is circulated amongst a number of participants, preferably experts in the matters being studied. Their answers are then aggregated and analysed, and the analysis is returned to the participants. Individual answers are not identified, although participants may be given the opportunity of providing written (but still anonymous) comments as to why they preferred a particular answer.

With the benefit of the group results, and other information provided, participants are asked to answer the questionnaire again to confirm or amend their earlier views. This process is repeated a number of times, usually four, although there is no theoretical basis for any particular number of repetitions.

The intent of a Delphi survey is not to drive participants to a consensus, but to ensure that they give careful consideration to the questions being asked, and to use all available information in arriving at their answers. In this way, if a measure of consensus is achieved it should be because of a convergence in the reasoning and conclusions of the participants. Note that consensus is not a necessary pre-requisite for a successful Delphi. Diverging opinions and a lack of consensus may provide useful information. That uncertainty exists is in itself important.

A vital feature of the Delphi process is that views and comments should not be attributed to specific respondents. In this way peer group pressure, and any desire to avoid contradicting 'eminent persons' in the group, are avoided.

The operation of this survey is described in this chapter.

THE QUESTIONNAIRE

The themes covered in the survey were confined to those which would be complementary to those discussed at the Workshop on the Future of Urban Passenger

Transport in Australia (BTE 1981). The themes were:

- energy;
- air pollution;
- travel demand;
- transport supply;
- public transport deficits; and
- transport organisations.

Many of the specific issues covered under these six broad themes were expected to overlap. For example, it is difficult to talk about the supply of public transport without referring to demand as the two are inter-dependent. However, overlaps were minimised by the selection of questions which were as self-contained as possible.

To ensure that the survey contained questions relevant to the workshop, intending participants were sent an initial questionnaire (Appendix I) which sought views on matters to be covered within each theme. Where appropriate these views were incorporated into a set of questions which were then tested within the BTE. By this process 15 questions (some of which were multiple-part) were selected. An additional two-part question was added prior to Round 2. The total number of questions to be answered was 41 (43 after Round 2).

The questionnaire format was dictated in part by the need to have a quick turn-around between the answering of the questions and the presentation of results so that the entire process could be accommodated within the time frame of the workshop. This resulted in a questionnaire which departed from the 'traditional' Delphi survey format in that respondents were restricted in the range of answers they could provide. Thirty-eight of the 43 questions restricted participants' answers to one of seven possible choices (eg a seven point scale from 'substantial increase' to 'substantial decrease'), four sought specific predictions and one asked respondents to rank a number of options. A more detailed discussion on the questionnaire format is contained in Appendix III.

The questionnaire also made provision for the individual assessment of expertise in each theme. This is described in Chapter 4.

DISSEMINATION OF INFORMATION

The Delphi process relies heavily on the dissemination of information among participants. The dissemination procedure generally takes three forms:

(a) *Background information.* Information provided to participants both before and during the running of the survey. For example, to assist participants in a question dealing with the future price of petrol, a number of graphs and tables were provided which traced the retail price of petrol (in both constant and current prices) since 1955 (see Appendix IV). Individuals drew their own conclusions from the data provided.

(b) *Individual views.* These views should be disseminated amongst the participants, with the proviso that they should not be individually attributable. This circulation of information is aimed at ensuring that participants continually update their views. This is useful, even if the end result is to confirm their earlier stance.

(c) *Group opinion.* This comprises the aggregated results of each round of the survey. These results can be given by way of histogram, cumulative frequency curves, tables etc., depending on the particular needs of the survey and the facilities available. The information fed back to participants should enable each individual to see exactly how they stand in relation to the views of the group as a whole.

In this particular survey types (a) and (c) information dissemination followed closely the pattern of a traditional Delphi. However, type (b) was limited, due to the time schedule adopted. Participants received only one limited opportunity to express individual views.

Where a more liberal time schedule is available, the interaction among participants by way of their (anonymously reported) views should be encouraged. This would be particularly simple to achieve if the Delphi were carried out by mail rather than within the confines of a workshop or conference (see Appendix II).

CONDUCT OF THE SURVEY

The timetable for the survey was dictated by the need to run it concurrently with the workshop on Urban Passenger Transport.

Participants were sent questionnaire forms approximately ten days before the workshop, and were asked to complete and return Round 1 before the commencement of the workshop. The data was processed and results produced for the workshop registration on the evening of Monday 11 May.

During the workshop the survey timetable was:

Time	*Activity*
Monday 11 May 1981 Tuesday 12 May 1981	Dissemination of Round 1 results at the same time as the workshop registration
2.00 pm	Presentation of Round 1 results; Round 2 collected
5.45 pm	Presentation of Round 2 results
Wednesday 13 May 1981	
9.00 am	Collection of Round 3 results
2.00 pm	Presentation of Round 3 results
5.00 pm	Collection of Round 4 results.

Results of Round 4 were processed and forwarded to participants after the workshop.

Results for each round were processed by computer to produce graphs, tables and appropriate statistics for each question. These graphs will be reproduced in full in a separate BTE Reference Paper (BTE 1982 forthcoming).

CHARACTERISTICS OF PARTICIPANTS

All 33 participants in the workshop on the Future of Urban Passenger Transport were surveyed. The State of origin of the delegates are shown in Table 2.1.

TABLE 2.1—HOME STATE OF THE DELPHI PARTICIPANTS

State	*No of delegates*
ACT	10
NSW	10
Vic	7
SA	3
Qld	1
WA	1
Tas	1
Total	33

The participants were selected because of their experience in, or association with, the transport industry in general, and urban passenger transport in particular. This selection criterion fitted in well with the requirements for 'experts' to undertake the survey. A summary of the participants' backgrounds is given in Table 2.2.

TABLE 2.2—DELPHI PARTICIPANTS LISTED ACCORDING TO BACKGROUND

Background	*No of delegates*
Policy/administrative/planning	12
Research/academics/consultants	11
Unions/consumers	4
Private transport operators	3
Public transport operators	3
Total	33

Two of the 33 participants were women.

A full list of participants and the organisations they represented is given in Appendix V.

CHAPTER 3—ANALYSIS OF RESULTS

This chapter analyses the movement of responses to each question and provides a commentary on the final results obtained in Round 4. A histogram of the final results for each question is provided. More detailed histograms showing changes in responses to questions in each round will be contained in a separate BTE Reference Paper (BTE 1982 forthcoming). (These are the histograms presented to participants following each round of the survey.)

To interpret the information contained in the histograms the following points should be noted:

- an abbreviated form of the question is given above each histogram. For the full text, refer to the questionnaire itself in Appendix II;
- the numbers on the horizontal axis correspond to the choice of answers offered to participants in the questionnaire (see Appendix II);
- the vertical axis gives the percentage of participants selecting each answer; and
- the actual frequency and percentage of participants selecting each answer, together with other relevant statistics are given below each histogram.

The first histogram in each theme shows the relevant expertise levels of the participants. Briefly, participants were asked to rate their own expertise from 'None' to 'High' in each round of the survey. The histogram shows the expertise rating for Round 4 (final round) of the survey. For further information on this rating see Chapter 4.

The comments provided for each question often note changes in responses from one round of the survey to the next. These movements are recorded in an associated Reference Paper (BTE 1982 forthcoming).

Apart from reporting the final results of the survey this chapter also comments on some results to assist interpretation of the results, or to provide some explanations as to why certain results may have arisen.

PART A—ENERGY THEME

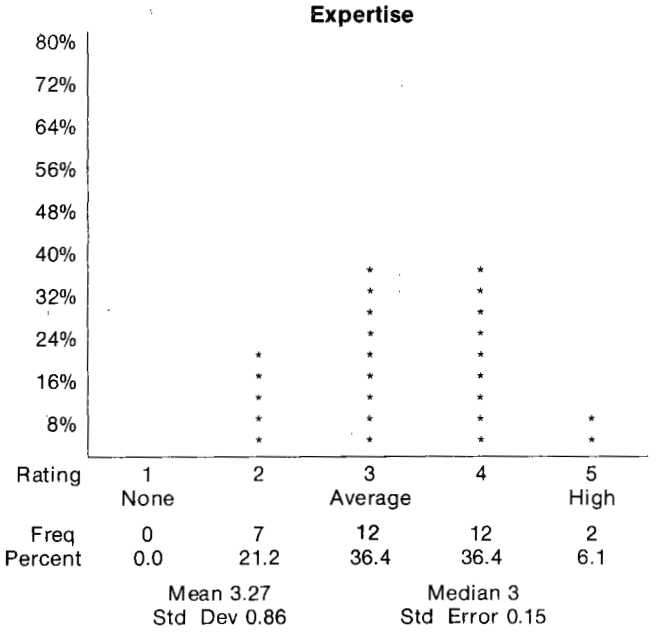


Figure 3.1—Expertise of participants

The expertise ratings for this part changed very little over the four rounds. As a group the participants rated themselves as slightly above average, although seven classified themselves as having little expertise.

Question 1 Effect of Fuel Price on Urban Private Car Demand

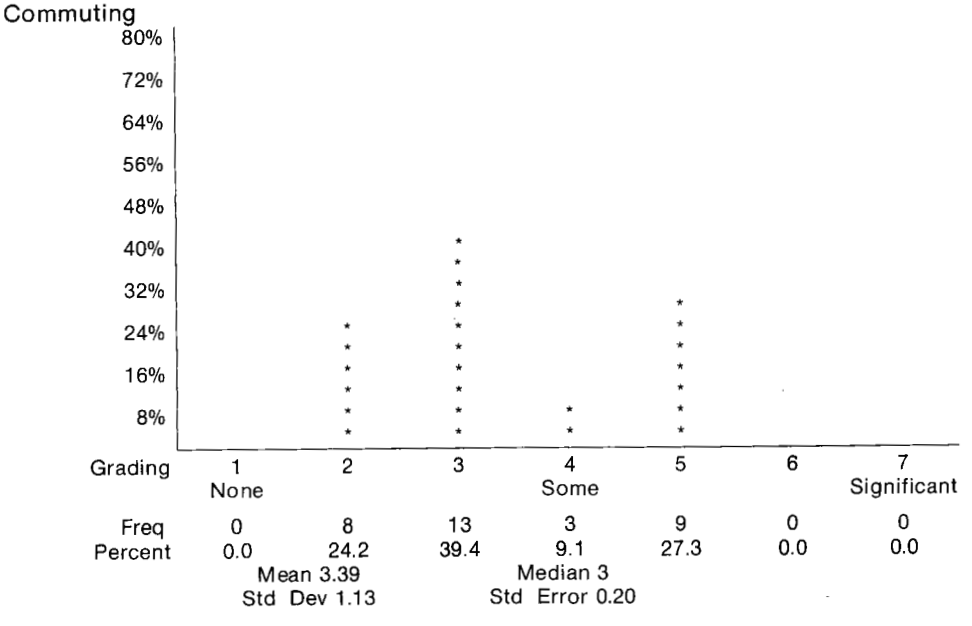


Figure 3.2—Effect of fuel prices on commuting

The effect of increasing fuel prices on commuter travel was seen as minimal, probably highlighting the captive nature of commuters and their low elasticity of demand to fuel prices. The mean effect declined (less significance) as the rounds progressed.

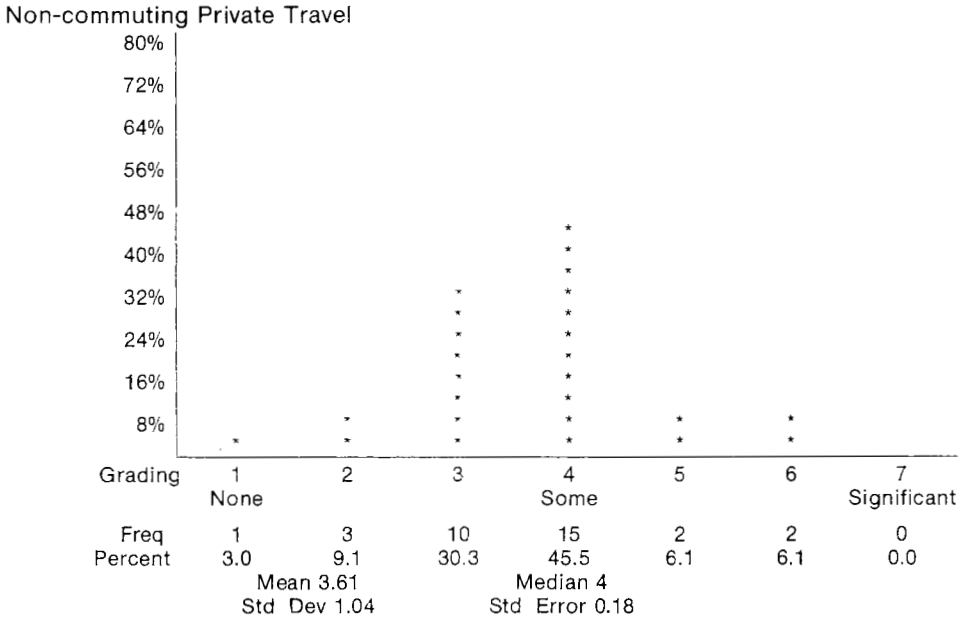


Figure 3.3—Effect of fuel prices on non-commuting private travel

The effect of fuel prices on private car demand is expected to be greater for non-commuting travel than for commuting. This could imply trips being foregone because of the less effective coverage of non-commuter routes by public transport. It may also be significant that the responses to this question showed a higher level of variation among respondents than in the earlier question.

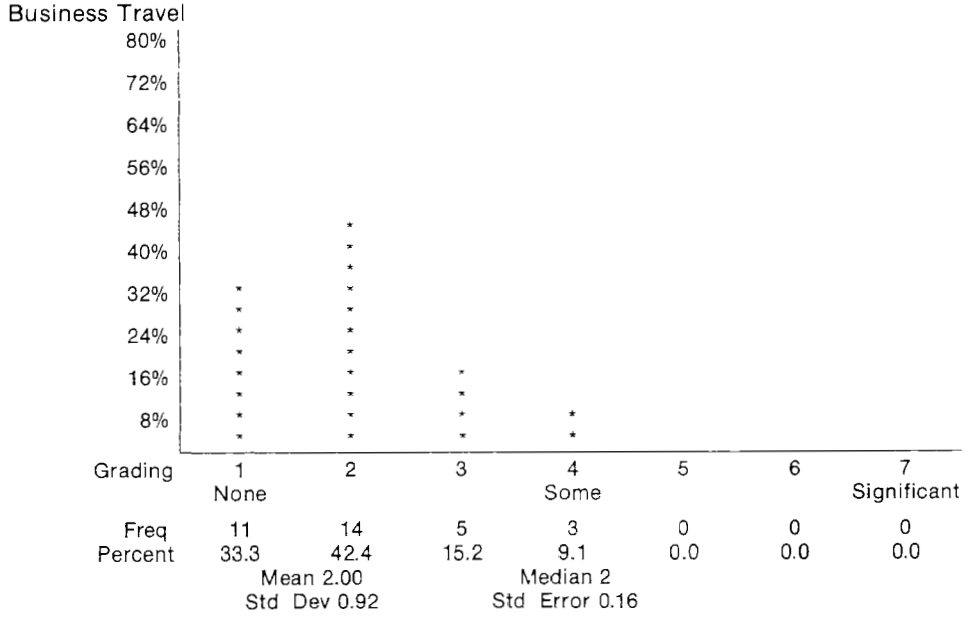


Figure 3.4—Effect of fuel prices on business travel

This category of travel is expected to suffer the lowest impact from increases in the price of fuels. Business travel has the greatest ability to accommodate increasing fuel costs; prices of goods and services can be raised and travel can be claimed as a taxation expense, thereby reducing the impact of higher fuel costs. The very strong consensus was that there would be very little impact on business travel, with over 75 per cent of respondents indicating either very slight or no effect.

Question 2: Public transport in energy management

This series of questions was designed to explore the capacity of public transport to act as a competitive alternative to the private car, and how it would cope with the influx of passengers in the event of the private car becoming generally unavailable for whatever reason (eg, protracted fuel strike). The questions were asked for the present (1981) and the future (1990) to test views as to what may occur in the intervening period.

Question 2 Public Transport in Energy Management

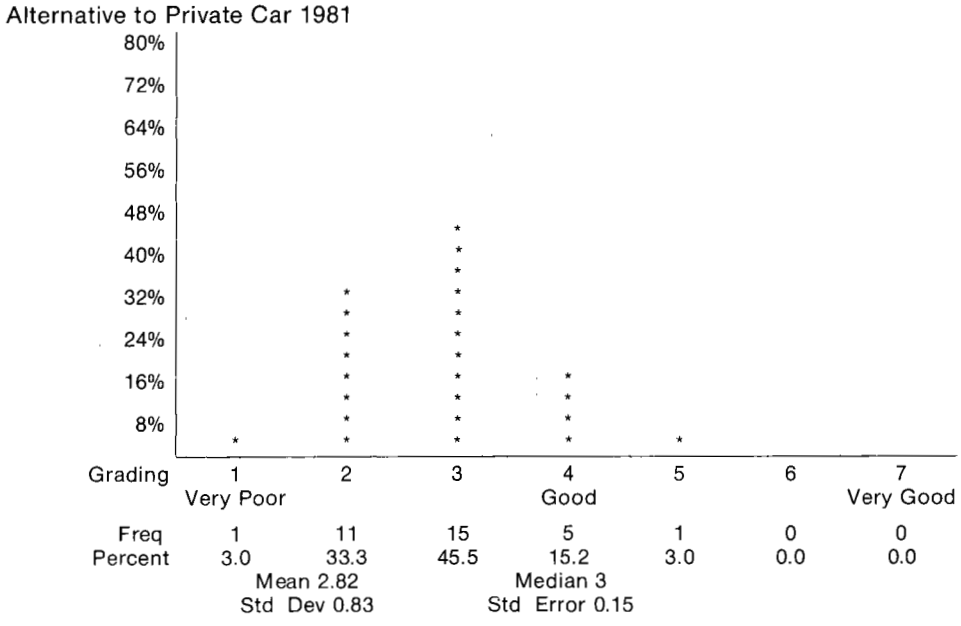


Figure 3.5—Public transport as an alternative to the private car (1981)

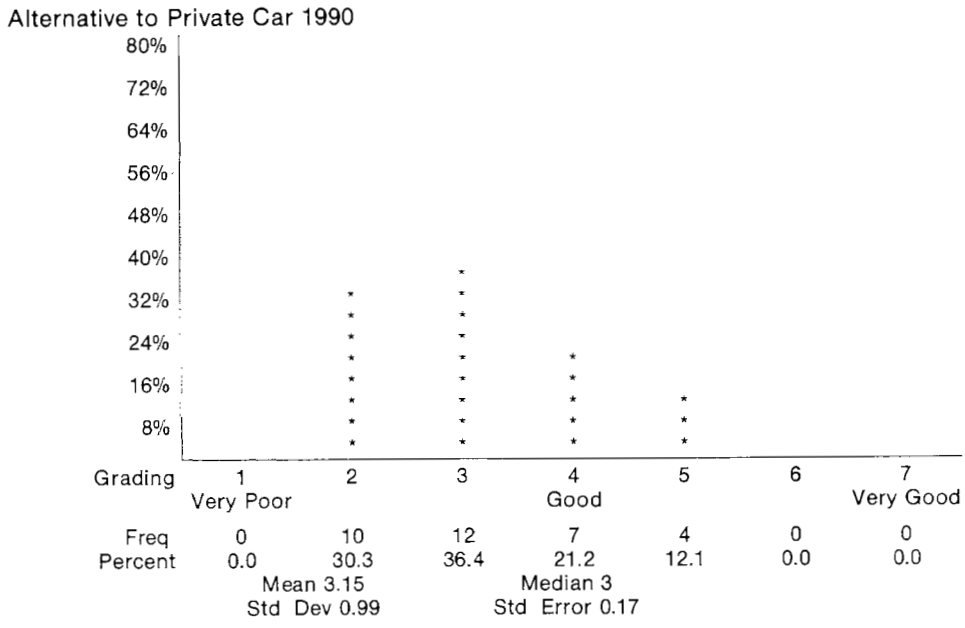


Figure 3.6—Public transport as an alternative to the private car (1990)

The present position is not seen as heartening. Although pessimism was reduced by the last round, the group view was that public transport is a poor alternative to the private car. This view is in line with declining public transport patronage arising from lack of flexibility, a lack of privacy and comfort, and a number of other reasons.

The position is expected to improve slightly by 1990, by which time public transport ought to be more capable of offering an alternative to the private motor car. No reasons were elicited for this view, but increasing future costs of car ownership and use (including fuel), a trend towards higher density inner city living, and perhaps a more effective and attractive public transport service would contribute to this trend.

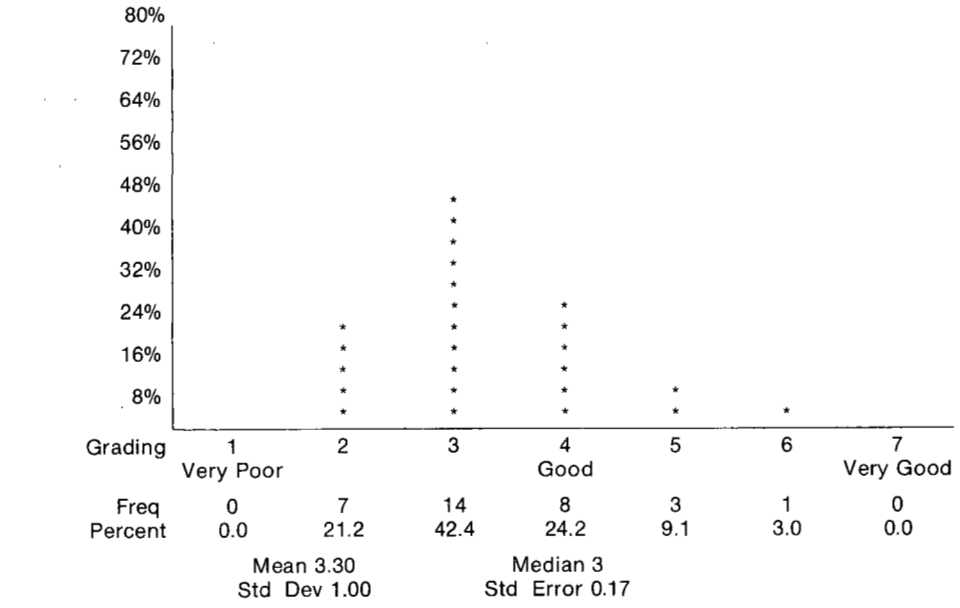


Figure 3.7—Public transport's fall back system role (1981)

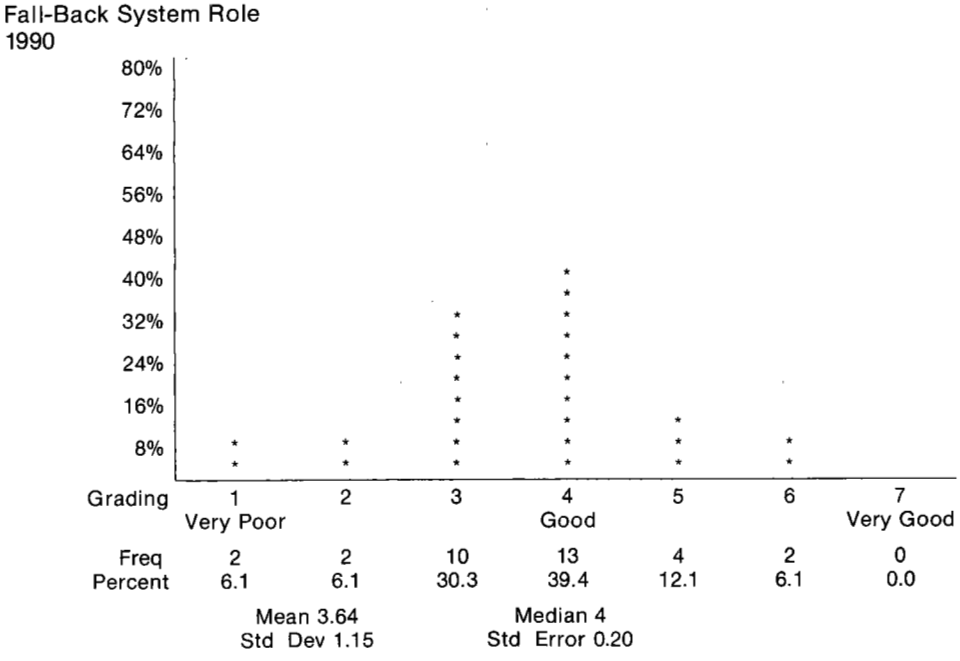
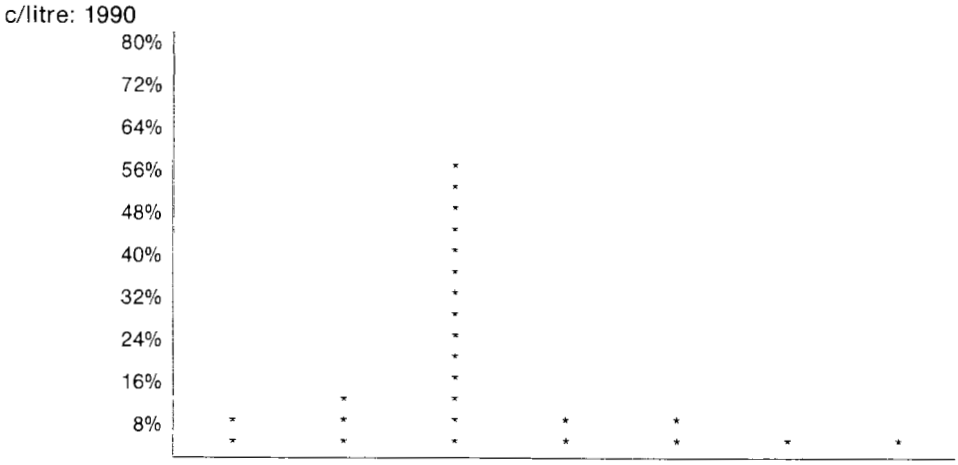


Figure 3.8—Public transport's fall back system role (1990)

The public transport system is seen as having little ability to provide a fall-back system in the event of failure of the private car as a transport system. As in the previous part, its capacity to perform this task is expected to improve over time. However, even at best this expected capability is only marginal, suggesting that in the case of a serious and protracted energy crisis public transport would not be able to cope with the transport task.

Question 3 Future Petrol Prices: Basis for Planning

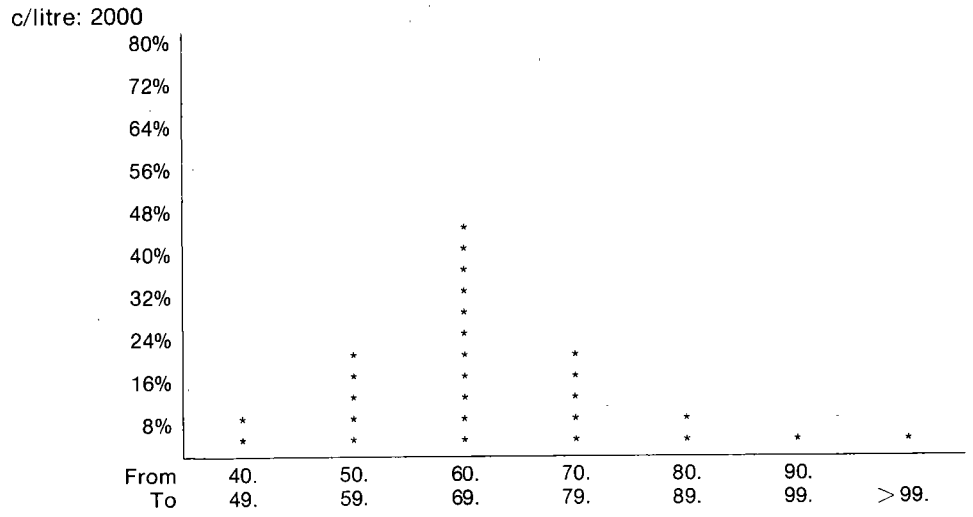


Range 40.00 to 100.00

Mean 52.24 Median 50.00
Std Dev 9.95 Std Error 1.73

c/litre	Frequency	c/litre	Frequency
40.00	2	45.00	4
48.00	1	50.00	16
52.00	2	55.00	2
57.00	1	60.00	3
65.00	1	100.00	1

Figure 3.9—Price of petrol in 1990 (in 1981 prices)



Range 44.00 to 120.00

Mean 66.82 Median 65.00
Std Dev 14.35 Std. Error 2.50

c/litre	Frequency	c/litre	Frequency
44.00	1	45.00	1
50.00	1	54.00	1
55.00	4	60.00	5
65.00	7	66.00	1
68.00	1	70.00	1
75.00	5	80.00	2
85.00	1	93.00	1
120.00	1		

Figure 3.10—Price of petrol in 2000 (in 1981 prices)

Participants were asked to consider the future price of petrol as a basis for planning future urban transport. The two time horizons to be considered were 1990 and 2000. Participants were asked to give answers in constant prices, in other words to neglect the effects of inflation, assuming the 1981 price for premium grade petrol to be 37 cents per litre.

For 1990 the average price varied between 52 cents and 56 cents. There was little variation, although some respondents predicted the real price of petrol to exceed $1 per litre. The final figure of about 52 cents represents a real price increase of 15 cents, or 41 per cent over the 1981 price.

There was considerably more uncertainty about the price for the year 2000. In the first round the average price was 82 cents, with strong support for prices of $1 or more. By Round 4 the average had fallen to about 67 cents, but, of more importance, only 5 of the 33 participants then still supported a price of more than 75 cents. A price of 67 cents by the year 2000 represents a rise of 30 cents in real terms over the 1981 price, an increase of 81 per cent (equivalent to 3 per cent a year).

As part of the background material, participants were provided with a graph which showed the price of premium grade petrol in Sydney between 1955 and 1981, in both current and constant prices (Appendix IV). The graph is partly reproduced in Figure 3.11 which includes the prices for 1990 and 2000 from the survey. By way of comparison some extrapolations are given based on different treatments of past trends.

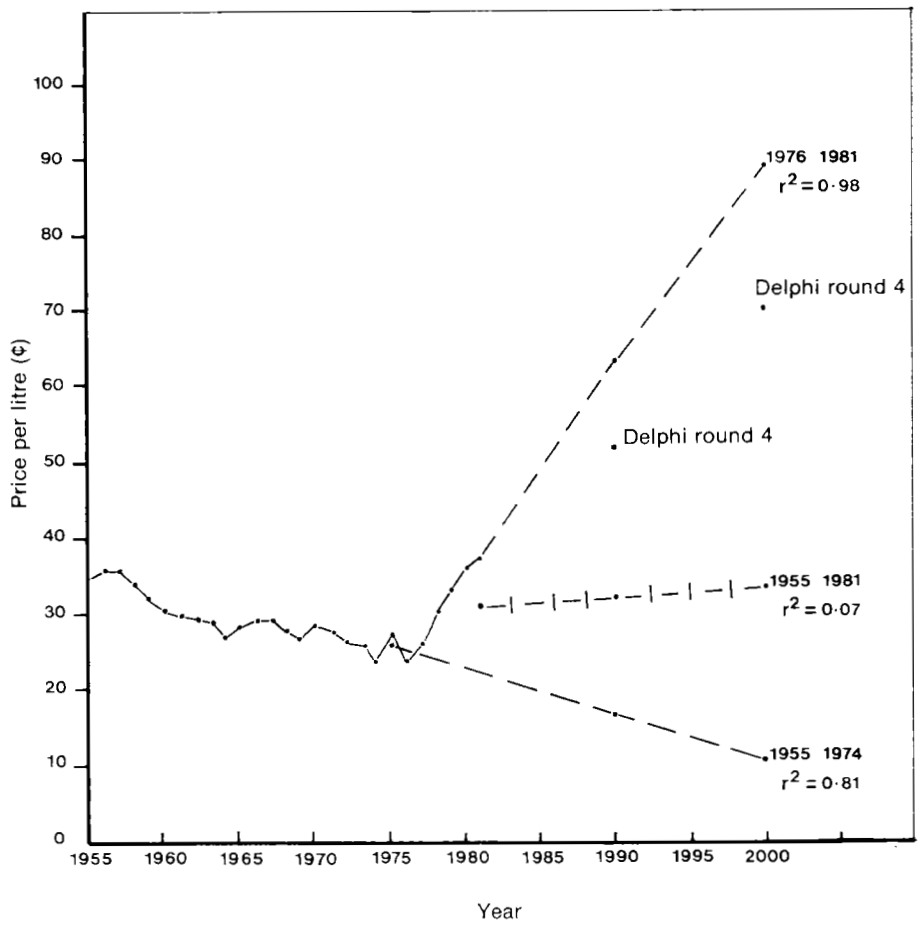


Figure 3.11—Fuel price trends 1955-2000 (in 1981 prices)

An 'average' linear trend from 1955 to 1981 would give an almost horizontal line, giving very marginal increases up to the year 2000. However, the correlation coefficient for the regression which produced the trend is only 0.07, highlighting the change in trends since 1974.

One view expounded during the workshop was that the sharp price increase since 1974 was a significant but temporary aberration, the effect of which would gradually diminish with the result that future prices would fall until they neared the trend line established between 1955 and 1974 (that is, ignoring the prices prevailing between 1975-80). If this were to occur the real price (1981 dollars) of petrol in the year 2000 would be about 11 cents/litre.

Alternatively, one could view the trend since 1974 as the norm rather than the exception, and that the circumstances which led to steeply rising prices (eg OPEC, dwindling and unevenly distributed supplies) will continue. On this basis, a trend line through the last six years (ignoring the 'uncharacteristic' trends between 1955 and 1974) yields an extrapolated price by the year 2000 of about 87 cents (compared to 67 cents in Delphi Round 4).

Participants who gave very high or very low prices in their responses were asked to provide brief reasons for their particular stance at the end of Round 3. These were summarised and presented to all participants prior to their undertaking Round 4.

Briefly, the reasons given by the proponents of *low* prices were:

- governments (unspecified but presumably Australian) would be 'forced by political pressures' to keep real prices down, recognising that a major component of fuel prices are government duties, taxes and levies;
- by the year 2000 there will be viable alternatives to petrol, and petrol prices will be adjusted to compete;
- the combination of a supply glut (not necessarily a glut of oil reserves) and a decline in consumption will have a dampening effect on future price increases; and
- despite the apparent OPEC solidarity, reducing demand (and therefore reducing revenues) will prevent any concerted OPEC effort to reduce output again to match supply (or more correctly a supply shortfall) to demand.

It is interesting to note that since the workshop and survey, events have moved to support the last two points.

The proponents of *high* petrol prices relied on the concentration of reserves in OPEC countries and the instability of the Middle East political, economic and religious conditions as catalysts to future oil shortages and concomitant price increases.

One participant noted (correctly) that the question was asked not in terms of the *actual* future price of fuel, but rather on the future price of petrol as the *basis for planning*. In this context he maintained, the uncertainty and instability of the future should be sufficient reason to assume a high price of fuel and to plan accordingly.

PART B—AIR POLLUTION THEME

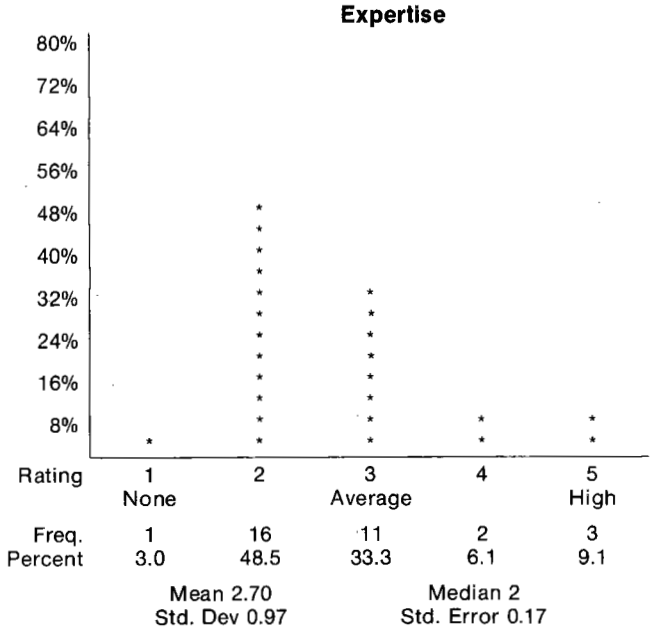


Figure 3.12—Expertise of participants

This part yielded the lowest overall rating of the respondents expertise. As a group, the participants claimed little expertise, although by Round 4 a few individuals rated themselves as having a high level.

Question 4 Severity of Pollution Problem

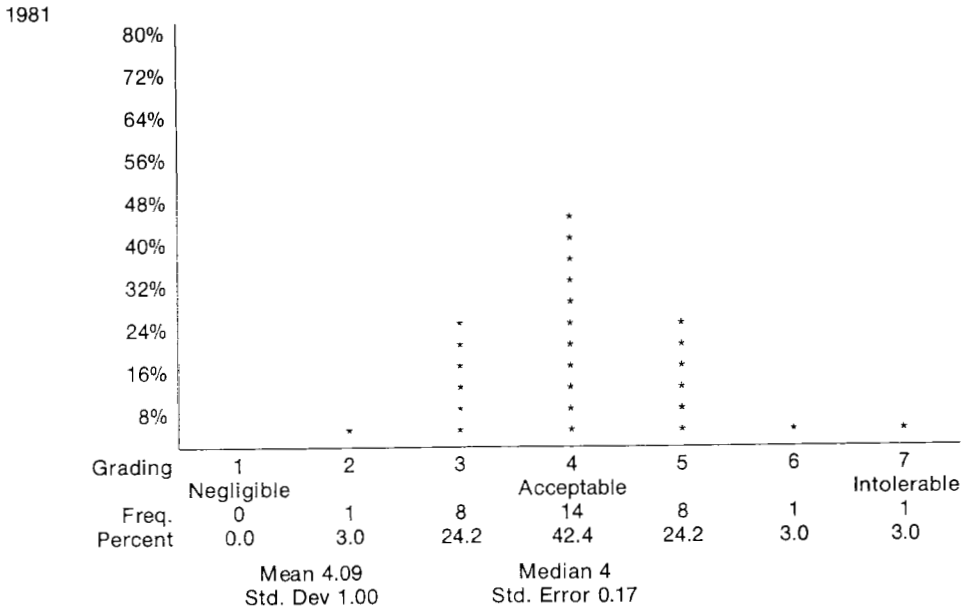


Figure 3.13—Severity of pollution problems in capital cities (1981)

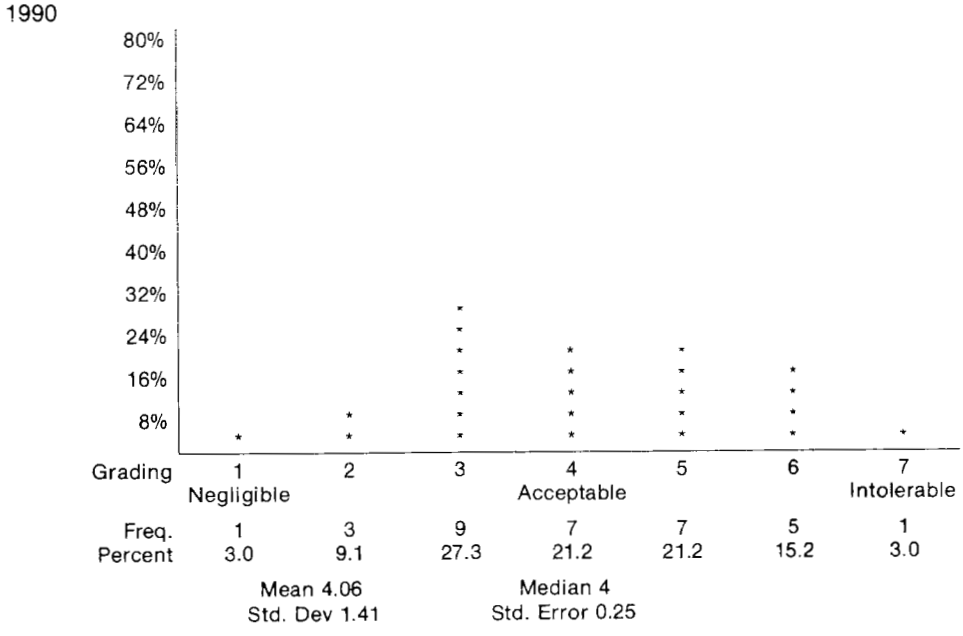


Figure 3.14—Severity of pollution problems in capital cities (1990)

A wide range of views were expressed in responses to this question and there were only very small movements from one round to the next. This was no doubt helped by the acknowledged lack of expertise of the participants which probably led respondents to make subjective judgments and maintain them for the four rounds of the survey.

Also, while the questionnaire specified the major capital cities as the target for the question, this left much up to individual interpretation as to how serious a given level of pollution would be. A level of pollution which may be judged to be acceptable in Sydney or Melbourne may be unacceptable in Adelaide or Perth. This level of subjectivity may have ruled out any possibility of objectively reasoned answers.

The average answer indicated that the level of pollution in 1981 and 1990 will be acceptable, although for 1990 12 per cent of respondents thought that pollution would be 'low to negligible', and 18 per cent thought it would be 'serious to intolerable'.

Question 5: Efficacy of possible solutions to reducing air pollution

This question asked participants to rank a number of alternative courses of action in terms of their likely efficacy in reducing air pollution. The results for this question have been presented in two ways.

Firstly, the answers are presented in Table 3.1 which shows, for the final round, the distribution of rankings for each alternative.

TABLE 3.1—RELATIVE RANKING OF ALTERNATIVE SOLUTIONS TO AIR POLLUTION

(number of times each solution ranked)

Alternative solutions	*Ranking*						*Not*
	1	*2*	*3*	*4*	*5*	*6*	*ranked*
A. Upgrading the levels of service of public transport in an effort to attract greater patronage	0	2	5	7	6	6	7
B. Active discouragement of private vehicle ownership and usage in inner urban areas	5	7	10	5	3	1	2
C. Investment in more sophisticated highway infrastructure to reduce congestion and by-pass Central Business Districts efficiently	1	5	3	4	7	6	7
D. Adoption of sophisticated traffic management techniques to reduce congestion and concentrations of idling vehicles	0	8	9	7	3	1	5
E. Encourage or mandate technological improvements to engine technology, and development of alternative fuel sources to reduce or eliminate motor vehicle emissions	24	5	0	2	1	0	1
F. Introduce land use and planning policies to reduce need for transport	3	6	5	5	2	8	4

Alternative E (encouragement of advanced engine technology) was regarded as having the greatest potential to reduce air pollution. By Round 4, 24 of the 33 participants ranked this as their first choice and further five ranked it as their second choice.

The only other alternative to achieve even moderate support was alternative B (discouragement of private vehicle ownership and usage in inner urban areas), which was ranked first by 5, second by 7 and third by 10 respondents.

The second presentation is the graph shown in Figure 3.15, which gives a 'score' for each alternative based on an inverse scoring arrangement:

Rank	1	2	3	4	5	6
Score	6	5	4	3	2	1

	Alternative					
	A	B	C	D	E	F
No. of rank						
1	0	5	1	0	24	3
2	2	7	5	8	5	6
3	5	10	3	9	0	5
4	7	5	4	7	2	5
5	6	3	7	3	1	2
6	6	1	6	1	0	8
Not Ranked	7	2	7	5	1	4

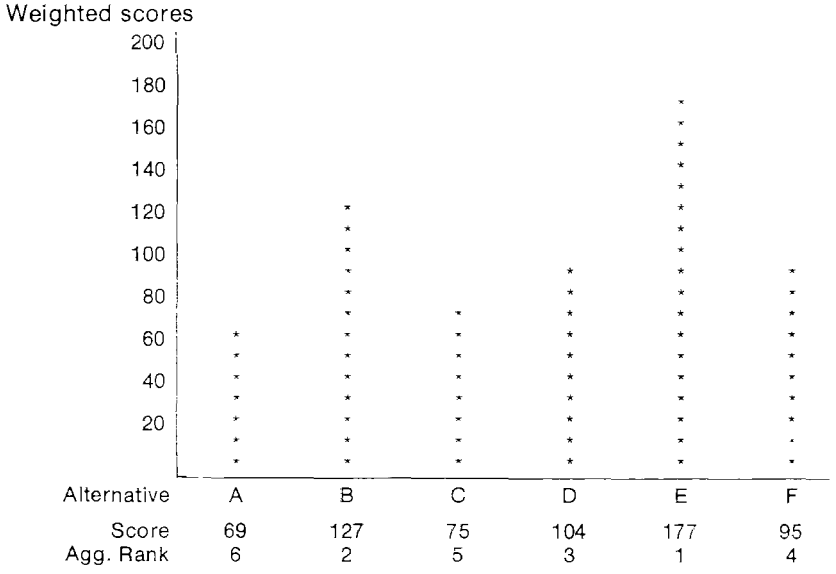


Figure 3.15—Efficacy of alternative solutions to air pollution (weighted scores)

The alternative with the highest score received the highest overall 'commendation of effectiveness', though not necessarily the highest number of first rankings. Figure 3.15 shows that alternatives E and B were still favoured by a considerable margin. The survey participants clearly hold the view that the most effective solutions to reduce air pollution in major cities are to encourage technology to develop engines which produce lower levels of pollutants, and to restrict car access to the Central Business District (CBD).

Of the other alternatives the outstanding failure seems to be option A, the upgrading of public transport to attract greater patronage. This was ranked low by most participants, indicating a view that either public transport would never attract greater patronage, or if it did it would not be drawn from present users of private cars.

Question 6 Engine Design: Pollution vs. Economy

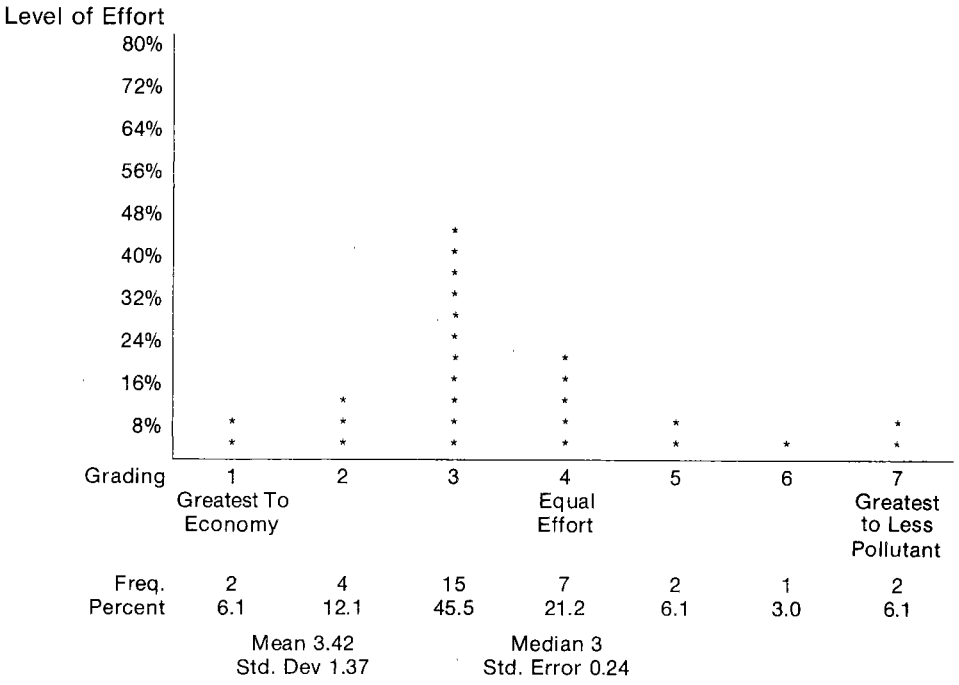


Figure 3.16—Direction of engine design efforts

The interest in the results of this question is not so much the final result (slightly greater effort towards economy rather than less pollution), but in the possible dichotomy of results between this question and Question 5.

In Question 5 there was almost universal support for advanced engine technology to reduce the level of pollutants. In Question 6 this enthusiasm for an apparently effective measure seems to have waned, and greater importance is placed on directing effort towards a more economical engine.

The questionnaire was quite specific in the recognition that the goals of increased economy/reduced pollutants were not necessarily mutually exclusive. In other words, an advance which reduced emissions *may* also improve its fuel economy. However, if technology is directed primarily towards increasing economy then reduced pollutants would be regarded as a useful, but not vital, by-product, and increased pollutants would be no barrier if this were necessary to reduce fuel consumption.

The inference—and it is no more than an inference—that can be drawn from the results of Questions 5 and 6, is that respondents implicitly considered that conservation of fuel is more important than air pollution, an inference that is supported by the results of Question 4.

PART C—TRAVEL DEMAND THEME

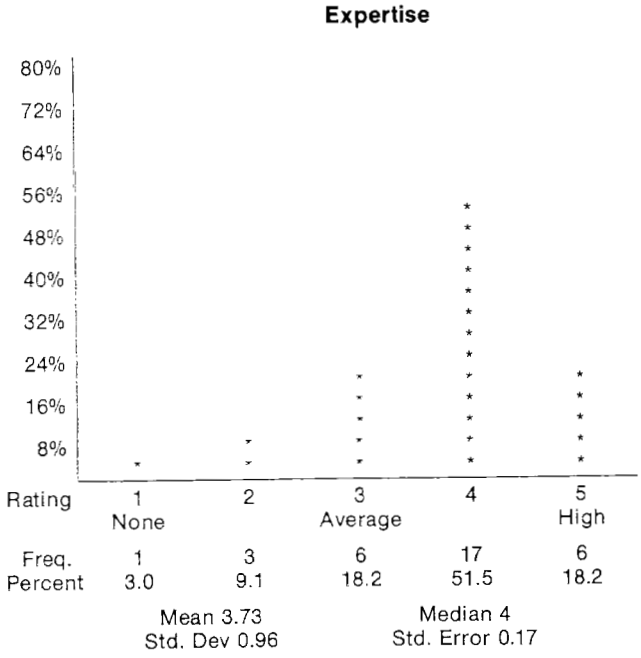
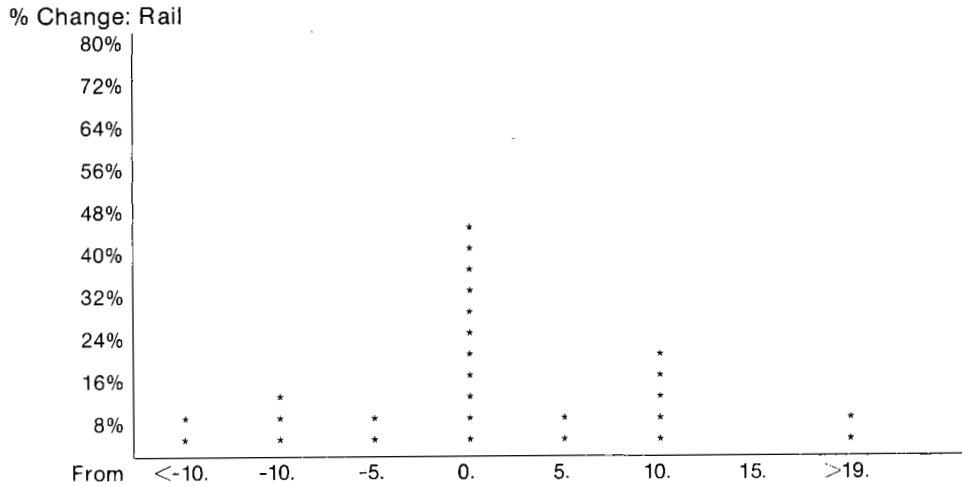


Figure 3.17—Expertise of participants

This theme yielded the highest overall ranking of the participants' level of expertise, with 23 participants claiming moderate or high expertise. Only 10 claimed to have little or no expertise.

Question 7 Public Transport Patronage Prospects



Range -15.00 to 34.00
Mean 1.55 Median 0.00
Std Dev 10.01 Std. Error 1.74

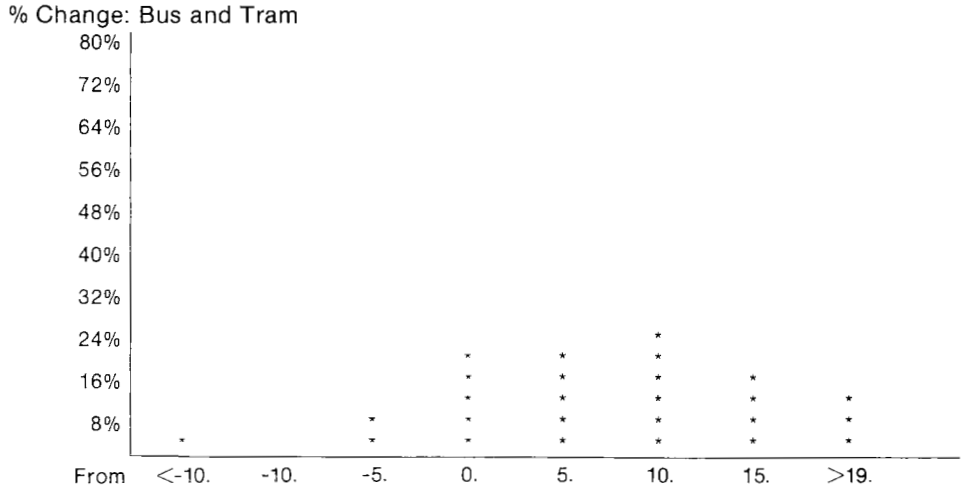
% Change	Frequency	% Change	Frequency
-15.00	2	-10.00	4
-5.00	2	-3.00	1
0.00	13	2.00	1
5.00	1	8.00	1
10.00	6	25.00	1
34.00	1		

Figure 3.18—Expected changes in demand for rail travel

The separation of rail and bus/tram modes was made because recent historical trends have shown a very clear difference between the two modes. These differences were given clear recognition in the views of the participants who saw rail as having relatively less 'success' in the future than buses and trams. However it is noteworthy that following decades of declining patronage, the consensus view was for a decade of stability and modest—if nearly undetectable—growth.

For rail, while the first round yielded a mean expectation of just over 5 per cent growth for the nine year period to 1990, this fell to 1.6 per cent by Round 4. In other words, the suburban rail systems can expect a continuing stagnation of their patronage, but not a further major decline. This was largely attributed to the relative inflexibility of rail systems and their resulting inability to diversify, expand and meet changing demands. In addition, the massive, but ageing infrastructure that already exists in the capital cities will impose enormous financial demands in the future, merely to maintain the asset. Any wholesale expansion or modernisation of the suburban rail networks seems unlikely (see question 10).

Question 7 Public Transport Patronage Prospects



Range -15.00 to 30.00

Mean 7.88 Median 10.00
Std Dev 9.11 Std. Error 1.59

% Change	Frequency	% Change	Frequency
-15.00	1	- 5.00	2
0.00	7	5.00	6
10.00	6	12.00	1
13.00	1	15.00	5
20.00	2	25.00	1
30.00	1		

Figure 3.19—Expected changes in demand for bus and tram travel

Buses, and to a lesser extent light rail systems, appear to have a slightly 'better' future, perhaps largely due to their greater flexibility and capability to react to changing needs. By Round 4 patronage was expected to increase by about 8 per cent to 1990.

Question 8 CBD Dependence on Public Transport

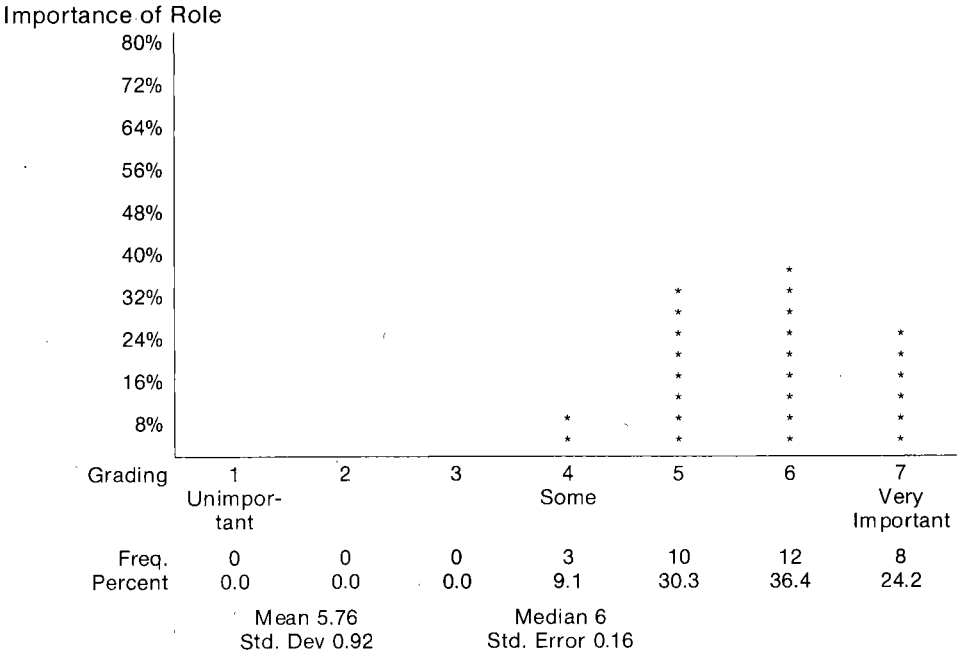


Figure 3.20—Importance of urban public transport in maintaining vitality of CBDs

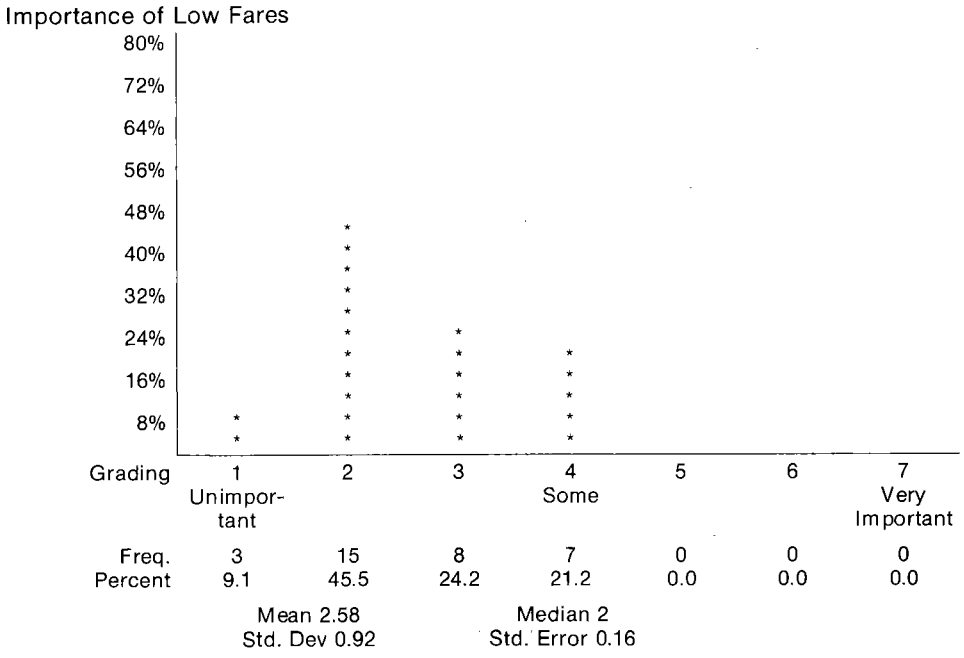


Figure 3.21—Importance of low fares in maintaining vitality of CBDs

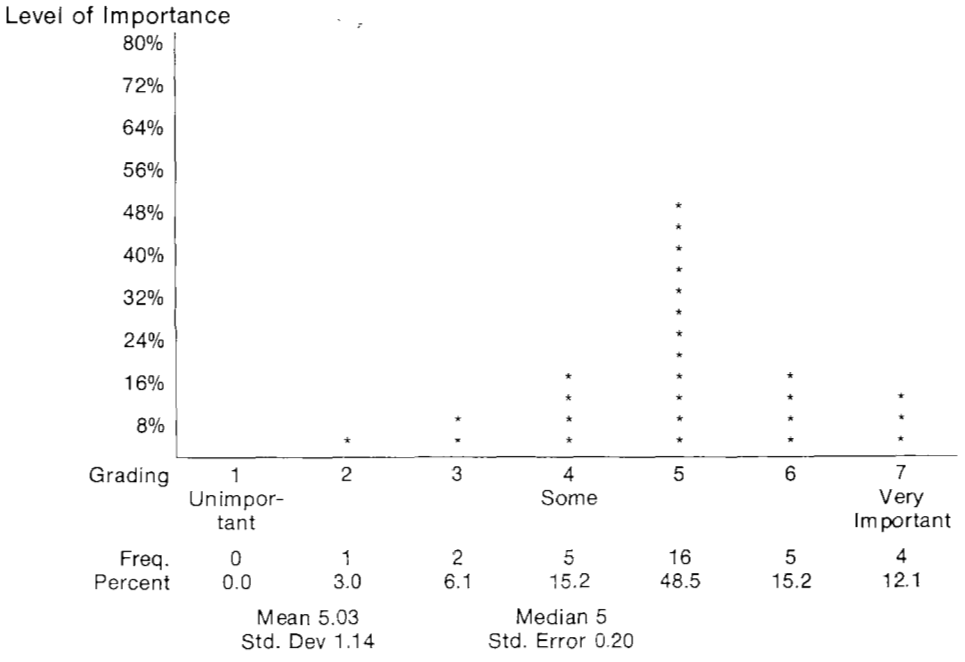


Figure 3.22—Importance of maintaining CBD functions at present levels

Figure 3.21 shows that the CBD is still thought to be quite important; the implication being that it 'ought' to be maintained as the principal focus of business and financial activity, and as the prime employment centre of the city. An adjunct was the strong support for the premise that public transport is still a very important factor in the continuing viability of the CBD.

However in fulfilling this role (of maintaining the CBD), it is *unimportant* that a 'low fares' policy be maintained for public transport. The survey did not seek individual reasons for arriving at this view, but they could include:

- reduction of fares would make little difference to public transport patronage to the CBD due to the low fare elasticities (see also Question 9 (b));
- the attraction of the CBD is sufficiently great and car parking sufficiently restricted to outweigh cost increases in the use of public transport.

Question 9 Demand Stimulation

Improvement to Delivery Systems

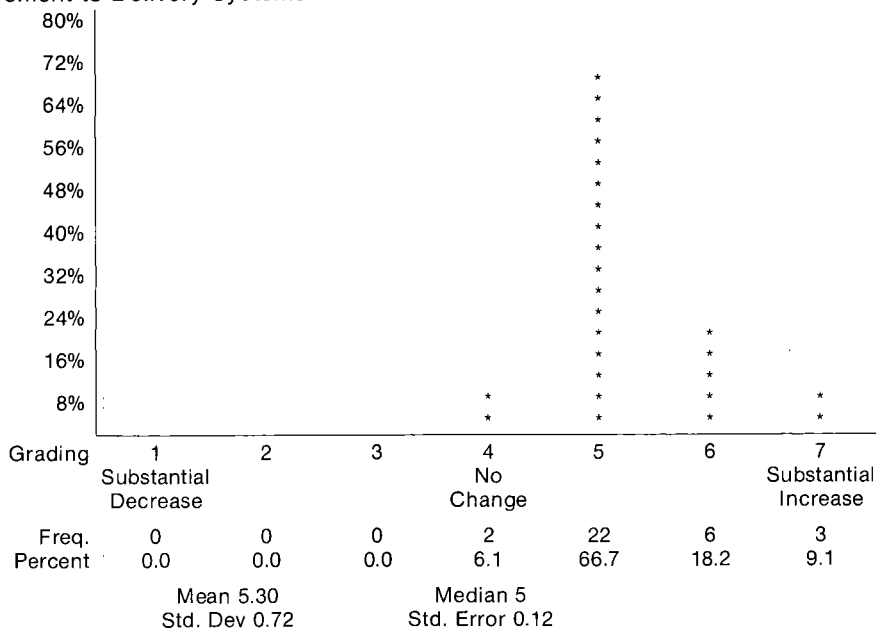


Figure 3.23—Changes in demand due to improvements in delivery systems

Lower or Zero Pricing

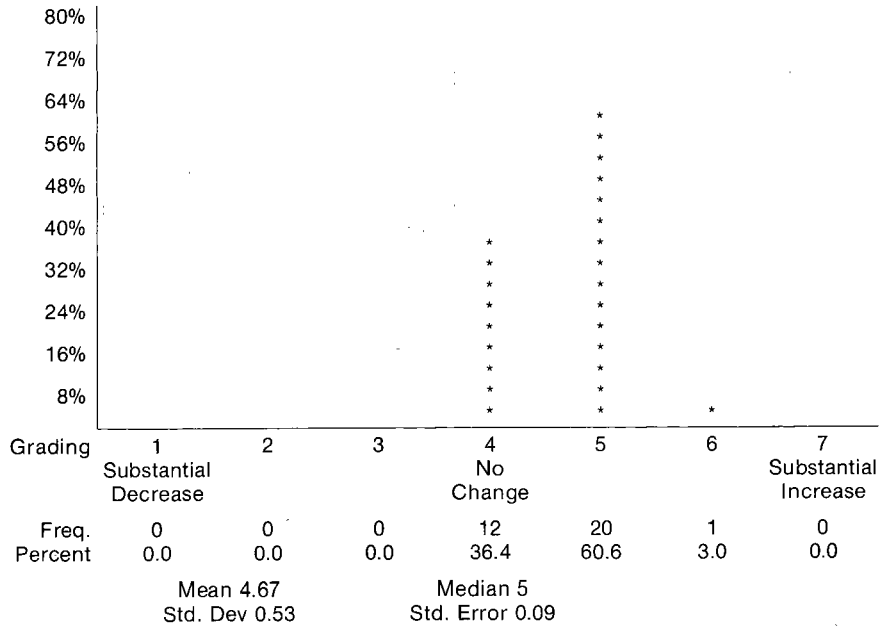


Figure 3.24—Changes in demand due to lower or zero pricing

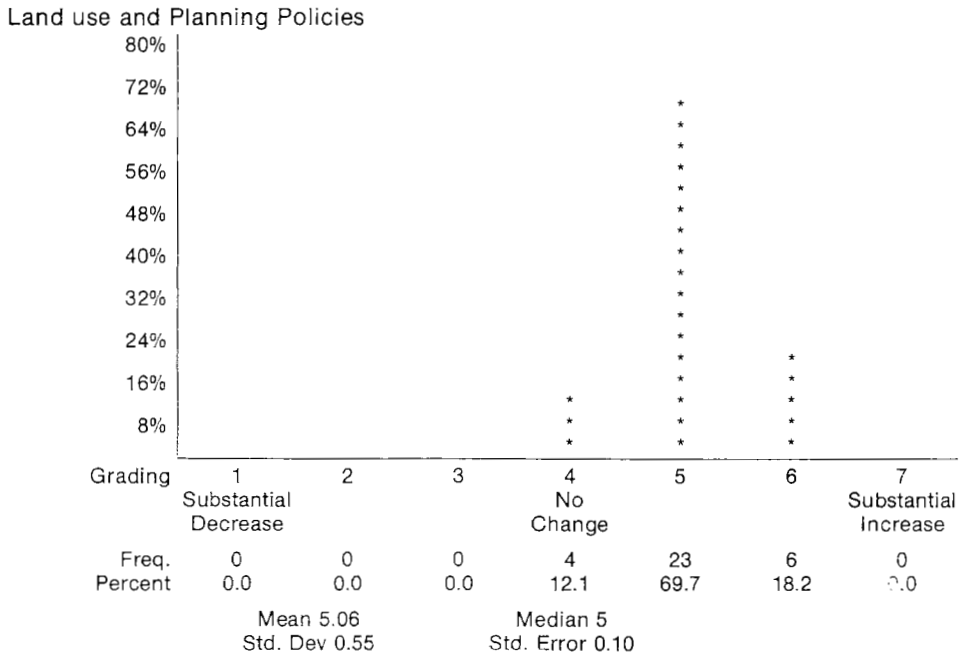


Figure 3.25—Changes in demand due to land use and planning policies

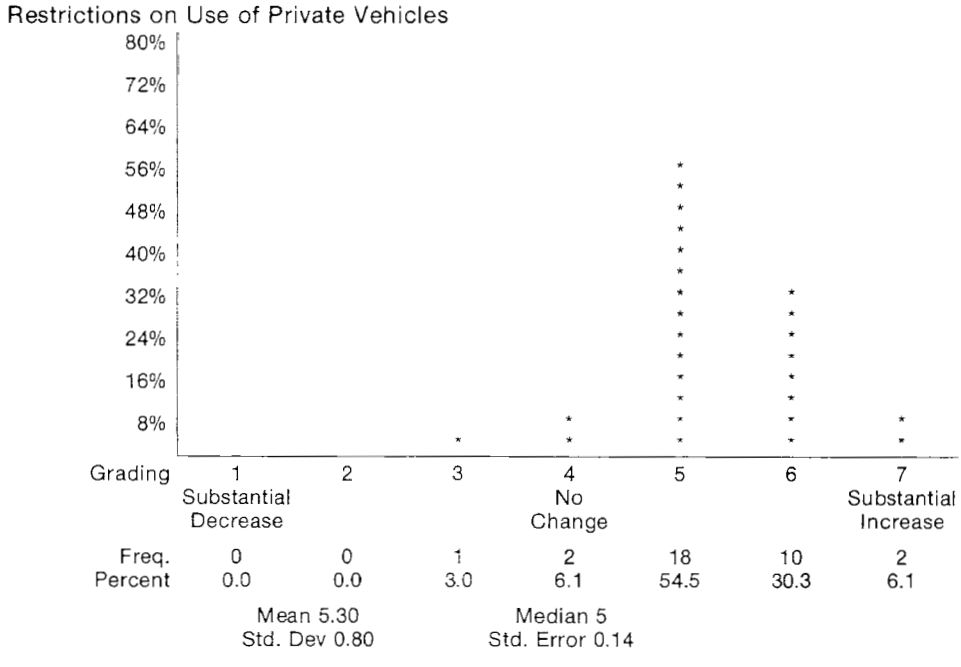


Figure 3.26—Changes in demand due to restrictions on use of private vehicles

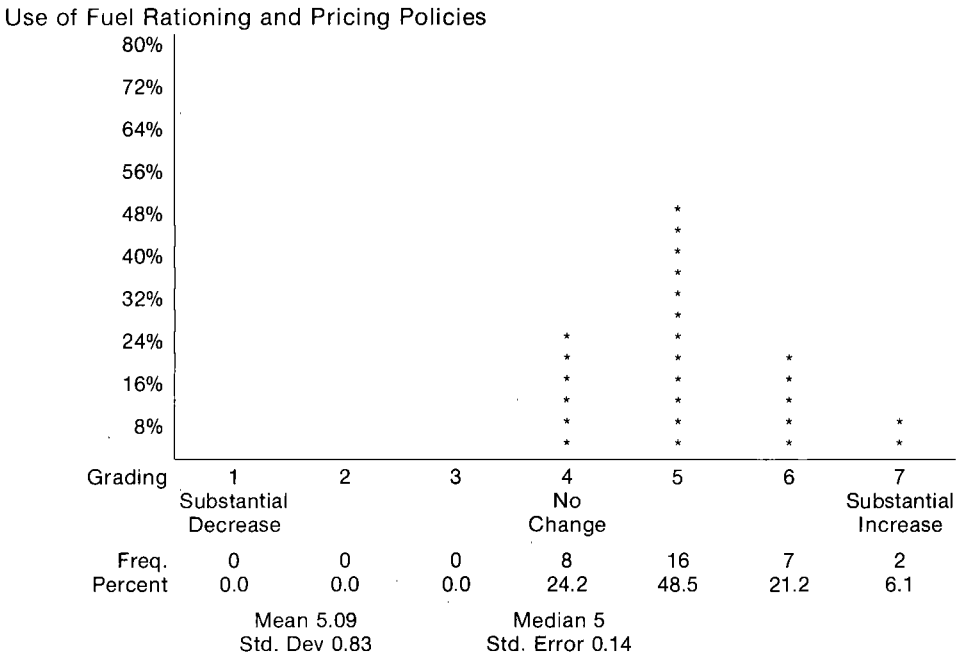


Figure 3.27—Changes in demand due to fuel rationing and pricing policies

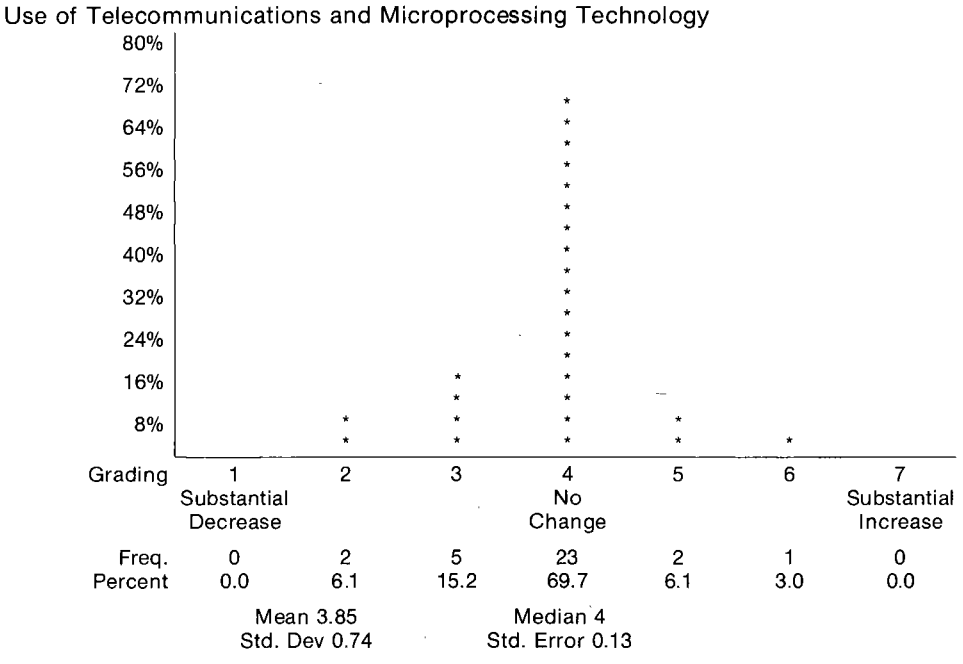


Figure 3.28—Changes in demand due to increased use of computer technology

The intent of this question was to elicit views on the relative effects that nominated measures would have on the demand for public transport. For simplicity, measures were considered to be independent of each other, although it is acknowledged that combinations of measures may in fact complement one another.

The results were not particularly conclusive, with the following measures all being considered to have the potential to have some positive effect on the demand for public transport:

- improvement to delivery systems (see Figure 3.23);
- land use and planning policies (see Figure 3.25);
- restrictions on use of private vehicles (see Figure 3.26); and
- fuel rationing and pricing policies (see Figure 3.27).

In no case, however, was there a clear view that any of the measures, on their own, would have any significant impact on demand. A possible reason for this could be that participants believed that single measures would be inappropriate and that positive results could only be expected from combinations of policies.

Results for measure (b) (lower or zero pricing) indicate that reducing, or even removing, fares would have little effect on demand, suggesting that consumers have very low price elasticities, even when the price of transport is falling.

It was also suggested that if telecommunication and microprocessing technology were to be much more widely adopted this could result in reduced demand for public transport. Such technology would include home offices, videophones, computer links, word processors, etc. It was postulated during the survey that such a reduction in demand for public transport (with no commensurate fall in work output) may in fact be a very beneficial by-product, as it would lessen demand for peak hour travel.

PART D—TRANSPORT SUPPLY THEME

Question 10 : Prospects for technology

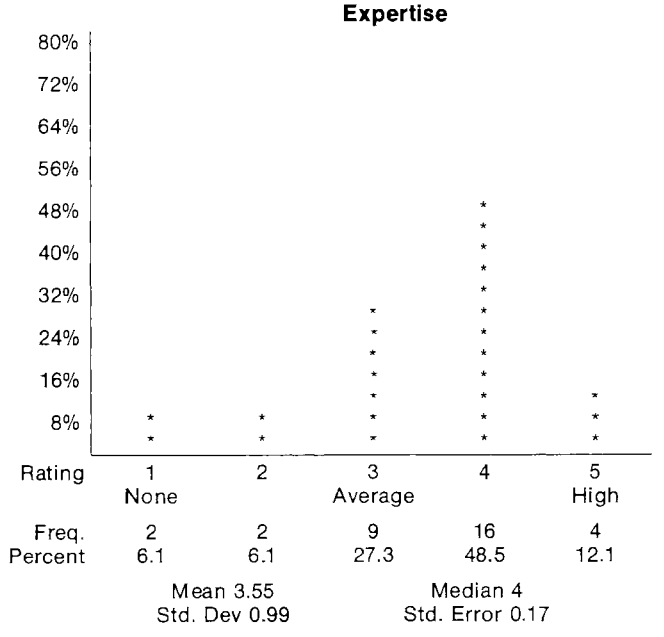


Figure 3.29—Expertise of participants

Question 10 Prospects for Technology

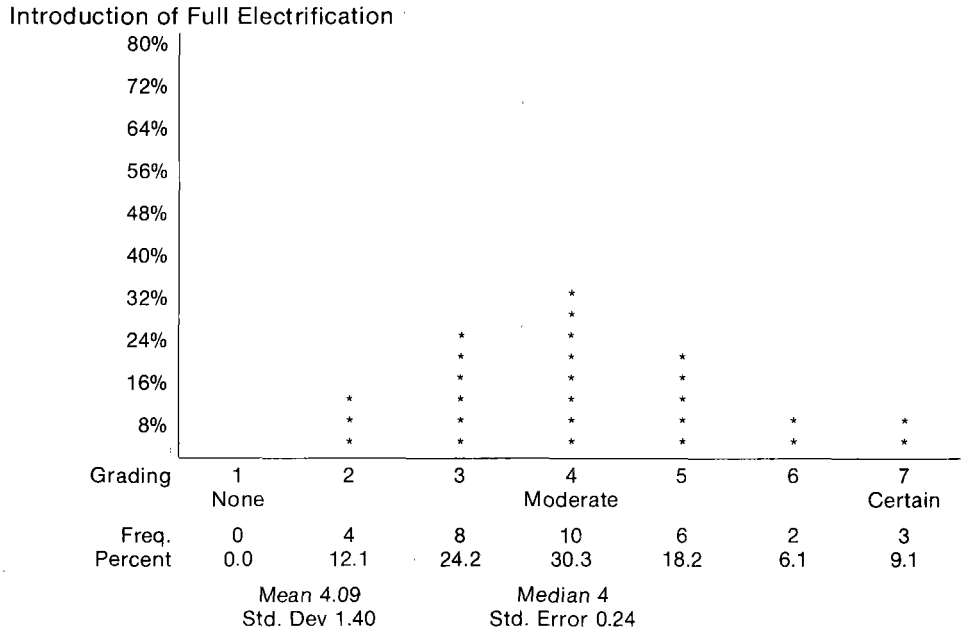


Figure 3.30—Likelihood of accelerated introduction of fully electrified suburban rail systems

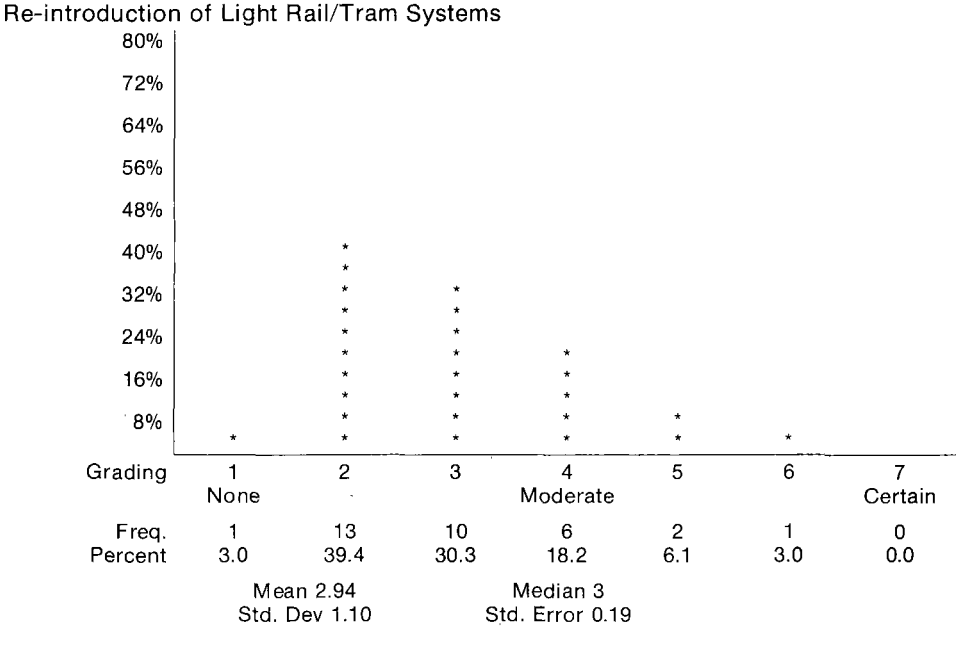


Figure 3.31—Likelihood of re-introduction of further expansion of light rail/tram systems

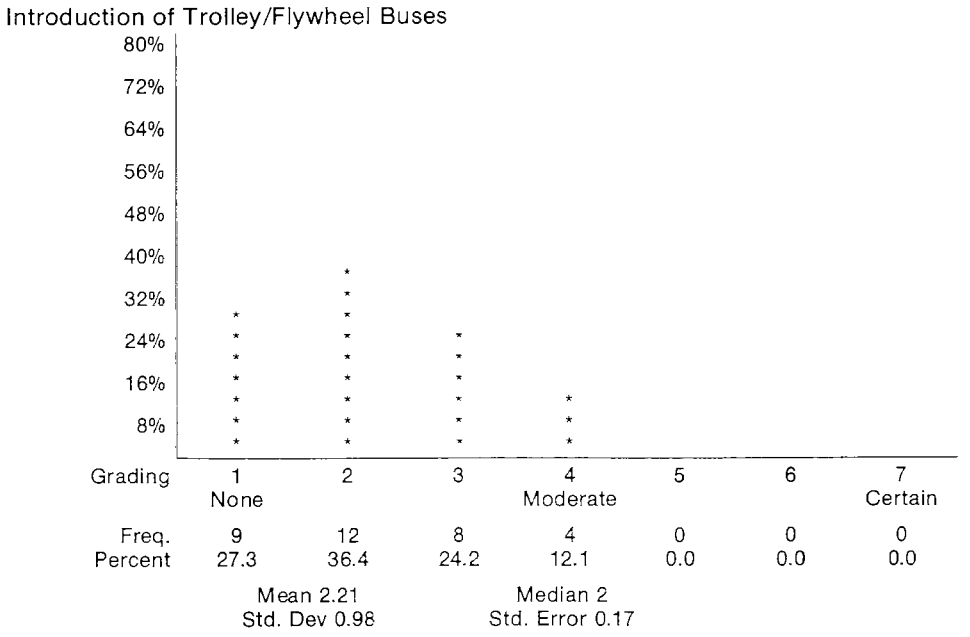


Figure 3.32—Likelihood of introduction of trolley/flywheel energy storage buses

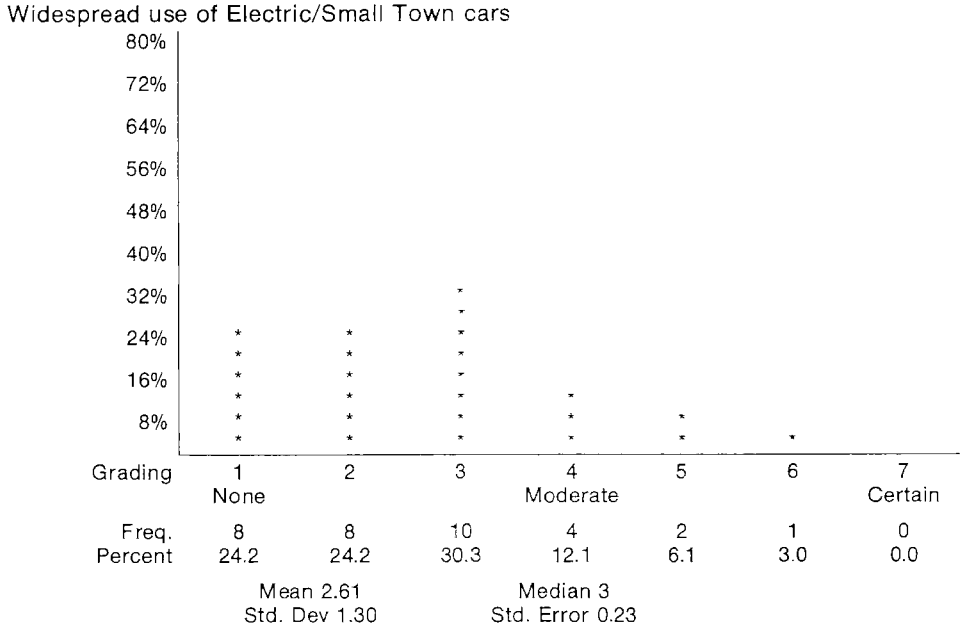


Figure 3.33—Likelihood of widespread use of electric or other town cars

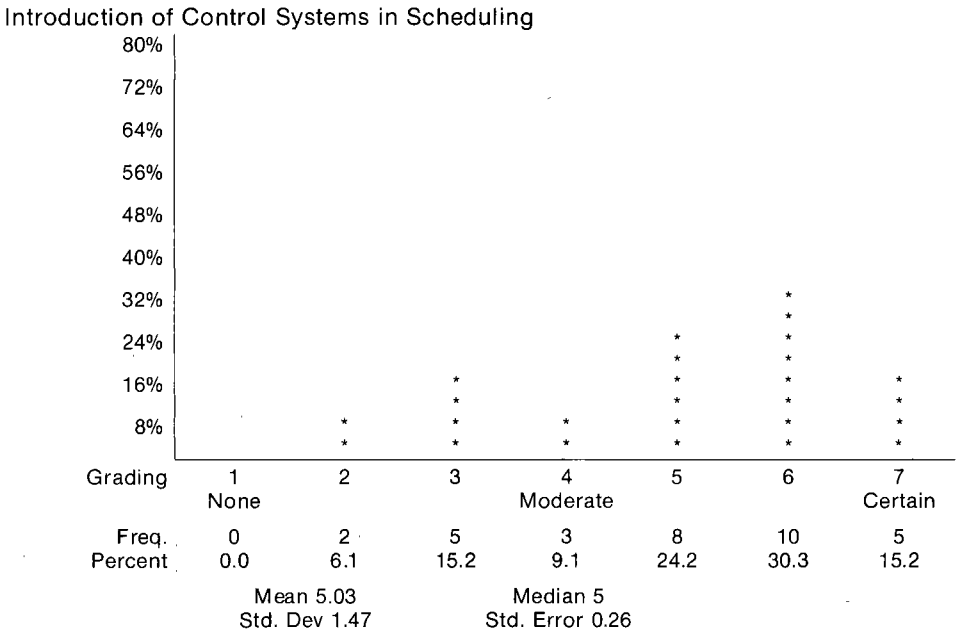


Figure 3.34—Likelihood of introduction of computer assisted control systems for mass public transport

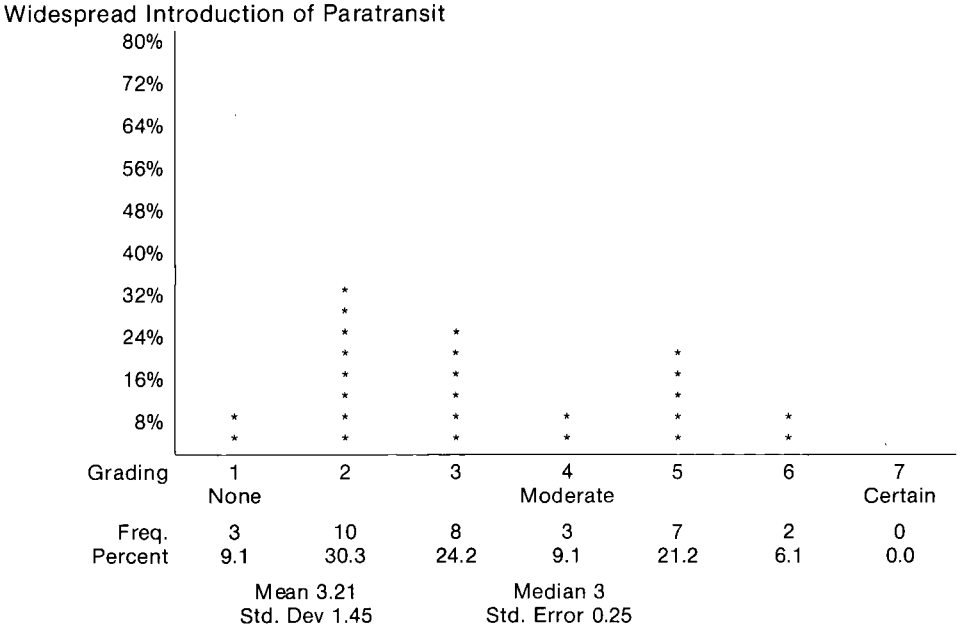


Figure 3.35—Likelihood of widespread introduction of paratransit

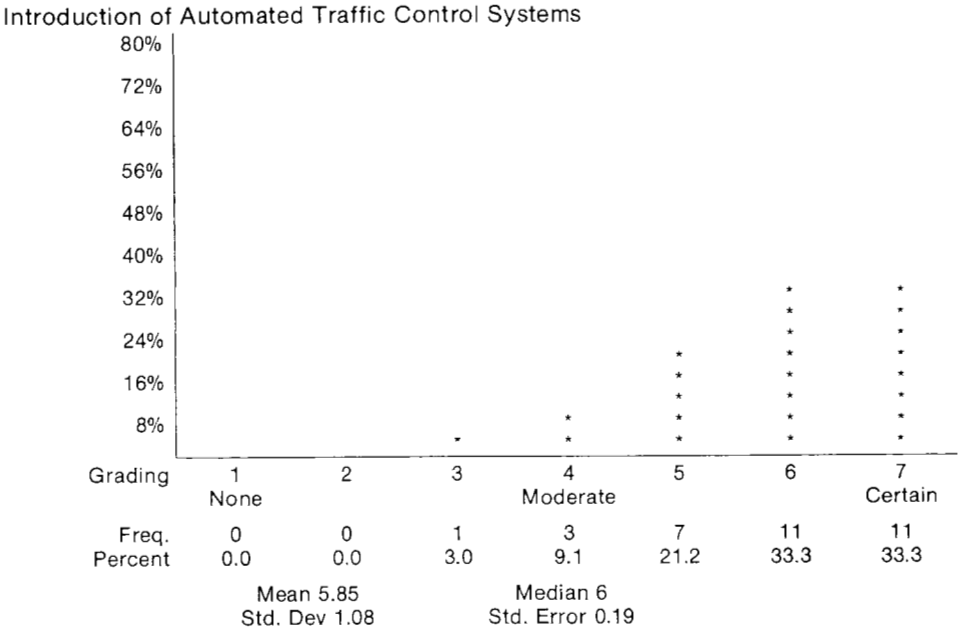


Figure 3.36—Likelihood of accelerated introduction of automated traffic control systems

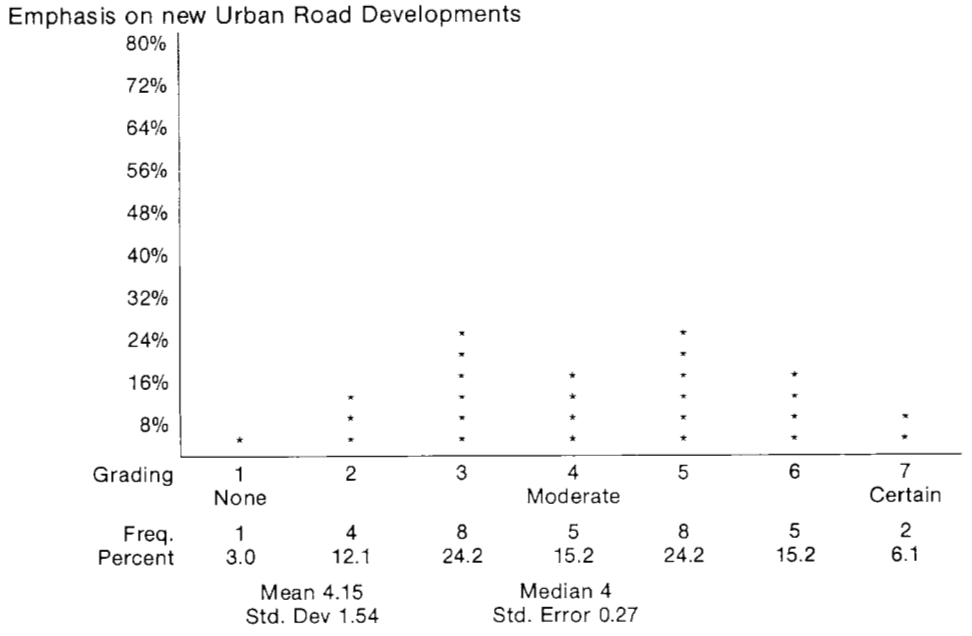


Figure 3.37—Likelihood of re-emergence of emphasis on new urban road systems

Taking Round 4 averages as guides to the likelihood of any of these measures being adopted gives the results as shown in Table 3.2. In the table an average or mode of 1 indicates a highly unlikely event, while 7 would indicate an almost certain event.

TABLE 3.2—LIKELIHOOD OF TECHNOLOGICAL MEASURES BEING ADOPTED OR INTRODUCED

(in order of likelihood)

Measure	*Average*[a]	*Mode*[a]
1. Automated traffic control systems	5.85	6,7
2. Control systems in scheduling	5.03	6
3. New urban road developments	4.55	3,5
4. Full electrification of railways	4.09	4
5. Introduction of paratransit	3.21	2
6. Light rail/tram systems	2.94	2
7. Electric/small town cars	2.61	3
8. Trolley/flywheel buses	2.21	2

a. Averages and modes are from Figures 3.30 to 3.37

The group considered that future technological developments will be aimed at improving the use of existing transport systems, rather than the development of radically new technologies. The three most likely innovations will be to improve the scheduling and reliability of buses and trains, to reduce road congestion, and increase the capacity of the road network.

The relatively high score given to new urban road developments shows a pragmatic view of how future transport needs will be met. Contrary to the trend in recent years when many major urban road projects were shelved, the survey participants accorded them quite a good chance of being adopted.

The distribution of responses—with a peak at each of '3' and '5' (see Table 3.2)—indicates some clustering of views around two likely scenarios, one on the low side, the other on the high side of a 'moderate' expectation of renewed emphasis on new urban road development. The extent to which this divergence can be accounted for by the expression of personal preferences (what the respondents would like it to be, rather than what it will be) is open to speculation.

The relatively low expectations for paratransit may be of some concern to those who see this as a feasible alternative to traditional modes for urban travel (BTE 1980). However, it should once again be noted that there was still some moderate support among participants with more than 25 per cent allocating a 'better than moderate' chance (see also Question 15).

The lack of support for electric and small town cars seems to be a contradiction to the research efforts currently being directed to the development of a viable town car, or more likely, a pessimistic view of its success (BTE 1974, 1975, 1977(a), 1977(b), 1978, Gannon 1980).

In general, the survey has indicated a greater likelihood of operational improvements (control systems, scheduling etc) being introduced rather than large infrastructure developments (light rail systems) or new technology (electric cars, flywheel buses). Full electrification of existing urban rail systems is rated a 'slightly better than even' chance of eventuating, as is a renewed emphasis on major urban road development.

PART E—PUBLIC TRANSPORT DEFICITS THEME

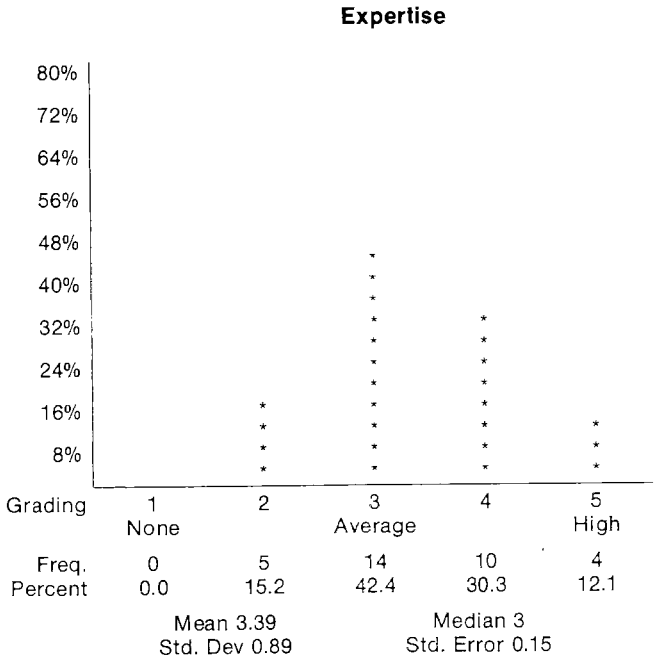
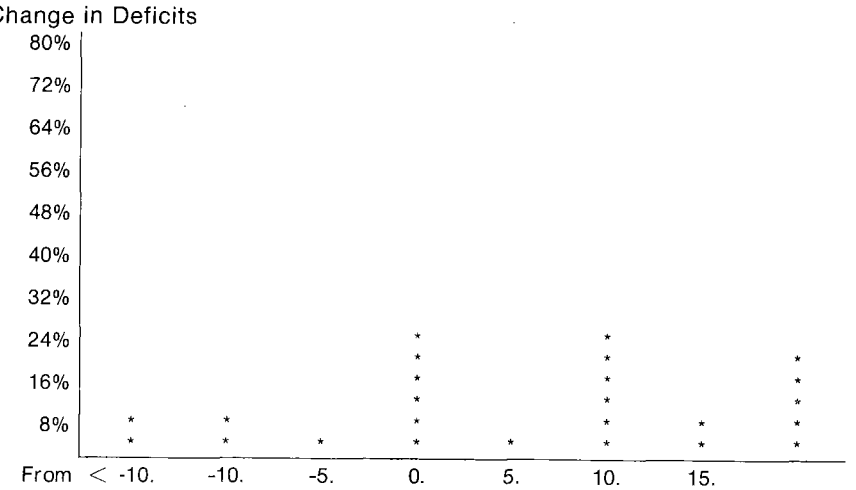


Figure 3.38—Expertise of participants

Question 11 Prospects for Deficits



Range -40.00 to 50.00

Mean 5.30 Median 10.00
Std Dev 16.52 Std. Error 2.88

% Change	Frequency	% Change	Frequency
-40.00	1	-30.00	1
-20.00	1	-10.00	2
-7.00	1	-5.00	1
0.00	8	5.00	1
10.00	8	15.00	2
20.00	4	22.00	1
30.00	1	50.00	1

Figure 3.39—Expected changes in urban public transport deficits

The wide range of views is clearly seen from Figure 3.39. Estimates for changes in the deficits in the next five years ranged from a reduction of 40 per cent to an increase of 70 per cent. These extremes clearly represent quite different expectations. The statistics provided with the graph provide little assistance in understanding the results, particularly where the magnitudes of changes are concerned.

If the results of the final round are grouped to indicate the direction of change the break-up of views is:

- deficits to fall 21 per cent;
- deficits to remain steady 24 per cent; and
- deficits to rise 55 per cent

The majority of respondents considered that deficits would increase in the next five years. However there was still a substantial body of opinion to the effect that deficits will fall,or at least be no higher than they are now. However the average expected change in deficits in the next five years was that they would increase by 5.30 per cent. The standard error of this estimate is 2.88, so that there is seen to be a greater than 90 per cent chance that deficits will be greater in five years time than they are now.

Question 12 Explicit Public Service Obligations

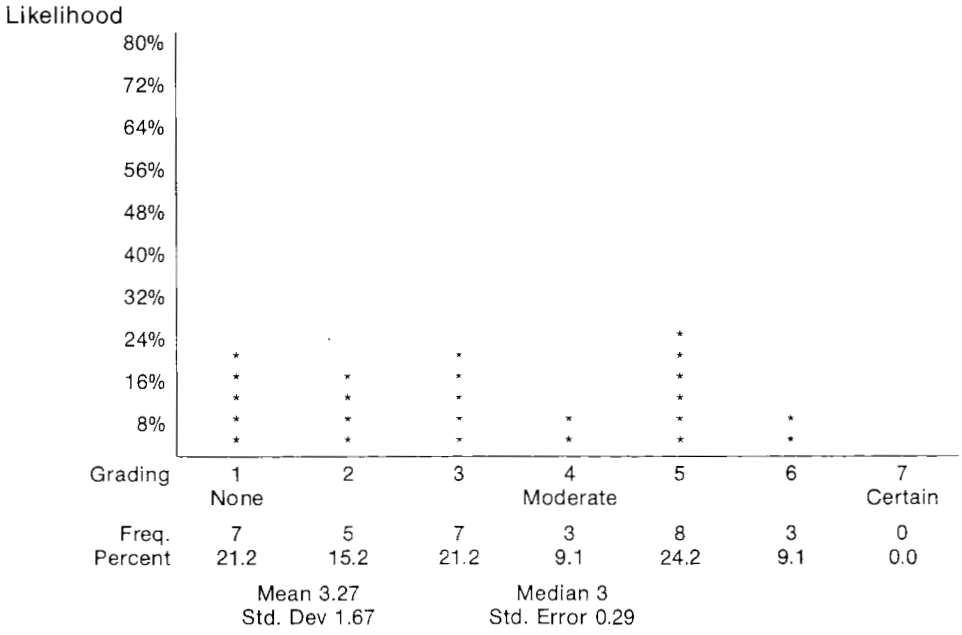


Figure 3.40—Likelihood of acceptance of public transport's public service obligations

This question was based on the thesis that public transport deficits may exist because operators are 'required' to provide uneconomic and subsidised services for social welfare, political and other reasons. If these explicit public (or in more recent jargon, 'community') service obligations were to be recognised by Governments and a specific budget subsidy provided, then this would remove (or at least reduce) the deficits which are attributed to operators.

There was no consensus in views on the likelihood of such recognition. There was a very even spread of opinion (shown in Figure 3.40) where most alternatives were evenly supported. Nearly 60 per cent of the participants thought that there was a 'less than moderate' chance of these obligations being explicitly recognised in terms of the political constraints and directives under which systems operate.

PART F—TRANSPORT ORGANISATION THEME

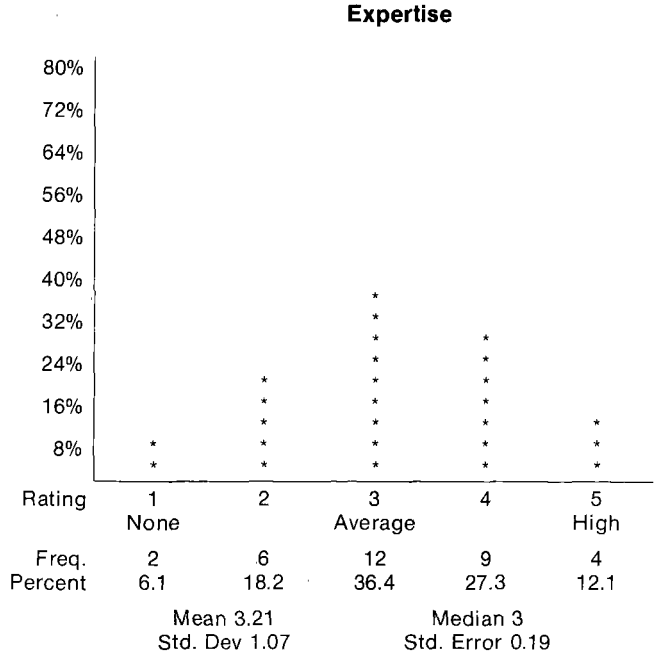


Figure 3.41—Expertise of participants

Question 13 Public vs Private Ownership of Urban Buses

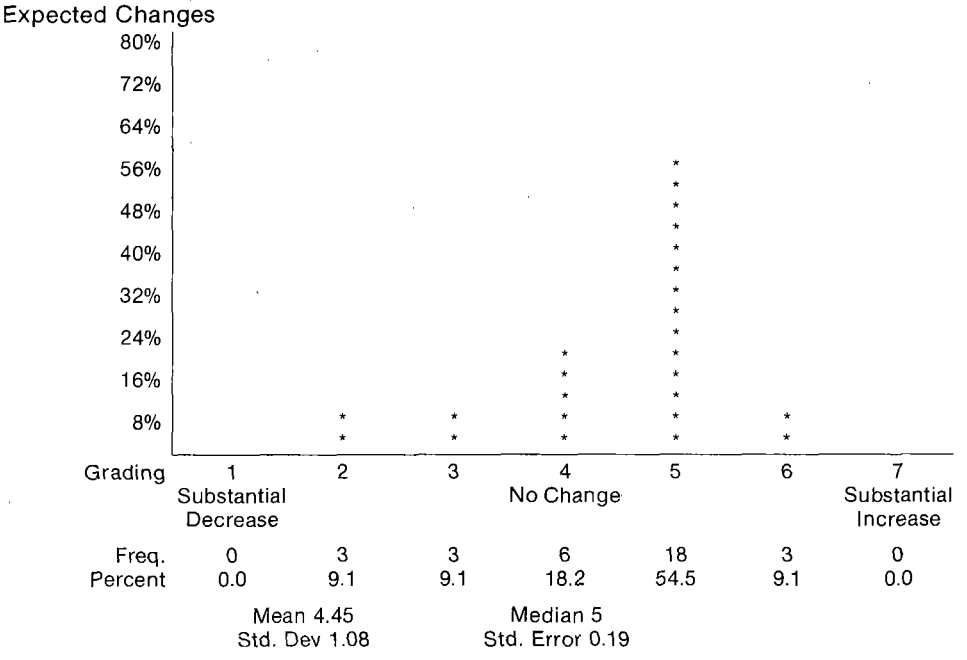


Figure 3.42—Proportion of urban bus services provided by private bus operators

The general view was that private bus companies would take on a slightly increased role in the provision of services in urban areas. This view contradicts past trends, which are that the number of private operators has been declining. The underlying reason for this optimistic view of the future role of private bus operators could lie in the fact that most population growth is occurring in smaller towns and in outer suburbs of capital cities. These are areas traditionally serviced by the private operators.

It is noteworthy that since the workshop and the survey, the NSW Minister for Transport, Mr Cox, has made statements which seem to support this finding, in NSW at least. Speaking at a hand-over ceremony for joint lease plan buses to private operators in Parramatta and Wollongong he foreshadowed that up to 2000 new private buses could go into service in the next decade[1].

Question 14 Institutional Structure and Trends

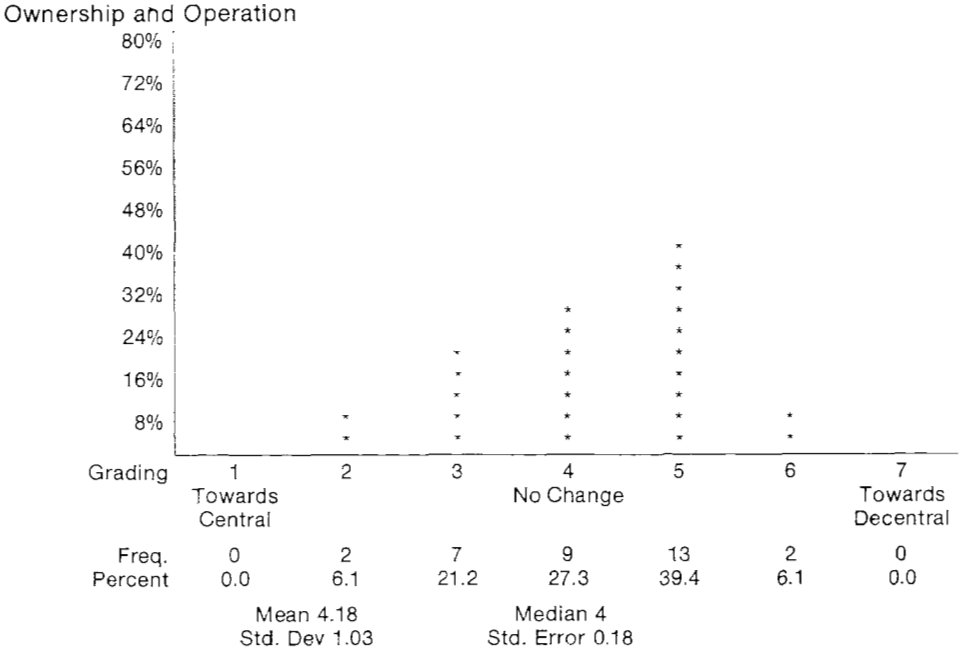


Figure 3.43—Trends in the ownership and operation of urban public transport

1. Speech given by NSW Minister for Transport, 22 February 1982.

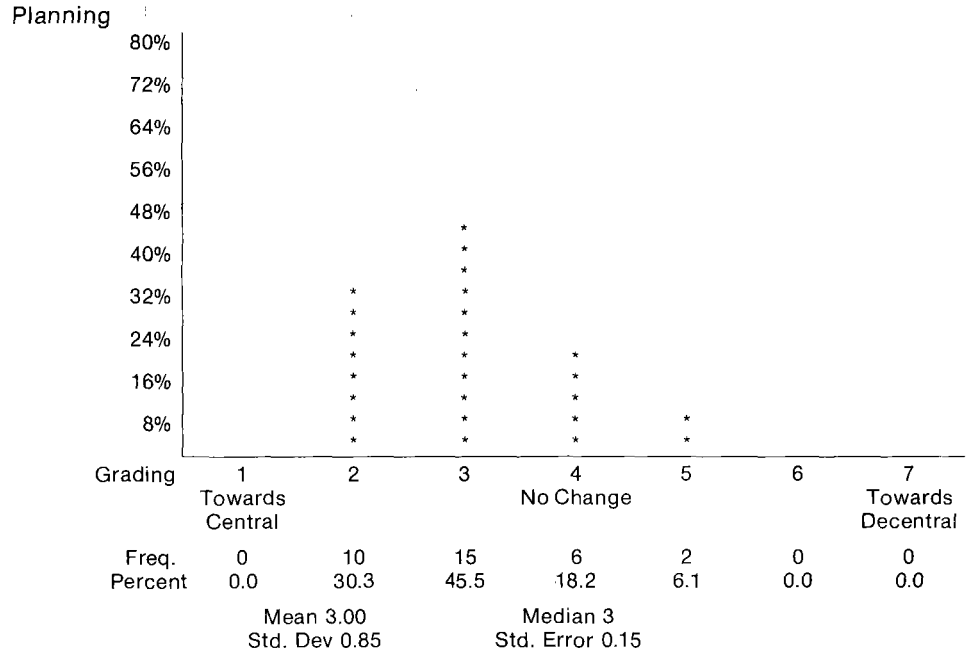


Figure 3.44—Trends in the planning of urban public transport

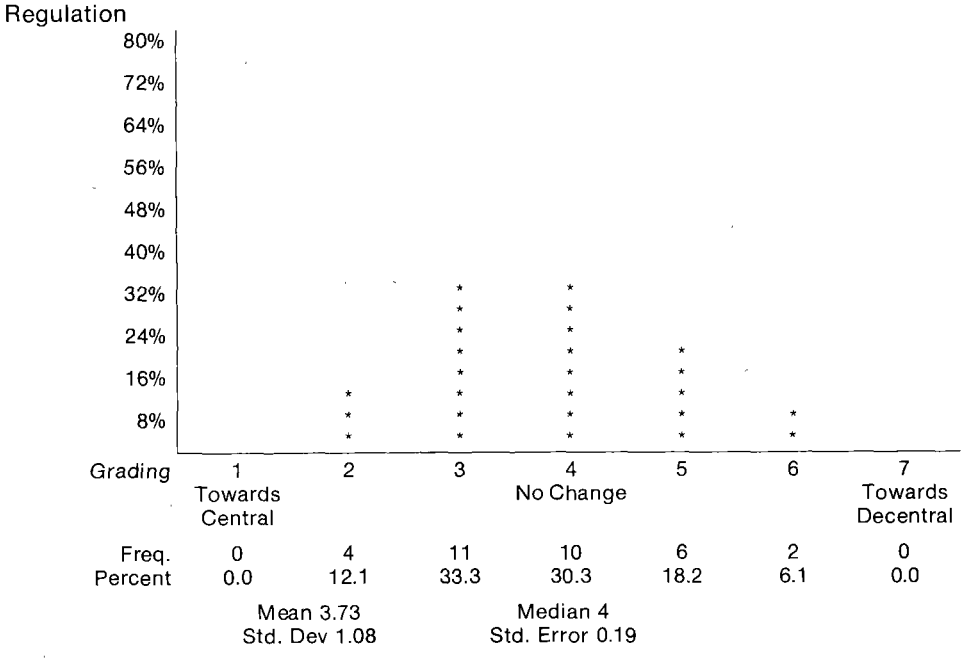


Figure 3.45—Trends in the regulation of urban public transport

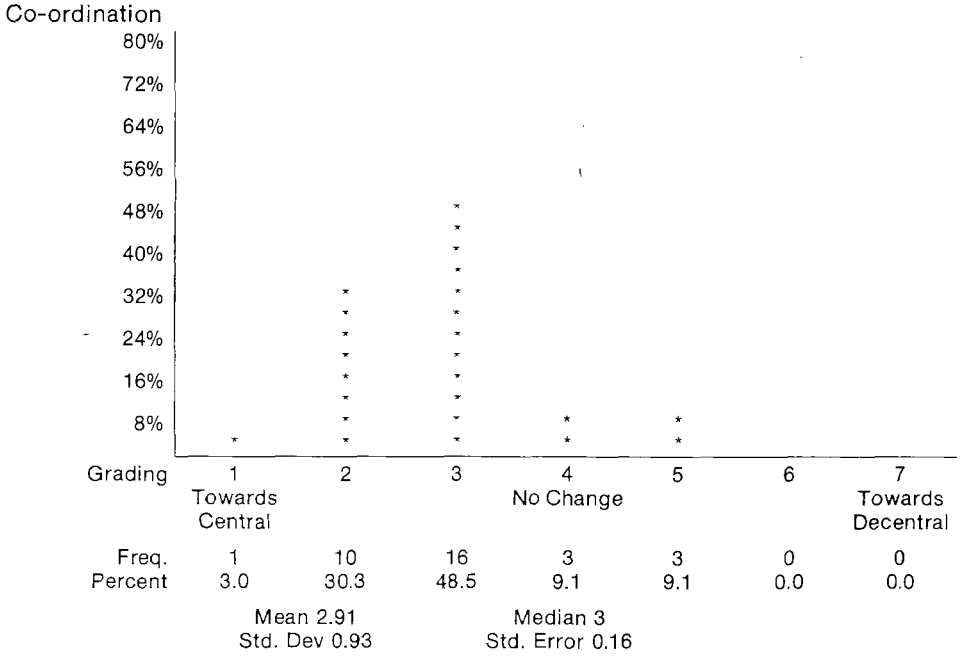


Figure 3.46—Trends in the co-ordination of urban public transport

In the institutional structure of public transport, the historical movement seems to have been towards a smaller number of more centralised organisations with wider responsibilities. This centralisation is presumably intended to achieve greater efficiency.

On the other hand there have been some moves to divide public transport bodies into smaller units. The separation of the Sydney Urban Transit Authority and State Rail Authority from the Public Transport Commission of NSW is one example of this.

Respondents to the survey saw the ownership and operation aspects to be moving towards greater decentralisation. This probably complements the participants' views in Question 13 that private bus companies would be providing a slightly greater proportion of bus services. This 'commercial' side of the operation is seen to be more appropriate to smaller, more decentralised. and perhaps more autonomous bodies.

The planning, regulation and co-ordination function are expected to move further into centralised bodies within the overall structure of government.

It is noteworthy that policy statements by the incoming administration in Victoria supports this conclusion for Melbourne, where a Metropolitan Transit Authority will be established to draw together Melbourne's trains, trams and buses into a single co-ordinated system[1].

1. Policy statement by Victorian Labour leader Mr J. Cain reported in the Melbourne Age of Thursday 18 March 1982.

Question 15 Future of Paratransit

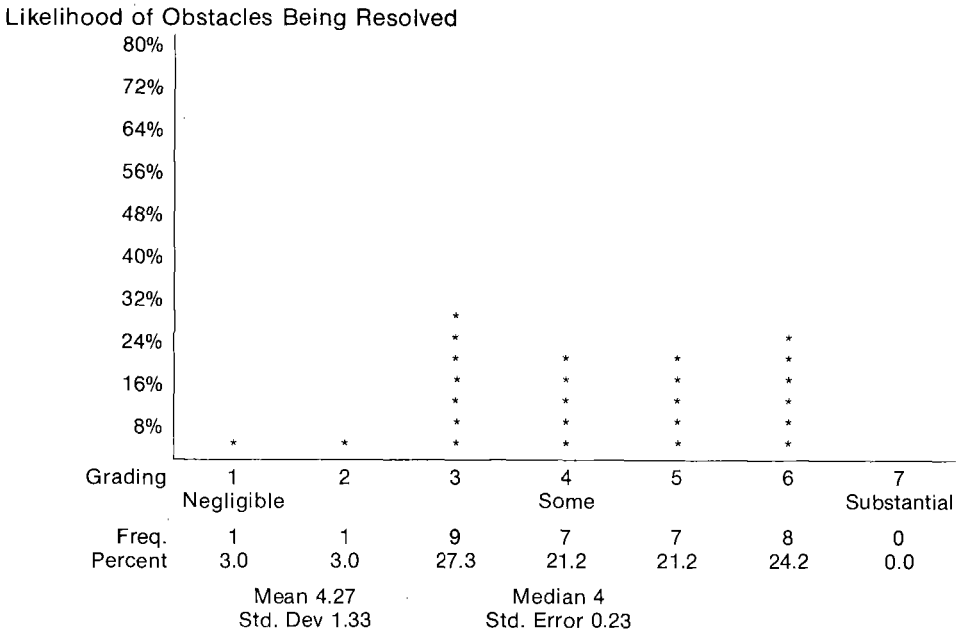


Figure 3.47—Likelihood of obstacles to paratransit being resolved

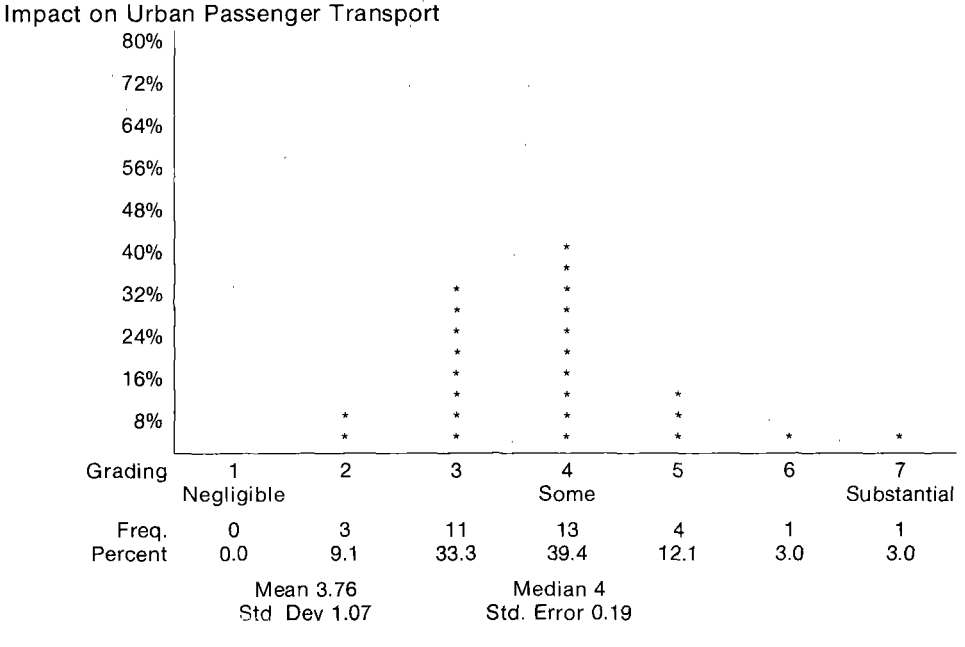


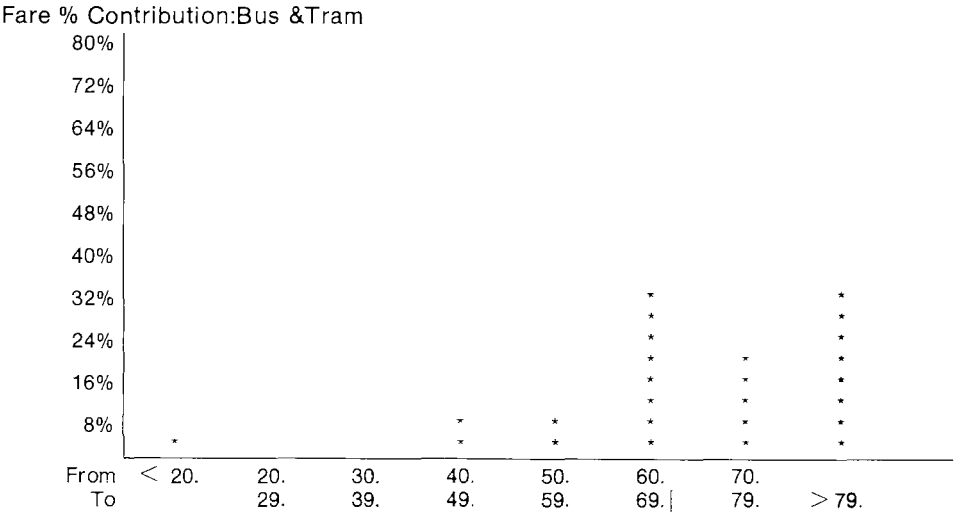
Figure 3.48—Likely impact of paratransit on urban passenger transport

In the earlier Question 10 (see Figure 3.35), participants expressed a slightly pessimistic view of the likelihood of widespread introduction of paratransit. As a follow up, this question addressed the likelihood of the removal of obstacles (largely institutional and commercial) which prevent the widespread introduction of paratransit services. Participants were also asked to assess the impact of paratransit on urban passenger transport if these obstacles were removed.

Overall, the views were negative. The survey indicated little likelihood of these obstacles being removed. However, as in the earlier question there was still a wide spread of views, with a large minority (25 per cent) believing that the likelihood was greater than this average would indicate.

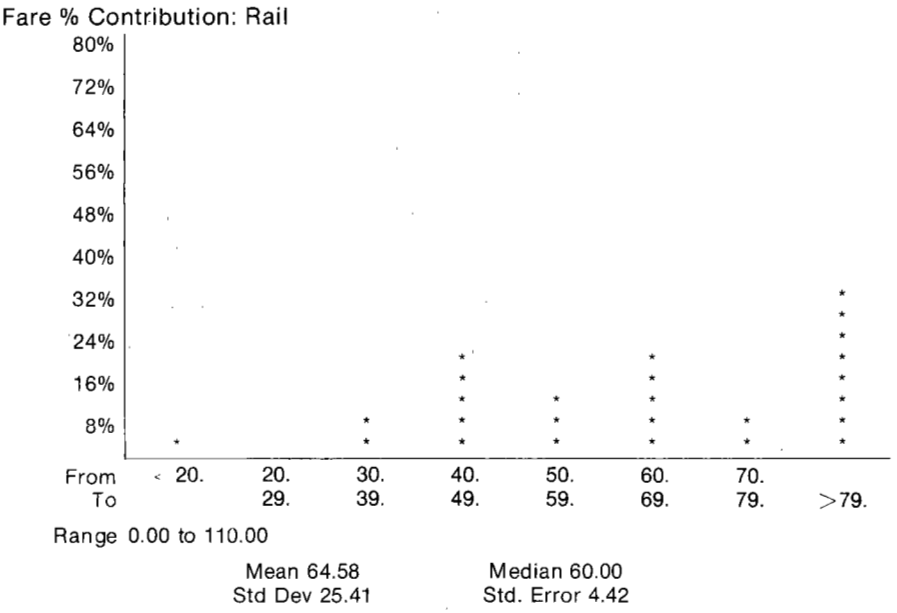
In the second part of the question, the survey predicted that even if the obstacles were to be removed, paratransit's impact on urban passenger transport would only be moderate—although no respondent thought that it would be negligible.

Question 16 Optimal level of Subsidy



Fare % C	Frequency	Fare % C	Frequency
0.00	1	40.00	1
45.00	2	50.00	1
55.00	2	60.00	10
70.00	4	75.00	2
80.00	2	100.00	7
110.00	1		

Figure 3.49—Percentage fare contribution to total cost—buses and trams



Fare %	Frequency	Fare %	Frequency
0.00	1	30.00	1
33.00	1	40.00	5
45.00	1	50.00	3
55.00	1	60.00	4
65.00	1	68.00	1
70.00	2	75.00	1
80.00	4	100.00	6
110.00	1		

Figure 3.50—Percentage fare contribution to total cost—rail

This was a supplementary question added after participants had completed Round 1 of the Delphi survey, and sought participants *prescriptive* views on what the optimal fare-box contribution to total cost *should* be. The question was asked for bus and tram, and for rail.

Background information provided to participants indicated that in recent years average fare-box contributions to costs for both bus and rail were well below 50 per cent.

The general conclusion was that fares should make a much greater contribution to operating costs than they do at present. In Round 4 the average figure for buses and trams was 69.4 per cent and for rail 64.6 per cent. The reasons for the differences between the modes were not sought.

The two questions attracted a wide range of responses, with one respondent suggesting that no fares should be charged and another suggesting that fares should make a 110 per cent contribution to costs (ie make a profit).

The results also show some support for very low contribution levels (say, below 40 per cent), the figures being 6 per cent and 24 per cent for bus and rail respectively. The remainder of the participants aligned themselves into two broad groups, one favouring

a 40-60 per cent contribution and the other a 70+ per cent contribution. Table 3.3 below shows the actual distribution.

TABLE 3.3—DISTRIBUTION OF PARTICIPANTS SUPPORTING ALTERNATIVE CONTRIBUTION LEVELS

Range of fare contributions	*Bus and tram*		*Rail*	
	Number	*Per cent*	*Number*	*Per cent*
0-40 per cent	2	6.0	8	24.2
41-60 per cent	15	45.5	9	27.3
71-100 + per cent	16	48.5	16	48.5

However, the bottom line is that the average group view was that the fare-box should contribute *69.4 per cent ± 8.1 per cent* to bus/tram and *64.6 per cent ± 9 per cent* to rail operating costs (at the 95 per cent confidence level).

CHAPTER 4—EFFECT OF THE EXPERTISE RATINGS ON FINAL RESULTS

BACKGROUND

Earlier studies on the Delphi technique (eg Brown and Helmer 1964) postulated and tested the theory that the more expert a person was on a particular subject, the more likely he was to produce an accurate estimate or forecast.

The purpose of the Brown and Helmer experiment was:

- to test whether answers given by the respondents moved towards consensus after the four rounds;
- whether this consensus moved closer to the correct answer;
- to test whether the 'experts' gave consistently better answers than the 'non-experts'.

The first two points are reported in more detail in Chapter 5.

In the Brown and Helmer study, each respondent was asked to rate his own expertise for each question. The results of the 'elite' group (ie the one-third of respondents who ranked themselves as having the highest expertise) were then compared with the group as a whole and with the best individual participant. In both test cases Brown and Helmer concluded that the experts did better than those who claimed no expertise.

The work carried out by Brown and Helmer centred around a questionnaire of 20 questions presented to 23 respondents drawn from the RAND Corporation's research staff.

The questions did not seek views on the likelihood of future occurrences, but asked questions on a variety of topics for which there were specific correct answers—although these were not always readily discernible by the respondents. For example, one question asked was:

> How many seconds after launch does a Minuteman (the model now in military use) reach an altitude of 100 000 feet?

In their summary, Brown and Helmer concluded:

> the use of self-appraisal competence ratings in forming a consensus appeared to be a powerful tool for increasing the reliability of the group estimates.

THE BTE EXPERIMENT

Taking the Brown and Helmer findings as a guide, the BTE's survey included a self rating mechanism where participants were asked to provide an absolute rating of their expertise. In addition, participants were given the opportunity at each round to re-assess their own rating, so that by Round 4 participants had had several opportunities to reconsider their own level of expertise.

To indicate their expertise participants were asked to score themselves from 1 (no expertise) to 5 (high expertise) for each of the six themes in the survey.

In introductory remarks prior to Round 2, participants were advised that their ratings would be used at a later date to produce weighted results for the survey. They were not told that their ratings would also be used to produce results for an 'elite' group. The elite group being defined as those who rated their expertise in the last Round as either 4 or 5, that is, the two highest levels of expertise.

MOVEMENTS IN EXPERTISE RATINGS BETWEEN ROUNDS

Table 4.1 gives a summary of the movement in the mean claimed expertise for each theme for each round of the survey.

TABLE 4.1—MOVEMENTS IN AVERAGE EXPERTISE RATINGS FOR EACH THEME

(in order of magnitude of changes)

Theme	*Round*				*Percentage change*
	1	*2*	*3*	*4*	*Rounds 1-4*
Air pollution	2.87	2.82	2.76	2.70	-5.9
Public tranport deficits	3.29	3.30	3.36	3.39	+3.0
Transport organisations	3.29	3.27	3.24	3.21	-2.4
Transport supply	3.48	3.45	3.52	3.55	+2.1
Energy	3.29	3.30	3.24	3.27	-0.6
Travel demand	3.71	3.73	3.70	3.73	+0.6

For all but one of the themes the group regarded itself as having above average expertise (where average equals 3.0). This was comforting to the workshop organisers as participants were specifically chosen for their expertise and involvement in urban public transport.

Table 4.1 also shows that the overall levels of expertise changed only slightly between the first and the last round. To ensure that movements were not masked through complementary movements (that is one up and one down), Table 4.2 was compiled to show the total number and frequency of movements amongst the participants. A 'movement' is here defined as a change in rating in any round in any theme. Hence, a respondent who over the four rounds changed his expertise rating only once for each of the six themes would be recorded as showing a movement of 6 over the survey.

TABLE 4.2—NUMBER AND FREQUENCY OF MOVEMENTS IN EXPERTISE RATINGS

Total No of individual movements	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
No of participants	11	7	9	1	0	3	1	0	1
Percentage of participants	33.3	21.2	27.3	3.0	0	9.1	3.0	0	3.0

The major features of Table 4.2 are:

- one person changed his expertise ratings eight times during the course of the survey (out of a possible maximum of eighteen), while eleven made no changes at all;
- the distribution is heavily skewed towards the low end of the scale (the mean is only 1.7 movements), indicating quite clearly that once most participants had decided on an expertise level they saw little necessity to change.

One conclusion that can be drawn from this is that there appears to be little value in giving participants an opportunity to revise their expertise ratings.

WEIGHTING OF ROUND 4 RESULTS BY EXPERTISE

This part of the experiment was based on the view that experts may provide 'better' results than non-experts (Brown and Helmer 1964), and therefore their views should be accorded greater weight in the analysis of results.

Because of the speculative nature of this particular survey there has been no opportunity to test whether the experts' views are in fact any 'better' than those of a random group of people. That particular judgement will have to be left to future researchers who may be able to judge the results of this survey with some measure of hindsight.

However, it is possible to examine the impact that such a weighting would have on the results, and to comment on the direction and magnitude of differences in views held. Results of the final Round of the survey were weighted by each participant's expertise rating for that theme. For example, if a participant ranked himself as five for (say), the Energy Theme, then his answers to all questions in that theme would be weighted by a factor of five. A participant who rated his expertise as one would be rated as one. (To avoid biasing any test statistics these weights were established as being relative rather than absolute, so that the sum of weighted responses equalled the original number of responses).

There are few differences between the original and the weighted results. In particular the differences in the means of answers to individual questions (as a simple measure of the overall view of the participants) are small (see Table 4.3). The largest movement in the mean (in a standard seven choice question) was in the responses to Question 15(a) (Likelihood of obstacles to paratransit being resolved), where the mean moved from 4.27 (unweighted) to 4.49 (weighted), a difference of 0.22. In effect this means that opinion shifted less than one-quarter of the distance along one of the equal intervals shown in Figure 3.47, a change of about 4 per cent overall. The changes in the responses to the other questions were much smaller than this (see Table 4.3).

These changes in responses are much smaller than those tested in the next part of this chapter (Analysis of Experts' Views). The tests there showed that even with the larger differences they were not statistically significant.

The weighting of results in this survey therefore, did not change the results of the survey. This is perhaps a rather surprising result given the relatively heavy weighting given to those who claimed to be experts.

ANALYSIS OF EXPERTS' VIEWS

The work of Brown and Helmer (1964) also indicated that experts could be regarded as an 'elite group'. In that particular study the 'elite group' was found to have greater reliability in their answers than a more widely selected group. The Brown and Helmer study differed from the BTE survey in that it dealt with a group of questions for which there were specific answers. This allowed the correctness of responses to be determined.

By contrast, the BTE's study sought views on issues for which there are currently no known 'correct' answers. Therefore the Brown and Helmer results are not necessarily transferable, and it may well be that an 'expert's' view of the future is no more reliable than a non-expert's. This may be particularly so in instances (such as this survey) where the participants are chosen for their expertise in a field and where the relative differences between the 'experts' and the 'non-experts' may be slight. It would only be possible to test the validity of the premise if a series of studies were carried out over time to test the relative accuracy of the expert and non-expert groups. This was clearly outside the scope of this study.

It is possible, however, to test the methodological importance of the premise by separating the responses of the two groups and testing them for significant differences.

TABLE 4.3—COMPARISON OF WEIGHTED AND UNWEIGHTED RESULTS FOR ROUND 4

Question	*Mean*		*Median*		*Mode*	
	U[a]	*W*[b]	*U*	*W*	*U*	*W*
Q1 Effect of fuel price on demand	3.39	3.30	3	3	3	3
(a) Commuting	3.61	3.56	4	4	4	4
(b) Non-commuting private travel	2.00	1.95	2	2	2	2
(c) Business travel						
Q2 Public transport in energy management						
(a) Alternative to private car role, 1981	2.82	2.79	3	3	3	3
(b) Alternative to private car role, 1990	3.15	3.09	3	3	3	3
(c) Fall back system role, 1981	3.30	3.25	3	3	3	3
(d) Fall back system role, 1990	3.63	3.59	4	4	4	4
Q3 Future petrol prices: basis for planning						
(a) Price in 1990	52.24	51.94	50	50	50	50
(b) Price in 2000	66.82	66.75	65	65	65	65
Q4 Severity of pollution problems						
(a) Severity in 1981	4.09	4.01	4	4	4	4
(b) Severity in 1990	4.06	3.83	4	4	3	3
Q5 Efficacy of solutions to reduce air pollution	*not applicable*					
Q6 Engine design: pollution vs economy						
(a) Level of effort	3.42	3.28	3	3	3	3
Q7 Public transport patronage prospects						
(a) Rail	1.55	1.11	0	0	0	0
(b) Bus and tram	7.88	7.68	10	10	0	0
Q8 CBD dependence on public transport						
(a) Role of urban public transport in maintaining CBDs	5.76	5.73	6	6	6	6
(b) Importance of maintaining low fares policy	2.58	2.50	2	2	2	2
(c) Importance of maintaining CBDs	5.03	5.01	5	5	5	5
Q9 Demand stimulation						
(a) Improvements to delivery systems	5.30	5.32	5	5	5	5
(b) Lower or zero pricing	4.67	4.67	5	5	5	5
(c) Concentrate demand by land use and planning policies	5.06	5.05	5	5	5	5
(d) Regulatory restrictions on use of private vehicles	5.30	5.28	5	5	5	5
(e) Pricing restrictions on use of private vehicles	5.09	5.08	5	5	5	5
(f) Use of telecommunications and micro-processor technology	3.85	3.89	4	4	4	4
Q10 Prospects for technology						
(a) Acceleration of full electrification of suburban rail	4.09	4.05	4	4	4	4
(b) Re-introduction of further expansion of light rail/tram systems	2.94	3.00	3	3	2	2
(c) Introduction of trolley/flywheel storage buses	2.21	2.24	2	2	2	2
(d) Widespread use of electric and other town cars	2.61	2.62	3	3	3	3
(e) Introduction of computer assisted control systems to assist in scheduling	5.03	5.18	5	5	6	6
(f) Widespread introduction of paratransit	3.21	3.32	6	6	6	6
(g) Accelerated introduction of automated traffic control systems	5.85	5.99	6	6	6,7	6,7
(h) Re-emergence of emphasis on new urban road developments	4.15	4.08	4	4	3,4	3
Q11 Prospects for deficits						
(a) Changes in deficits	5.30	6.21	10	10	10	10
Q12 Explicit public service obligations						
(a) Likelihood of acceptance	3.27	3.23	3	3	5	5
Q13 Public vs private ownership of urban buses						
(a) Expected change in ownership	4.45	4.50	5	5	5	5
Q14 Institutional structure and trends						
(a) Changes in ownership and operation	4.18	4.11	4	4	5	5
(b) Changes in planning	3.00	2.95	3	3	3	3
(c) Changes in regulation	3.73	3.75	4	4	3	3
(d) Changes in co-ordination	2.91	2.83	3	3	3	3
Q15 Future of paratransit						
(a) Likelihood of obstacles being resolved	4.27	4.49	4	5	3	6
(b) Impact on urban passenger transport	3.76	3.75	4	4	4	4
Q16 Optimal level of subsidy						
(a) Bus and tram	63.39	70.42	60	60	60	60
(b) Rail	64.58	65.11	60	60	100	100

a. U = unweighted results.
b. W = weighted results.

Definition of expert

For the purpose of this survey the 'experts' in each theme were defined as those who claimed an expertise rating of 4 or 5; in other words those who claimed 'above average' expertise. The number (and composition) varied among themes (see Table 4.4).

TABLE 4.4—NUMBER OF EXPERTS IN EACH SURVEY THEME

Theme	*Experts*	*Non-experts*	*Percentage experts*
Energy	14	19	42.4
Air pollution	5	28	15.2
Travel demand	23	10	69.7
Transport supply	20	13	60.6
Public transport deficits	14	19	42.4
Transport organisations	13	20	39.4

Overall level of expertise

The workshop participants were chosen for their expertise and involvement in urban public transport. The overall level of individual expertise would be expected to be relatively high. If a person had high expertise in each theme, then he could achieve a maximum rating of 30 (5 for each of the 6 themes). This provides a yardstick with which to measure the overall expertise of the survey participants. The results of this measurement are contained in Table 4.5.

TABLE 4.5—OVERALL EXPERTISE LEVELS OF PARTICIPANTS

Score	26	25	24	23	22	21	20	19	18	17	15	12	11	10
Frequency (No of participants)	2	3	1	2	2	3	6	6	3	1	1	1	1	1
	Mean 19.91							Mode 19.20						
	Median 20.00							Standard Deviation 3.85						

Source: Round 4 of Survey.

If a score of 18 is taken as representing an hypothetical average (ie a score of 3 in each of the 6 themes), then we find that the group is slightly above average in its overall level of expertise. The mean expertise of 19.9 is just above the hypothetical average of 18. Table 4.4 indicated that the Air Pollution Theme in particular attracted few claims of expertise and this undoubtedly lowered the overall expertise score of the participants.

Analysis

The results for both expert and non-expert groups were analysed separately in the same way as the overall results reported in Chapter 3. The basic statistics (mean, median, mode) are given in Table 4.6.

Some differences exist between the two groups, as evidenced by the number of questions where the means for the two groups differ by substantial margins. For example, in Question 15(a) (Likelihood of obstacles to paratransit being resolved) the mean for the expert group is 5.15 ('considerable likelihood'), while for the non-expert group it is 3.70 ('some likelihood'). This implies that the two groups hold different views, a fact which would be important if the differences were statistically significant.

A number of nonparametric statistical tests are available to test the significance of differences between two samples of the type obtained in this analysis. The most appropriate for the data in this survey is the Median Test, although both the Mann-

TABLE 4.6—COMPARATIVE STATISTICS FOR EXPERTS AND NON-EXPERTS, ROUND 4

Question	Mean		Median		Mode	
	E[a]	NE[b]	E	NE	E	NE
Q1 Effect of fuel price on demand						
(a) Commuting	2.79	3.84	3	4	3	5
(b) Non-commuting private travel	3.64	3.58	4	4	4	4
(c) Business travel	1.64	2.26	1	2	1	2
Q2 Public transport in energy management						
(a) Alternative to private car role, 1981	2.71	2.89	3	3	3	3
(b) Alternative to private car role, 1990	2.93	3.32	3	3	2,3	3
(c) Fall back system role, 1981	3.07	3.21	3	3	3	3
(d) Fall back system role, 1990	3.36	3.84	3	4	3	4
Q3 Future petrol prices: basis for planning						
(a) Price in 1990	51.36	52.89	50	50	50	50
(b) Price in 2000	62.79	69.79	60	68	60	65
Q4 Severity of pollution problems						
(a) Severity in 1981	3.80	4.14	4	4	4	4
(b) Severity in 1990	3.00	4.24	3	4	3	5
Q5 Efficacy of solutions to reduce air pollution	*not applicable*					
Q6 Engine design: pollution vs economy						
(a) Level of effort	2.60	3.57	3	3	3	3
Q7 Public transport patronage prospects						
(a) Rail	0.09	4.90	0	0	0	0
(b) Bus and tram	5.78	8.50	10	7.5	5	0
Q8 CBD dependence on public transport						
(a) Role of urban public transport in maintaining CBDs	5.78	5.70	6	5.5	6	5
(b) Importance of maintaining low fares policy	2.39	3.00	2	3	2	3
(c) Importance of maintaining CBDs	5.09	4.90	5	5	5	5
Q9 Demand stimulation						
(a) Improvements to delivery systems	5.35	5.20	5	5	5	5
(b) Lower or zero pricing	4.70	4.60	5	5	5	5
(c) Concentrate demand by land use and planning policies	5.04	5.10	5	5	5	5
(d) Regulatory restrictions on use of private vehicles	5.30	5.30	5	5	5	5
(e) Pricing restrictions on use of private vehicles	5.09	5.10	5	5	5	5
(f) Use of telecommunications and micro-processor technology	4.00	3.50	4	4	4	4
Q10 Prospects for technology						
(a) Acceleration of full electrification of suburban rail	3.90	4.38	4	4	3,4,5	4
(b) Re-introduction of further expansion of light rail/tram systems	3.10	2.69	3	2	3	2
(c) Introduction of trolley/flywheel storage buses	2.35	2.00	2	2	2,3	2
(d) Widespread use of electric and other town cars	2.60	2.62	2	3	3	3
(e) Introduction of computer assisted control systems to assist in scheduling	5.10	4.92	5	5	6	5
(f) Widespread introduction of paratransit	3.45	2.85	3	3	5	2
(g) Accelerated introduction of automated traffic control systems	6.20	5.31	6	5	6	5
(h) Re-emergence of emphasis on new urban road developments	4.05	4.31	4	4	3	4,5
Q11 Prospects for deficits						
(a) Changes in deficits	8.21	3.16	10	5	0	10
Q12 Explicit public service obligations						
(a) Likelihood of acceptance	3.29	3.26	3	3	1,4,5	3,4
Q13 Public vs private ownership of urban buses						
(a) Expected change in ownership	4.46	4.45	5	5	5	5
Q14 Institutional structure and trends						
(a) Changes in ownership and operation	3.85	4.40	4	4.5	3.5	5
(b) Changes in planning	2.77	3.15	2	3	2	3
(c) Changes in regulation	3.69	3.75	3	4	3	3,4
(d) Changes in co-ordination	2.54	3.15	2	3	2	3
Q15 Future of paratransit						
(a) Likelihood of obstacles being resolved	5.15	3.70	5	3	5,6	3
(b) Impact on urban passenger transport	3.85	3.70	4	3	4	4
Q16 Optimal level of subsidy						
(a) Bus and tram	66.95	71.00	60	60.5	60	60,100
(b) Rail	60.08	67.50	60	67.5	40,60	70,100

a E = Expert.
b. NE = Non expert.

Whitney Test and (in certain circumstances) the Randomization Test for Two Independent Samples are powerful alternatives (Siegel 1956, Conover 1971, Gibbons 1971).

The Median Test

The Median Test determines the probability that two independent samples (not necessarily of the same size) have been drawn from populations with the same median. The null hypothesis tested is that the two groups are from a population with the same median. The alternative hypothesis is that the median of one population is different from that of the other. The process provides a two-tailed test for differences in both directions.

Briefly, the procedure is first to determine the median score for the combined group, and second to re-arrange both sets of scores at that combined median and cast these data in a 2x2 table as shown in Table 4.7.

TABLE 4.7—MEDIAN TEST

	Experts	*Non-experts*	*Total*
No greater than combined median	A	B	A+B
No less than or equal to combined median	C	D	C+D
Total	A+C	B+D	N

where N = Σ number of samples in each group = A+B+C+D.

With such tables we can utilise a chi-square test (χ^2) in which the sampled distribution can be approximated by a chi-square distribution with (in this case) one degree of freedom; that is:

degrees of freedom = (r-1) (k-1) (1)
where r = number of classifications (rows)
k = number of groups (columns)

The χ^2 value can be computed by the application of the following formula:

$$\chi^2 = \frac{N(|AD-BC|-\frac{N}{2})^2}{(A+B)(C+D)(A+C)(B+D)} \quad (2)$$

The application of the test[1] to the 42 eligible questions (Question 5 was not compatible as it asked respondents to *rank* a number of alternatives) yielded the results contained in Table 4.8. For the null hypothesis that the medians of the two samples are drawn from the same population, the differences in Table 4.8 are significant if the chi-square probability is less than that shown at the two chosen levels of significance, 0.1 and 0.2 (that is at the 90 and 80 per cent confidence levels respectively).

At the 90 per cent confidence level there are only two questions where the distributions of the two samples are statistically different. At the 80 per cent confidence level this rises to seven questions, 17 per cent of the relevant total.

The conclusion from this analysis is that in this survey the experts did not generally hold views which were detectably significantly different from those held by the non-

1. Where tied answers existed these were resolved according to the approach contained in Gibbons (1974, p131).

TABLE 4.8—RESULTS OF THE MEDIAN TEST ON EXPERT AND NON-EXPERT GROUPS

Question		Chi-square probability
Q1	Effect of fuel price on demand	
	(a) Commuting	0.01[a]
	(b) Non-commuting private travel	0.50
	(c) Business travel	0.50
Q2	Public transport in energy management	
	(a) Alternative to private car role, 1981	0.95
	(b) Alternative to private car role, 1990	0.90
	(c) Fall back system role, 1981	0.70
	(d) Fall back system role, 1990	0.40
Q3	Future petrol prices: basis for planning	
	(a) Price in 1990	0.60
	(b) Price in 2000	0.15[b]
Q4	Severity of pollution problems	
	(a) Severity in 1981	0.25
	(b) Severity in 1990	0.15[b]
Q5	Efficacy of solutions to reduce air pollution	Test inapplicable
Q6	Engine design: pollution vs economy	
	(a) Level of effort	0.18[b]
Q7	Public transport patronage prospects	
	(a) Rail	0.90
	(b) Bus and tram	0.90
Q8	CBD dependence on public transport	
	(a) Role of urban public transport in maintaining CBDs	0.95
	(b) Importance of maintaining low fares policy	0.15[b]
	(c) Importance of maintaining CBDs	0.85
Q9	Demand stimulation	
	(a) Improvements to delivery systems	0.85
	(b) Lower or zero pricing	0.90
	(c) Concentrate demand by land use and planning policies	0.75
	(d) Regulatory restrictions on use of private vehicles	0.90
	(e) Pricing restrictions on use of private vehicles	0.85
	(f) Use of telecommunications and micro-processor technology	0.55
Q10	Prospects for technology	
	(a) Acceleration of full electrification of suburban rail	0.90
	(b) Re-introduction of further expansion of light rail/tram systems	0.85
	(c) Introduction of trolley/flywheel storage buses	0.40
	(d) Widespread use of electric and other town cars	0.83
	(e) Introduction of computer assisted control systems to assist in scheduling	0.77
	(f) Widespread introduction of paratransit	0.40
	(g) Accelerated introduction of automated traffic control systems	0.55
	(h) Re-emergence of emphasis on new urban road developments	0.77
Q11	Prospects for deficits	
	(a) Changes in deficits	0.18[b]
Q12	Explicit public service obligations	
	(a) Likelihood of acceptance	0.70
Q13	Public vs private ownership of urban buses	
	(a) Expected change in ownership	0.70
Q14	Institutional structure and trends	
	(a) Changes in ownership and operation	0.77
	(b) Changes in planning	0.77
	(c) Changes in regulation	0.77
	(d) Changes in co-ordination	0.90
Q15	Future of paratransit	
	(a) Likelihood of obstacles being resolved	0.01[a]
	(b) Impact on urban passenger transport	0.90
Q16	Optimal level of subsidy	
	(a) Bus and tram	0.60
	(b) Rail	0.90

a. Significant at 90 per cent confidence level
b. Significant at 80 per cent confidence level.

expert group. Some possible reasons for this result could be:

- the structure of the questions presented to the participants, and the method for recording their answers, may not have been sufficiently flexible to accommodate all expressions and changes of opinion;
- when faced with uncertain future events both experts and non-experts may tend to respond in similar fashion (that is, the distribution of views in both groups are equally distributed); and
- because all members of the group (experts and non-experts) were provided with the same information between rounds, the tendency (or stimulus) to have the same convergence in answers could have been heightened.

CONCLUSION

The overall conclusion from the analysis in this chapter is that both the weighting of results, and the separation of experts into an 'elite' group, did not produce statistically significant differences in the results. However, this should be treated as a result specific to this survey, there is no evidence to suggest that similar results would necessarily be produced in other surveys.

CHAPTER 5—THE DELPHI TECHNIQUE AS A FORECASTING AND CONSENSUS MEASURING TOOL

THE DELPHI AS A FORECASTING TOOL

The Delphi technique has the potential to provide a method of forecasting uncertain future events. Its advantage over other methodologies is that it canvasses a panel of 'experts' who are given a number of opportunities to reconsider their views in the light of available information including the aggregated interim views of the panel. These opportunities to confirm or amend one's views free from direct peer group pressure is one of the Delphi's supposed greatest attributes (Gordon and Helmer 1964, Helmer 1966).

The theory sounds plausible, but how do Delphi surveys perform in practice? More specifically, how confident could one be that the answers produced by a Delphi survey would be as reliable (on the average), as forecasts produced by other means?

There has been no systematic study of the Delphi technique aimed at establishing a general level of confidence in the predictions provided. The BTE survey is itself not equipped to add further to a general appreciation of Delphi's supposed advantages in the field of forecasting accuracy. The survey dealt largely with future events with no mechanism to follow the results with future studies to assess how the predictions may perform. Also, many of the questions were, of necessity, drafted in general and subjective terms (eg Question 4 sought views on the 'acceptability' or otherwise of air pollution). This would make objective treatment of any subsequent comparative study difficult.

It is worthwhile, however, noting two Delphi surveys carried out in 1964, to assess how the results fared with the passage of time. Accepting that two examples may not necessarily prove or disprove a case, these examples are offered for general interest.

The Brown-Helmer experiment

The authors (Brown and Helmer 1964) carried out a Delphi survey of 23 respondents from the RAND Corporation research staff. The respondents were asked 20 questions, all having numerical answers and covering a variety of topics. Eighteen of the questions were of a kind for which the answers could be found in generally available reference material. The remaining two were mathematical questions for which answers could be computed—but only with effort. The subjects were asked to give their answers without using any reference material and without spending more than a few minutes on each question. This experiment did not deal with forecasting, but it gives some guidance as to how participants responded to group opinion on matters which were outside their immediate experience.

Briefly, the results of the experiment were as follows.

- In Round 1 only 21 per cent of the 460 responses were even in the right 'ball park' (arbitrarily defined by the authors as anything within 25 per cent of the true answer). By Round 4 this had increased to 38 per cent.
- The spread of opinions on all questions shrank considerably from Round to Round. The authors expected this to happen because of the way the experiment was structured.
- The median, as a measure of the central element had generally moved closer to the

correct answer by Round 4. The actual distribution for the 20 questions was:

— median moved closer to the true answer	11
— median moved away from the true answer	4
— no change	5

- The self-ranked 'expert' group produced a set of answers which performed 50 per cent better than that of the very best individual participant.

One fact which the authors did not highlight was that the group 'answer' (as measured by the median) gave only one correct answer out of the 20 questions (that sought the year in which an historical event had taken place). For the remaining 19 questions the medians differed by varying amounts.

TABLE 5.1—EXTENT OF VARIATIONS BETWEEN MEDIANS AND TRUE ANSWERS

Extent of variation (per cent)	*Frequency*
0 (correct answer)	1
1-5	4
6-10	1
11-20	3
21-50	3
51-100	6
>100	2

Source: Brown and Helmer (1964) and BTE analysis.

The Gordon-Helmer long range forecasting study

This study (Gordon and Helmer 1964) consisted of a year-long Delphi survey of 82 experts (the composition of the group changed from time to time) on the following topics:

- scientific breakthroughs
- population control
- automation
- space progress
- war prevention
- weapons systems.

The Delphi consisted of a standard four-round survey, with the questionnaires amended from round to round in order to maximise the understanding of the questions by participants, and to pursue in greater detail topics of particular interest.

The report records a large number of forecasts on the six topics, and it is possible to examine these with the aid of almost twenty years of hindsight. The intent is not to go through each forecast to test its outcome as this would be tedious. It suffices to reproduce a section of the Gordon and Helmer report which describes the expected state of the world in 1984. The italicised comments give the present position for the various forecasts.

The world of 1984

> If we abstract the most significant items from the forecasts of all six panels, the following picture emerges of the state of the world as of 1984:
>
> The population of the world will have increased by about 40 per cent from its present size to 4.3 billion—that is, provided no third world war will have taken place before then. There is an 80 to 85 per cent probability that it will not, if present trends continue, but this probability can be raised to 95 per cent by appropriate policy measures. *Estimated world population in 1980 was 3.97 billion, we have so far escaped World War III.*

To provide the increased quantities of food needed, agriculture will be aided by automation and by the availability of desalinated sea water. *Technically feasible but not yet economic.*

Effective fertility control will be practised, with the result that the birth rate will continue to drop. *Fertility control is effective and widely used, particularly in the western world where the birth rate has been declining for many years.*

In the field of medicine, transplantation *(sic)* of natural organs and implantation *(sic)* of artificial (plastic and electronic) organs will be common practice. The use of personality-control drugs will be widespread and widely accepted. *Transplants are common (to the stage of organisation of 'organ banks'); personality-control drugs not yet widely available and their acceptance would be unlikely.*

Sophisticated teaching machines will be in general use. Automated libraries which look up and reproduce relevant material will greatly aid research. World-wide communication will be enhanced by a universal satellite relay system and by automatic translating machines. Automation will span the gamut from many service operations to some types of decision-making at the management level. *Sophisticated teaching machines (computers) available. Computer library systems in general use, telecommunication satellites in widespread use. Automatic translating machines still under development. Automation has made impacts on wide cross-section of society.*

In space, a permanent lunar base will have been established. Manned Mars and Venus fly-bys will have been accomplished. Deep-space laboratories will be in operation. Propulsion by solid-core nuclear-reactor and ionic engines will be becoming available. *Permanent lunar base not on the horizon, neither are the manned Mars and Venus fly-bys. Other forecasts not yet achieved or even within reach.*

In the military arena, ground warfare will be modified by rapid mobility and a highly automated tactical capability, aided by the availability of a large spectrum of weapons, ranging from non-lethal biological devices and light-weight rocket-type personnel armament to small tactical nuclear bombs and directed-energy weapons of various kinds. Ground-launched anti-ICBM missiles will have become quite effective. Anti-submarine warfare techniques will have advanced greatly, but improved, deep-diving, hard-to-detect submarines will present new problems. *Most of these are probably feasible if not actually deployed.*

These paragraphs point to some of the difficulties inherent in forecasting. The predicted permanent lunar base and manned Mars and Venus fly-bys, have not yet taken place and certainly will not by 1984. However, the appropriate technology (which is what the panel members were forecasting) probably exists to undertake these projects. The reasons they have not been undertaken have been largely due to economic factors which were probably not even considered by the scientific panel in 1964.

However, the 1964 Delphi survey managed to produce its share of quite accurate predictions. Certainly the results on fertility control, organ transplants and communications cannot be faulted. In particular, the time frames produced by the Delphi survey were realistic; a case where the visionaries and the pragmatists played as perfect foils to produce 'reasonable' predictions which have stood the test of time quite well.

As with every other form of forecasting, the Delphi in this case has had its share of successes and failures. It does not seem that the Delphi process has yet established any greater claims to reliability than other forms of forecasting. Conversely, there is also no direct evidence that it is any *less* reliable, and for this reason it ought not to be ignored as an available methodology when handling uncertain events.

THE DELPHI TECHNIQUE AS A CONSENSUS-MEASURING TOOL

This use of the Delphi process is complementary to its forecasting capacities. The rationale is that the processes used in the Delphi survey are conducive to narrowing the views of a group, as well as enabling the true views of the group to be established without open confrontation.

In effect, the Delphi is midway between an open discussion, such as a round table meeting, and a secret ballot of views. In the former, there is a danger of peer-group pressure, the presence of gifted orators who can sway opinion, the well known 'bandwagon' effect, and the reluctance of individuals to retract or reverse publicly stated views. In the latter case there is the problem of possible lack of information and interaction and the lack of exposure to reasoned argument.

Ostensibly the Delphi can bridge these problems by providing an environment where consensus, if it exists, can be deduced and recognised.

Measurement of consensus

If there was perfect consensus on any issue then, obviously, all answers would be the same. Statistically such a result would have a standard deviation of zero. In absolute terms the standard deviation of a group of views could be a measure of the centrality of the views. Further, if these views were to be measured a number of times (as in the Delphi process) then we could indicate the direction of consensus by the simple means of determining whether the standard deviation was reducing or increasing. A reducing standard deviation would indicate a tighter clustering about the mean, and therefore would represent a move towards consensus.

This study has made no attempt to determine comparative or absolute levels of consensus amongst the questions, but has restricted itself to determining the movements in consensus within each question from Round 1 to Round 4.

The results of these movements in the consensus, as indicated by the change in the standard deviations, are shown in Table 5.2.

Of the 42 questions for which the comparison was possible (Question 5 asked respondents to *rank* a number of alternatives), a total of 35 had standard deviations which were smaller in Round 4 than they were in Round 1. This indicates some tendency towards centrality and consensus.

There is little doubt that the Delphi process narrows the views held by respondents, and tends to increase the level of consensus in the group. This is not to say that the process aims solely at pushing participants to a position of consensus. The occurrence during this survey of some bimodal distributions of responses indicates that the process is equally capable of handling dissension and polarized views as well as consensus.

SUMMARY

This chapter has shown that the Delphi process can produce credible forecasts which may be as useful as forecasts produced by other methods. Also it has shown that the process facilitates the movement of opinion towards consensus, if such consensus exists. There is at present no measure of the extent of consensus, that remains a judgement to be made subjectively in each specific case.

TABLE 5.2—COMPARISON OF STANDARD DEVIATIONS BETWEEN ROUNDS 1 AND 4

Question	Standard deviation Round 1	Round 4	+ [a] or -
Q1 Effect of fuel price on demand			
(a) Commuting	1.30	1.13	-
(b) Non-commuting private travel	1.37	1.04	-
(c) Business travel	1.27	0.92	-
Q2 Public transport in energy management			
(a) Alternative to private car role, 1981	0.86	0.83	-
(b) Alternative to private car role, 1990	1.08	0.99	-
(c) Fall back system role, 1981	1.09	1.00	-
(d) Fall back system role, 1990	1.21	1.15	-
Q3 Future petrol prices: basis for planning			
(a) Price in 1990	16.52	9.95	-
(b) Price in 2000	59.74	14.35	-
Q4 Severity of pollution problems			
(a) Severity in 1981	0.96	1.00	+
(b) Severity in 1990	1.36	1.41	+
Q5 Efficacy of solutions to reduce air pollution		*not applicable*	
Q6 Engine design: pollution vs economy			
(a) Level of effort	1.50	1.37	-
Q7 Public transport patronage prospects			
(a) Rail	11.61	10.01	-
(b) Bus and tram	12.38	9.11	-
Q8 CBD dependence on public transport			
(a) Role of urban public transport in maintaining CBDs	1.13	0.92	-
(b) Importance of maintaining low fares policy	1.27	0.92	-
(c) Importance of maintaining CBDs	1.33	1.14	-
Q9 Demand stimulation			
(a) Improvements to delivery systems	0.76	0.72	-
(b) Lower or zero pricing	0.75	0.53	-
(c) Concentrate demand by land use and planning policies	0.78	0.55	-
(d) Regulatory restrictions on use of private vehicles	1.05	0.80	-
(e) Pricing restrictions on use of private vehicles	1.02	0.83	-
(f) Use of telecommunications and micro-processor technology	0.72	0.74	+
Q10 Prospects for technology			
(a) Acceleration of full electrification of suburban rail	1.52	1.40	-
(b) Re-introduction of further expansion of light rail/tram systems	1.22	1.10	-
(c) Introduction of trolley/flywheel storage buses	1.41	0.98	-
(d) Widespread use of electric and other town cars	1.50	1.30	-
(e) Introduction of computer assisted control systems to assist in scheduling	1.64	1.47	-
(f) Widespread introduction of paratransit	1.75	1.45	-
(g) Accelerated introduction of automated traffic control systems	1.19	1.08	-
(h) Re-emergence of emphasis on new urban road developments	1.66	1.54	-
Q11 Prospects for deficits			
(a) Changes in deficits	17.72	16.52	-
Q12 Explicit public service obligations			
(a) Likelihood of acceptance	1.70	1.67	-
Q13 Public vs private ownership of urban buses			
(a) Expected change in ownership	1.14	1.08	-
Q14 Institutional structure and trends			
(a) Changes in ownership and operation	1.00	1.03	-
(b) Changes in planning	1.14	0.85	-
(c) Changes in regulation	1.35	1.08	-
(d) Changes in co-ordination	1.63	1.33	-
Q15 Future of paratransit			
(a) Likelihood of obstacles being resolved	1.45	1.07	-
(b) Impact on urban passenger transport	20.62	22.72	+
Q16 Optimal level of subsidy			
(a) Bus and tram			
(b) Rail	23.05	25.41	+

a. + indicates an increase in the standard deviation.
- indicates a decrease in the standard deviation.
b. Questions 16(a) and (b) were added to the questionnaire after Round 1. Figures show change between Rounds 2 and 4.

APPENDIX I

WORKSHOP ON THE FUTURE OF URBAN PASSENGER TRANSPORT IN AUSTRALIA

The proposed Delphi survey to be conducted in conjunction with the workshop will canvass opinions on a range of issues which are relevant and topical in considering the future of urban passenger transport in Australia.

The Delphi survey method involves a series of questionnaires in which participants are informed about the trend of responses to the previous questionnaire in each successive round of the exercise. By providing individual participants with an opportunity to compare their assessments with those of others, this approach facilitates a more considered response to the issues in question.

At this stage the purpose of the exercise is largely exploratory. However, it should produce a structured view of the future as seen by those actively involved in urban passenger transport in Australia. It is planned that the final results of the survey will be published.

We would be grateful if you could assist us by answering the questions contained in this attachment and returning it with your registration for attendance. The replies received will be used in the drafting of the Delphi survey questionnaire.

The questionnaire will address six basic themes:

- Energy
- Pollution
- Demand
- Supply
- Deficits
- Organisation.

For each of these themes you are firstly asked to provide a comment on topics which you consider should be included in the questionnaire, and secondly, to provide comment on some specific items and questions.

Energy

We are basically concerned with the effects that a possible energy crisis, and/or continuing price increases will have on the demand for, and the quantity, quality and format of urban public transport.

1. Are there any specific energy issues concerning energy and UPT which you think ought to be included in the questionnaire?
2. Could you list those forms of energy that you consider may feasibly be utilised in the future to replace liquid fuel for the propulsion of motor vehicles?

Pollution

Motor vehicles cause a substantial amount of air pollution in inner urban areas. The survey will direct its attention to establishing a consensus as to what effort should be put into reducing the level of air pollution.

1. Are there any specific issues concerning pollution and urban passenger transport which you think ought to be included in the survey?

2. One of the presently planned questions deals with the likely effectiveness of a number of initiatives aimed at reducing air pollution. Could you please list initiatives which you believe may, if they were to be implemented, reduce the level of pollution?

Demand

Demand for public transport has been generally decreasing for some years in the face of competition from the private motor car. The survey will address the question of how to increase demand for urban public transport.

1. Are there any specific issues relating to the demand side of urban passenger transport (both private and public) which you think ought to be included in the survey?
2. Demand for public transport can be influenced by a variety of means. Could you list every means (however impractical it may seem) that you think could be used to effect a change in the demand for urban public transport?

Supply

This topic includes all aspects such as type, quality and quantity of transport provided. Our main interest is in technological advances that may take place in transportation in the future and the survey will probably concentrate on this aspect.

1. Are there any specific issues concerning the supply side of urban passenger transport which you think ought to be included in the questionnaire?
2. Could you please list any technological advance (whether feasible or not in 1981) which may have an impact on the form of transport that may be supplied in the year 2000?

Deficits

Most UPT operators in Australia incur significant financial losses prior to public subsidy. The cost to the taxpayer is measured in the hundreds of millions of dollars. The questionnaire will seek views on how best to control these deficits.

1. Do you have any specific issue related to deficits which you think ought to be included in the questionnaire?
2. Could you please list, as you see them, the reasons for the apparent inevitability of large deficits? (List only those which you consider account for the greatest proportion of losses.)
3. Could you list candidate measures which could be considered for implementation in an attempt to reduce or control the deficits, and hence the burden on the taxpayer?

Organisation

The provision of public transport seems to require large organisations funded largely from the public purse. Some of these organisations (representing operators, regulators and planners) have undergone substantial transformations in the past few years, supposedly in attempts to increase efficiency and effectiveness. The survey will canvass possible changes that we can expect to see in the next 10 years.

1. Are there any specific organisational issues that you consider should be included in the questionnaire? (You are not restricted to public sector organisations, and you may also be interested in suggesting possible future scenarios for public/private operators.)
2. Are there any specific operational or organisational changes that you believe will be necessary to enable operators to meet the new demands and contingencies of the late 1980s and 1990s.

Name: .....

APPENDIX II

Workshop on the Future of Urban Passenger Transport in Australia

DELPHI SURVEY OF PARTICIPANTS

CANBERRA
May 12/13 1981

Bureau of Transport Economics
Outlook Series

Name: .....

Workshop on the Future of Urban Passenger Transport in Australia
DELPHI SURVEY OF PARTICIPANTS

Introduction

As part of the 1981 Urban Passenger Transport Workshop, the BTE is conducting a Delphi Survey of Workshop participants. This questionnaire contains the survey questions and provides for four sets of responses to each question -- one in each of the four successive rounds.

The Delphi technique is designed to test group consensus by giving individuals successive opportunities to revise their views in the light of the overall views held by the group. A key factor of the Delphi technique is that individual views are not known to the group. Therefore, your individual answers, although known to the organisers will not be made available to other participants.

Themes

The questionnaire covers six principal themes:

Energy
Pollution
Demand
Supply
Deficits
Organisation.

Expertise Assessment

At the beginning of each theme you are asked to provide a self-ranking of your expertise in the particular area. This should be an absolute ranking rather than a ranking relative to the remaining group members. In reporting, the self-rankings will be displayed in the form of frequency curves for the information of the remainder of the group.

There will be an opportunity for you to re-assess your own level of expertise in subsequent rounds, once you have seen how the group as a whole has assessed itself.

Question Types

There are three basic types of questions. The first is a series of linked boxes which represent discrete points along a continuum. For example:

Substantial Decrease			No Change			Substantial Increase
□	□	□	□	□	□	□

In these questions (which are the most numerous) you should tick the box which most closely matches your view.

The second type is where you are asked to rank a number of alternatives with the number 1 representing the alternative which you favour most, two for the next most favoured and so on.

The third type is where you are asked to estimate the likelihood of an event taking place. You should answer these questions by providing the estimate which most closely reflects your view on the subject matter being tested.

Most questions have been written to obtain views on what *will* happen rather than what *ought* to happen. Each question will have key words underlined to enable you to clearly identify the type of answer we are seeking from you.

We should stress that this Delphi survey is aimed at establishing professional views of general trends and possibilities rather than specific predictions. Therefore, answers to many of the questions will be couched in generalised terms.

Four Rounds

The questionnaire has been designed to be re-used in each of the four 'rounds' of the Delphi survey. Your own questionnaire will be returned to you after each round together with a report on the results of the previous round.

Queries

Should you have any queries on this Delphi questionnaire please contact Mr Danny Scorpecci on (062) 45 2287.

PART A – ENERGY THEME

RANKING OF EXPERTISE

Please indicate your own assessment of your expertise in the subject matter in Part A of the questionnaire. Your assessment should be confirmed or modified in each successive round.

Round	EXPERTISE None	Low	Average	Moderate	High
1	☐	☐	☐	☐	☐
2	■	☐	☐	☐	☐
3	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐

1. EFFECT OF FUEL PRICE ON DEMAND

Urban travel accounts for a high proportion of transport energy usage in Australia. There are indications that fuel price rises so far have not greatly affected urban private car travel demand, having rather reduced discretionary ex-urban travel. To what extent do you consider future petrol price increases will affect private car travel in urban areas in 1990?

	EFFECT None	Some	Significant
ROUND 1			
Commuting	■	☐	☐
Non-commuting private travel	☐	☐	☐
Business travel	☐	☐	☐
ROUND 2			
Commuting	☐	☐	☐
Non-commuting private travel	☐	☐	☐
Business travel	☐	☐	☐
ROUND 3			
Commuting	☐	☐	☐
Non-commuting private travel	☐	■	☐
Business travel	☐	☐	☐
ROUND 4			
Commuting	☐	☐	☐
Non-commuting private travel	☐	☐	☐
Business travel	☐	☐	☐

2. PUBLIC TRANSPORT IN ENERGY MANAGEMENT

Two roles can be ascribed to urban public transport in the context of energy management:

(1) as an alternative to the private motor car to divert usage and hence reduce energy consumption

(2) to provide a 'fall back' urban transport system in the event of any major disruption to the supply of liquid fuel.

In general, how well are present Australian urban public transport systems suited to each of these two roles, and how, if at all, is that suitability likely to be enhanced by 1990 on present day trends and expectations?

		SUITABILITY Very Poor	Poor	Good	Very Good
ROUND 1					
Alternative to private car role	1981	☐	☐	☐	☐
	1990	☐	☐	☐	☐
Fall back system role	1981	■	☐	☐	☐
	1990	☐	☐	☐	☐
ROUND 2					
Alternative to private car role	1981	☐	☐	☐	☐
	1990	☐	☐	☐	☐
Fall back system role	1981	☐	☐	☐	☐
	1990	☐	☐	☐	☐

2. PUBLIC TRANSPORT IN ENERGY MANAGEMENT (Cont.)

		SUITABILITY Very Poor — Poor — Good — Very Good
ROUND 3		
Alternative to private car role	1981	
	1990	
Fall back system role	1981	
	1990	
ROUND 4		
Alternative to private car role	1981	
	1990	
Fall back system role	1981	
	1990	

3. FUTURE PETROL PRICES: BASIS FOR PLANNING

In planning for transport systems, the future price of liquid fuel for private cars is often considered to be a major determinant of both the demand for, and economics of, private and public transport. In March 1981 the recommended retail price of petrol in major cities was about 37 cents/litre, but there is little official guidance as to what future prices may be. What do you consider <u>will be</u> appropriate petrol prices on which to base future UPT planning? (Use 1981 prices, i.e. ignore the effect of general inflation.)
More information is contained in Appendix A.

ROUND 1	1990 ..... c/litre
	2000 ..... c/litre
ROUND 2	1990 ..... c/litre
	2000 ..... c/litre
ROUND 3	1990 ..... c/litre
	2000 ..... c/litre
ROUND 4	1990 ..... c/litre
	2000 ..... c/litre

PART B – AIR POLLUTION THEME

RANKING OF EXPERTISE

Please indicate your own assessment of your expertise in the subject matter in Part B of the questionnaire. Your assessment should be confirmed or modified in each successive round.

Round	EXPERTISE				
	None	Low	Average	Moderate	High
1	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐

4. SEVERITY OF POLLUTION PROBLEM

Air pollution due to motor vehicle emission in Australia's major capital cities is regarded by some to be a major problem with implications for the future. Some measures are already in train (e.g. the ATAC lead free petrol decision) to alleviate the problem. In your opinion what is the level of air pollution caused by vehicle emission and will it improve or worsen in the next ten years if no further action is taken?

		LEVEL OF AIR POLLUTION			
		Negligible	Acceptable	Serious	Intolerable
ROUND 1	1981	☐	☐	☐	☐
	1990	☐	☐	☐	☐
ROUND 2	1981	☐	☐	☐	☐
	1990	☐	☐	☐	☐
ROUND 3	1981	☐	☐	☐	☐
	1990	☐	☐	☐	☐
ROUND 4	1981	☐	☐	☐	☐
	1990	☐	☐	☐	☐

5. EFFICACY OF SOLUTIONS

Which of the following transport policies do you believe would be the most effective in reducing air pollution from motor vehicle emission? (Please rank the alternatives with 1 for the most effective, 2 for the next most effective and so on. You do not have to rank all the alternatives.)

	ROUND			
	1	2	3	4
(A) Upgrading the levels of service of public transport in an effort to attract greater patronage	☐	☐	☐	☐
(B) Active discouragement of private vehicle ownership and usage in inner urban areas	☐	☐	☐	☐
(C) Investment in more sophisticated highway infrastructure to reduce congestion and bypass CBD's efficiently	☐	☐	☐	☐
(D) Adoption of sophisticated traffic management techniques to reduce congestion and concentrations of idling vehicles	☐	☐	☐	☐
(E) Encourage or mandate technological improvements to engine technology, and development of alternative fuel sources to reduce or eliminate motor vehicle emissions	☐	☐	☐	☐
(F) Introduce land use and planning policies to reduce need for transport.	☐	☐	☐	☐

6. ENGINE DESIGN: POLLUTION vs ECONOMY

Present day engine design faces the dual goals of fuel efficiency and reduced pollution emission. Acknowledging that in engine design the two objectives are not necessarily mutually exclusive, do you believe more effort should be made at present to develop engines which are more fuel efficient or which are less polluting?

	LEVEL OF EFFORT		
	Greatest towards economy	Equal effort	Greatest towards less pollutants
ROUND 1	☐	☐	☐
ROUND 2	☐	☐	☐
ROUND 3	☐	☐	☐
ROUND 4	☐	☐	☐

PART C – TRAVEL DEMAND THEME

RANKING OF EXPERTISE

Please indicate your own assessment of your expertise in the subject matter in Part C of the questionnaire. Your assessment should be confirmed or modified in each successive round.

Round	EXPERTISE None	Low	Average	Moderate	High
1	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐

7. PUBLIC TRANSPORT PATRONAGE PROSPECTS

Since 1972, usage of urban rail services has declined by about 30%. In the same period patronage of bus and tram services has only managed to remain steady. (More information on this can be obtained from the resource paper "Demand for Urban Passenger Transport".) In your view <u>will</u> these trends be reversed in the next 10 years, or <u>will</u> urban passenger systems continue to face stagnant or declining patronage? (Write in the percentage by which demand will increase or decrease over the period or tick the box if you believe it will remain steady.)

		DEMAND CHANGE Decrease by	Steady	Increase by
ROUND 1	Rail	%	☐	%
	Bus and Tram	%	☐	%
ROUND 2	Rail	%	☐	%
	Bus and Tram	%	☐	%
ROUND 3	Rail	%	☐	%
	Bus and Tram	%	☐	%
ROUND 4	Rail	%	☐	%
	Bus and Tram	%	☐	%

8. CBD DEPENDENCE ON PUBLIC TRANSPORT

Prior to the widespread availability of, and reliance on, the private car, the development patterns of cities were heavily constrained by the routes of public transport services – in particular fixed track systems such as suburban rail and tram. The private car has relaxed these constraints and as one consequence has permitted more widespread suburbanisation. However, it is often claimed that the economic vitality of city centres is still inextricably linked to the traditional radial public transport systems. To what extent is this claim justified?

How important is the role of urban public transport in maintaining the vitality of city centres?

Round	IMPORTANCE OF ROLE Unimportant	Some importance	Absolutely vital
1	☐—☐—☐—☐—☐—☐—☐		
2	☐—☐—☐—☐—☐—☐—☐		
3	☐—☐—■—☐—☐—☐—☐		
4	☐—■—☐—☐—☐—☐—☐		

In fulfilling this role, how important is it that 'low fares' policies be maintained?

Round	IMPORTANCE OF LOW FARES Unimportant	Important	Very important
1	☐—☐—☐—☐—☐—☐—☐		
2	☐—☐—☐—☐—☐—☐—☐		
3	☐—☐—☐—☐—☐—☐—☐		
4	☐—☐—☐—☐—☐—☐—☐		

Overall, how important is it that city centre functions be maintained at about present level?

Round	LEVEL OF IMPORTANCE Undesirable	Unimportant	Desirable	Very important
1	☐—☐—☐—☐—☐—☐—☐			
2	☐—☐—☐—☐—☐—☐—☐			
3	☐—☐—☐—☐—☐—☐—☐			
4	☐—☐—■—☐—☐—☐—☐			

9. DEMAND STIMULATION

What effect do you believe each of the following measures could have in achieving changes in demand for urban public transport by 1990?

	Round	Substantial decrease — No change — Substantial Increase
Improvement to delivery systems (modernise equipment, integrate services, better route planning, greater punctuality and reliability)	1	
	2	
	3	
	4	
Lower or zero pricing, discriminatory pricing (to make specific routes attractive)	Round 1	
	2	
	3	
	4	
Concentrate demand by land use and planning policies	Round 1	
	2	
	3	
	4	
Regulatory restriction on the use of private vehicles by entry restrictions, parking policies and special licencing	Round 1	
	2	
	3	
	4	
Pricing restrictions on the use of private vehicles by fuel rationing, fuel pricing policies and cost of ownership and operation	Round 1	
	2	
	3	
	4	
Use of telecommunication and microprocessing technology to reduce trips to work and shopping (i.e. offices in the home and by shopping by computer)	Round 1	
	2	
	3	
	4	

PART D – TRANSPORT SUPPLY THEME

RANKING OF EXPERTISE

Please indicate your own assessment of your expertise in the subject matter in Part D of the questionnaire. Your assessment should be confirmed or modified in each successive round.

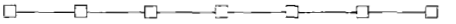
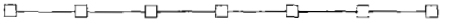
Round	EXPERTISE None	Low	Average	Moderate	High
1	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐

10. PROSPECTS FOR TECHNOLOGY

Whatever the events of the next ten years there will still be a substantial and growing demand for transport in urban areas to be met by public and private systems. Listed below are a number of technological measures which may facilitate the provision of transport to meet demand. What are your views of the likelihood of introduction of each of these measures?

	Round	LIKELIHOOD OF INTRODUCTION None – Moderate – Certain
Acceleration of full electrification of suburban rail systems	1	☐—☐—☐—☐—☐—☐—☐
	2	☐—☐—☐—☐—☐—☐—☐
	3	☐—☐—☐—☐—☐—☐—☐
	4	☐—☐—☐—☐—☐—☐—☐
Re-introduction or further expansion of light rail/tram systems	Round 1	☐—☐—☐—☐—☐—☐—☐
	2	☐—☐—☐—☐—☐—☐—☐
	3	☐—☐—☐—☐—☐—☐—☐
	4	☐—☐—☐—☐—☐—☐—☐
Introduction of trolley/flywheel energy storage buses	Round 1	☐—☐—☐—☐—☐—☐—☐
	2	☐—☐—☐—☐—☐—☐—☐
	3	☐—☐—☐—☐—☐—☐—☐
	4	☐—☐—☐—☐—☐—☐—☐
Widespread use of electric or other small, low fuel consumption town cars	Round 1	☐—☐—☐—☐—☐—☐—☐
	2	☐—☐—☐—☐—☐—☐—☐
	3	☐—☐—☐—☐—☐—☐—☐
	4	☐—☐—☐—☐—☐—☐—☐
Introduction of computer assisted control systems for mass public transport to assist scheduling and reliability	Round 1	☐—☐—☐—☐—☐—☐—☐
	2	☐—☐—☐—☐—☐—☐—☐
	3	☐—☐—☐—☐—☐—☐—☐
	4	☐—☐—☐—☐—☐—☐—☐
Widespread introduction of paratransit	Round 1	☐—☐—☐—☐—☐—☐—☐
	2	☐—☐—☐—☐—☐—☐—☐
	3	☐—☐—☐—☐—☐—☐—☐
	4	☐—☐—☐—☐—☐—☐—☐
Accelerated introduction of automated/computer assisted traffic control systems to reduce congestion	Round 1	☐—☐—☐—☐—☐—☐—☐
	2	☐—☐—☐—☐—☐—☐—☐
	3	☐—☐—☐—☐—☐—☐—☐
	4	☐—☐—☐—☐—☐—☐—☐

10. PROSPECTS FOR TECHNOLOGY (Cont.)

	Round	LIKELIHOOD OF INTRODUCTION None — Moderate — Certain
Re-emergence of emphasis on new urban road developments, including selected freeways	1	
	2	
	3	
	4	

PART E – PUBLIC TRANSPORT DEFICITS THEME

RANKING OF EXPERTISE

Please indicate your own assessment of your expertise in the subject matter in Part E of the questionnaire. Your assessment should be confirmed or modified in each successive round.

Round	EXPERTISE None	Low	Average	Moderate	High
1	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐

11. PROSPECTS FOR DEFICITS

In 1979/80 urban public transport operations in capital cities incurred losses of many millions of dollars (see resource paper "Financial Performance of Australian Public Transport"). In your view what will be the trend in the size of these deficits in the next 5 years? (Consider changes in real terms only, i.e. discount effects of inflation.)

Round	CHANGES IN DEFICITS Decrease by	No change	Increase by
1	%	☐	%
2	%	☐	%
3	%	☐	%
4	%	☐	%

12. EXPLICIT PUBLIC SERVICE OBLIGATIONS

Public transport services have implicit obligations to provide services for social, welfare and even political reasons. Many of these services may be uneconomic to maintain. In your view, what is the likelihood that within 5 years, Governments will state these obligations explicitly, with specific funding being provided for necessary but uneconomic services?

Round	LIKELIHOOD None – Moderate – Certain
1	☐—☐—☐—☐—☐—☐—☐
2	☐—☐—☐—☐—☐—☐—☐
3	☐—☐—☐—☐—☐—☐—☐
4	☐—☐—☐—☐—☐—☐—☐

PART F – TRANSPORT ORGANISATION THEME

RANKING OF EXPERTISE

Please indicate your own assessment of your expertise in the subject matter in Part F of the questionnaire. Your assessment should be confirmed or modified in each successive round.

Round	EXPERTISE None	Low	Average	Moderate	High
1	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	■
3	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐

13. PUBLIC vs PRIVATE OWNERSHIP OF URBAN BUSES

In the course of the next ten years how will the proportion of urban bus services provided by privately owned (even if publicly subsidised) operators change?

Round	EXPECTED CHANGES Substantial decrease			No change			Substantial increase
1	☐	☐	☐	☐	☐	☐	☐
2	☐	■	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐	☐	☐

14. INSTITUTIONAL STRUCTURE AND TRENDS

The recent past has seen considerable re-arrangement in institutional arrangements affecting urban public transport in Australian cities (the formation of the PTC followed by its separation into the UTA and SRA in NSW; the establishment of the MTC in Melbourne and the MTA in Brisbane; the formation of the STA in SA with the public takeover of all metropolitan private bus operators in Adelaide). None of these institutional changes appear to have resulted in increased public transport patronage or in reduced deficits. The direction of change has been towards greater centralisation – either of ownership (MTT in Perth, STA in Adelaide), or of planning, regulation or 'co-ordination' (MTA in Brisbane, MTC in Melbourne). In the meantime evidence has emerged that indicates that smaller (e.g. private sector) bus operators may be more cost effective in providing services (particularly in low density areas). What will be the institutional trends in the next 10 years for each of the following aspects?

	Round	Towards greater centralization			No change			Towards greater decentralization
Ownership and Operation	1	☐	☐	☐	☐	☐	☐	☐
	2	☐	☐	☐	☐	☐	☐	☐
	3	☐	☐	☐	☐	☐	☐	☐
	4	☐	☐	☐	☐	☐	☐	☐
	Round							
Planning	1	☐	☐	☐	☐	☐	☐	☐
	2	☐	☐	☐	☐	☐	☐	☐
	3	☐	☐	☐	☐	☐	☐	☐
	4	☐	☐	☐	☐	☐	☐	☐
	Round							
Regulation	1	☐	☐	☐	☐	☐	☐	☐
	2	☐	☐	☐	☐	☐	☐	☐
	3	☐	☐	☐	☐	☐	☐	☐
	4	☐	☐	☐	☐	☐	☐	☐
	Round							
Co-ordination	1	☐	☐	☐	☐	☐	☐	☐
	2	☐	☐	☐	☐	☐	☐	☐
	3	☐	☐	☐	☐	☐	☐	☐
	4	☐	☐	☐	☐	☐	☐	☐

15. FUTURE OF PARATRANSIT

The development of paratransit services has been hampered by institutional restrictions (e.g. multiple hiring of taxis, charging of fares by private motorists) and operational difficulties (e.g. intrusions into services provided by bus operators). How likely is it that paratransit services will overcome these obstacles in the next 10 years and if they are what will be the magnitude of their impact on urban passenger transport?

	Round	LIKELIHOOD None — Moderate — Certain
Likelihood of obstacles being resolved	1	
	2	
	3	
	4	

	Round	IMPACT Negligible — Some — Substantial
Impact on urban passenger transport	1	
	2	
	3	
	4	

16. OPTIMAL LEVEL OF SUBSIDY
(Supplementary question, rounds 2, 3, 4)

Most, although not all, observers agree that urban public transport should be funded by both passenger fare revenue and by tax-based subsidies. There is no general agreement as to the optimum proportion of costs which should be met from fares. In your view, what should the proportion of total costs—including full interest and depreciation charges—that should be met from passenger fares?

(The attached table shows the present position)

	Bus Tram	**Rail**
Round 2	____	____
Round 3	____	____
Round 4	____	____

APPENDIX III—DISCUSSION ON VARIATIONS FROM STANDARD DELPHI SURVEY FORMATS

The Delphi survey as developed by Helmer and others (Helmer 1966, Brown and Helmer 1964, Gordon and Helmer 1964) contained a number of processes or techniques which have since become accepted as integral parts of the Delphi survey.

This survey departed in a number of ways from the traditional formats in order to overcome problems which were specific to this study. The reasons for, and extent of, these departures are discussed in this Appendix.

QUESTIONNAIRE FORMAT

The questionnaire design was governed by the need to have a fast turn-around between completion of the questionnaires and presentation of results, so that the entire process of the survey would be accommodated within the time frame of the workshop.

Ideally, the questionnaire should impose as few restrictions as possible on the answers that participants can provide. For example, a typical question which addresses the probability of a certain event taking place within a specified period should give the respondents the choice of any probability from 0 to 100 per cent. A question asking the likely date for a certain event to take place should allow respondents a range of answers from tomorrow to infinity.

The wide dispersion of answers that this method encourages is usually most desirable, given that the technique aims to elicit as wide a range of views as are available. However, in this particular exercise speed was of the essence and this created problems not normally experienced by organisers of more protracted Delphi surveys.

In particular, an early decision to produce the results in graphical form meant that it was not possible simply to produce a table showing the distribution of answers along with other useful statistics such as means, standard deviations and quartile ranges. Instead, it was necessary to produce a graph which contained this information directly from the computer. This necessitated some compromises and the output was restricted to histograms with a fixed and limited number of discrete points on the horizontal and vertical axes.

The compromise reached was to design the questionnaire in such a way that respondents' choices were restricted to seven discrete points along a continuum running from one extreme to the other. In the example below the extremes run from a 'substantial decrease' to a 'substantial increase':

1	2	3	4	5	6	7
Substantial decrease	Moderate decrease	Small decrease	No change	Small increase	Moderate increase	Substantial increase

This style of question format was pilot tested within the Bureau. The seven point format seemed to be a reasonable compromise between giving respondents an adequate number of choices, and avoiding too many discrete points which would make the questions complex, and difficult to handle in the results.

A further consideration was that the number of choices given should not be so few as to discourage respondents from making shifts in their opinions. The seven point format had the additional advantage of providing a clearly identifiable mid-point, or average

between the two extremities. This proved to be a convenient format for this particular survey.

DISSEMINATION OF INDIVIDUAL VIEWS

At the presentation of Round 2 results, a number of questions were selected, the responses to which showed either a strong polarisation of views, or which contained a strong minority view which differed significantly from the apparent consensus of the majority.

Participants who were in one of these categories were asked to provide anonymous written reasons as to why they held particular views if they intended taking a similar stance in Round 3.

During the preparation of Round 3 results these written reasons were collated and distributed to all participants. Where necessary statements were paraphrased to conceal the identities of authors. Participants were then able to use this additional information in formulating their views for Round 4.

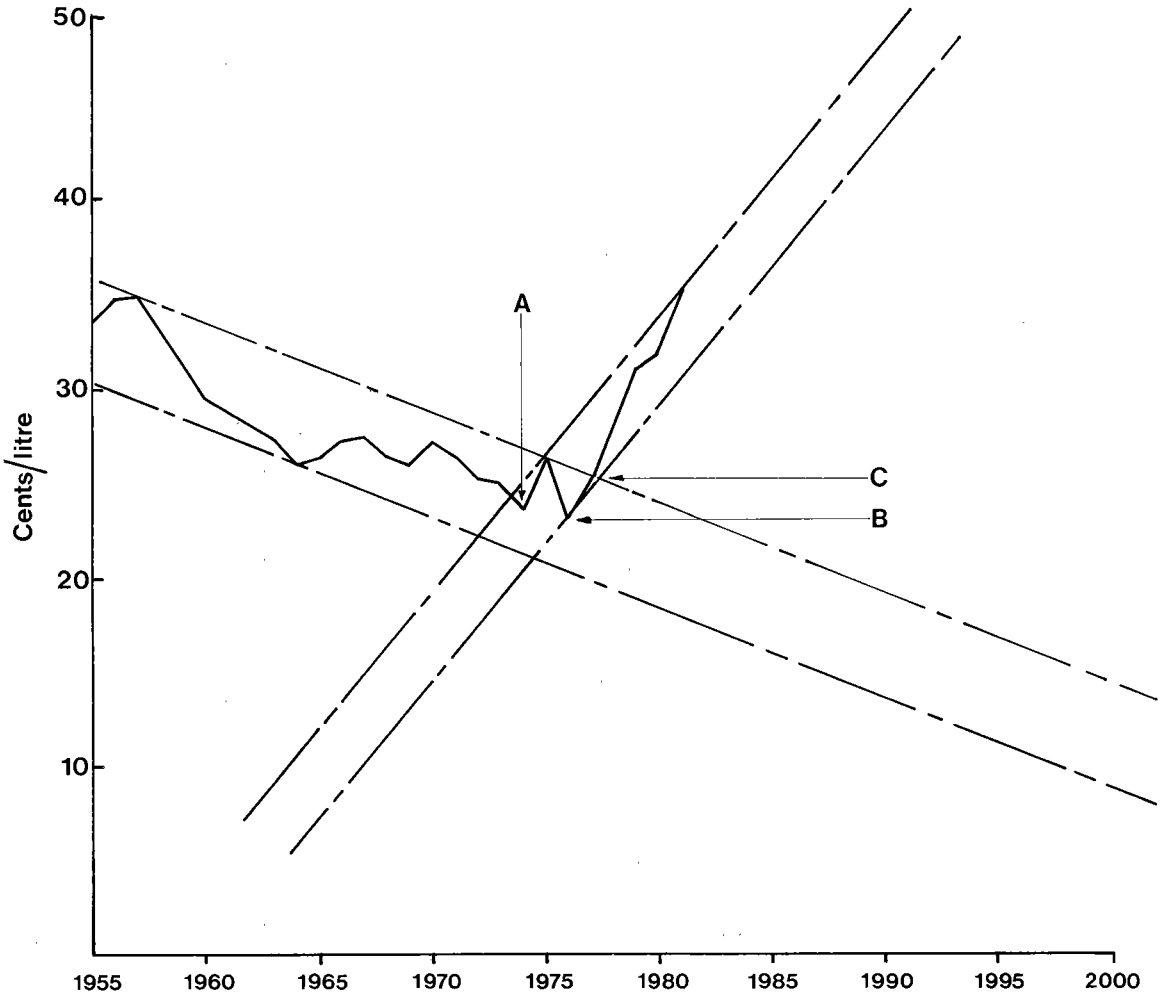
This single opportunity to disseminate individual views was probably insufficient. It occurred late in the process when many participants would have finally settled their views. Also the selective nature of the views sought meant that the Delphi group only received justifications for views which were extreme (in the context of the individual Delphi questions) and received no counter-balancing views from those who held more moderate views.

The inadequate dissemination of this type of information was a function of the survey being conducted as a peripheral part of the workshop and of the necessity to work within its confines. This did not provide sufficient time between rounds in which to collect and analyse reasons for each question from every participant.

APPENDIX IV—BACKGROUND MATERIAL AND INFORMATION

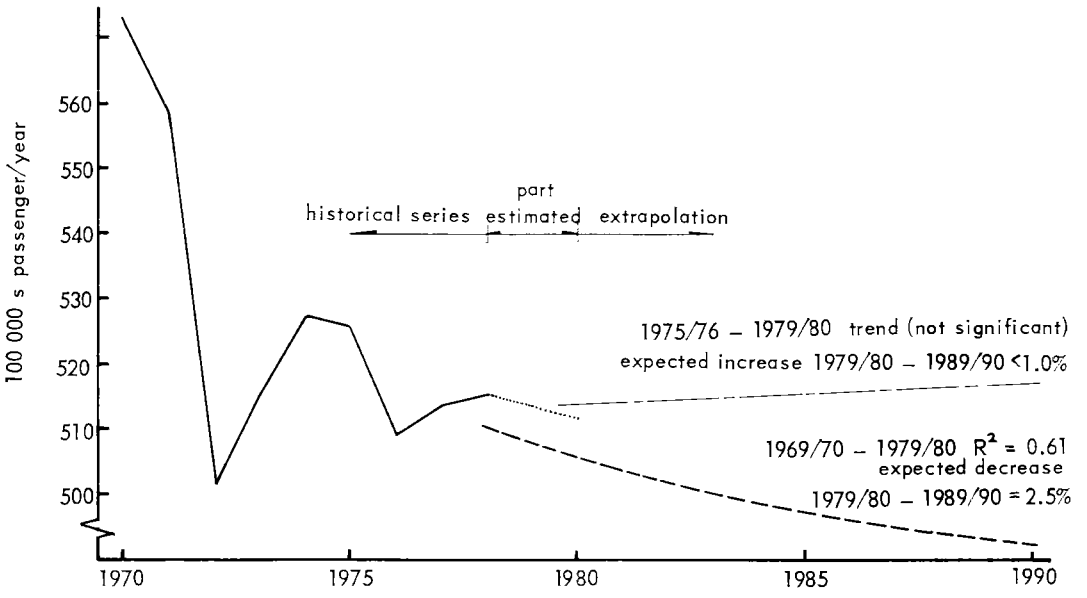
PRICE OF SUPER PETROL IN SYDNEY 1955-MARCH 1981 IN CURRENT AND CONSTANT MARCH 1981 PRICES

Date	*Current prices (cents per litre)*	*CPI factor*	*Constant March 81 prices (cents per litre)*	*Percentage + or - (real terms)*	*Comment*
Dec55	7.9	0.2262	34.9		Super grade petrol introduced
56	8.7	0.2413	36.1	+3.44	
57	8.8	0.2428	36.2	+0.28	
58	8.4	0.2467	34.1	-5.80	
59	8.3	0.2612	31.8	-6.74	
60	8.3	0.2732	30.4	-4.40	
61	8.1	0.2741	29.6	-2.63	
62	8.1	0.2770	29.2	-1.35	
63	8.0	0.2791	28.7	-1.71	
64	7.9	0.2902	27.2	-5.23	
65	8.3	0.3003	27.6	+1.42	
66	8.7	0.3085	28.2	+2.17	
67	9.1	0.3208	28.4	+0.71	
68	9.1	0.3274	27.8	-2.11	
69	9.2	0.3403	27.0	-2.88	
70	10.1	0.3580	28.2	+4.44	
71	10.6	0.3831	27.7	-1.77	
72	10.6	0.4029	26.3	-5.05	
73	11.7	0.4489	26.1	-0.76	
74	12.9	0.5286	24.4	-6.51	OPEC quadruples oil prices
75	16.8	0.6115	27.5	+12.70	
76	16.5	0.6789	24.3	-11.64	
77	19.6	0.7464	26.3	+8.23	Aust Govt introduces 50 per cent world parity price
78	23.9	0.8126	29.4	+11.79	Aust Govt introduces 100 per cent world parity price
79	29.5	0.8939	33.0	+12.24	
80	35.0	0.9767	35.8	+8.48	
Mar81	37.0	1.0000	37.0	+3.35	



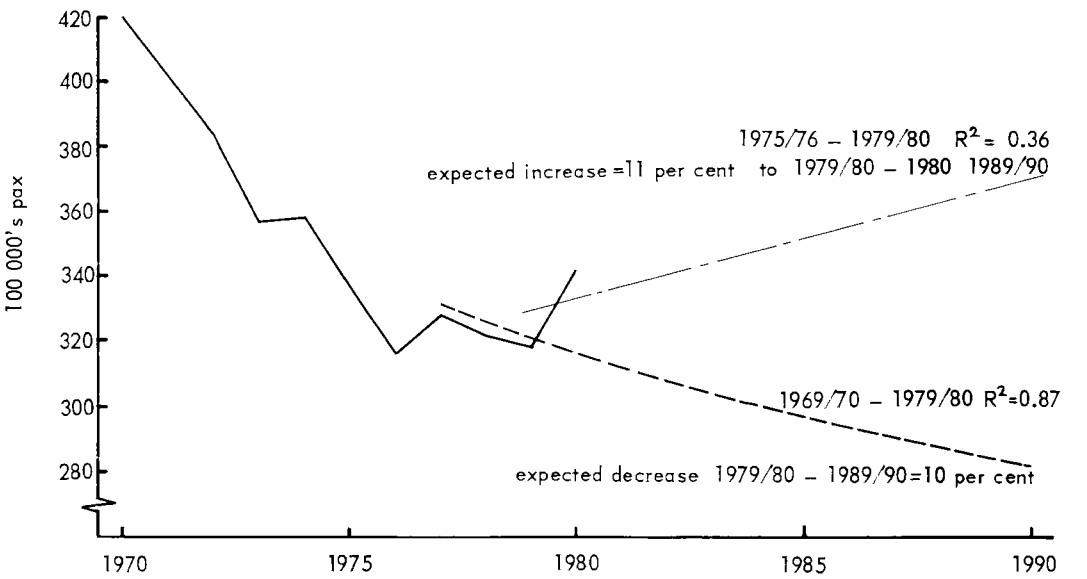
A. World oil prices quadrupled by OPEC
B. Aust.Gov. imposes 50% world parity pricing
C. Aust.Gov. imposes full world parity pricing

PRICE OF PETROL
DEC.1955 – MAR.1981 (DEC 1980 PRICES)



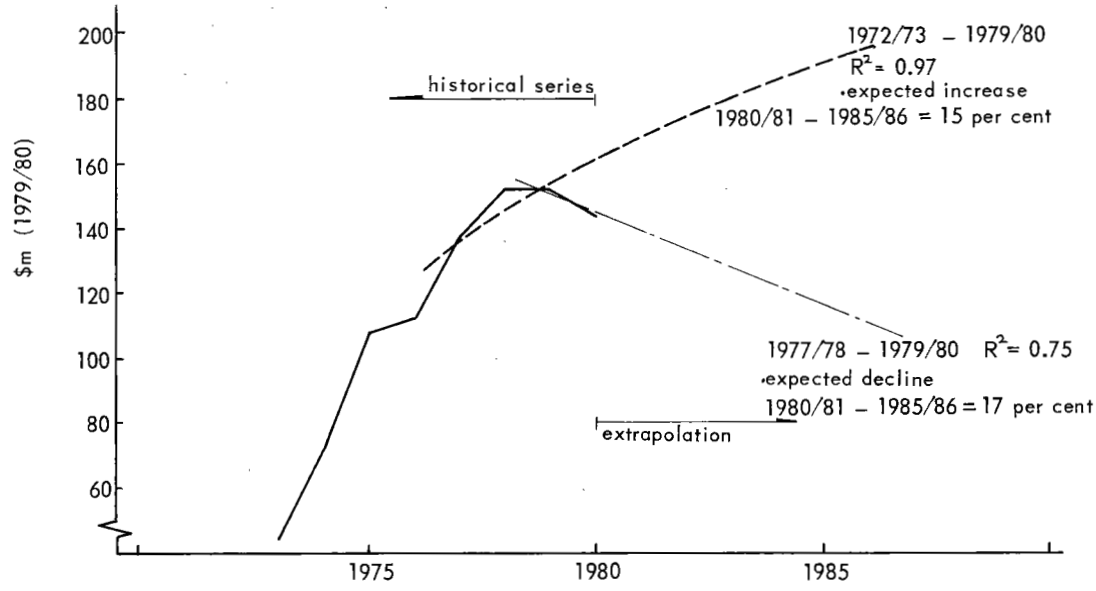
TRENDS IN URBAN BUS AND TRAM PASSENGERS : all public systems in all states

Source: ABS and BTE analysis



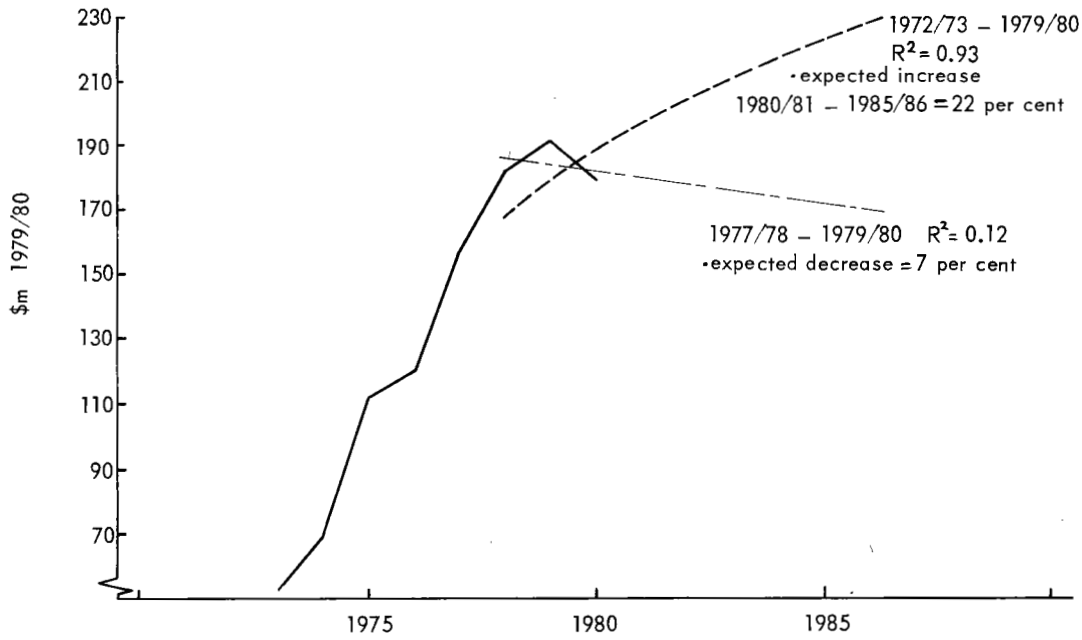
TRENDS IN PASSENGERS CARRIED : all mainland capital cities : rail

Source : ABS and BTE analysis



TRENDS IN BUS AND TRAM DEFICITS : all capital city public systems

Source : Table 2 Henning and Shaw 1981 : plus BTE analysis



TRENDS IN URBAN RAIL DEFICITS : Sydney Melbourne Adelaide

Source : Henning and Shaw 1981 and BTE analysis

FARE BOX CONTRIBUTIONS TO PUBLIC SECTOR UPT COSTS

(per cent)

		1977-78	*1978-79*	*1979-80*
Sydney	PTC Rail	—	34.26	39.86
	PTC Bus (includes Newcastle)	—	36.18	46.43
Melbourne	MMTB	—	49.86	52.88
	VicRail	—	na	50.61[a]
	Private Bus Operators	79.72	—	—
Adelaide	STA (bus, tram rail)	—	22.00	na
Canberra	ACTION bus	—	38.67[a]	35.73[a]
Tasmania	MTT bus	—	34.90	na
Perth	MTT bus	—	45.82	40.35
	MTT rail	—	19.85	15.68
Brisbane	BCC bus	—	54.99[a]	52.26[a]

a. Costs exclude depreciation and interest charges; actual contributions will be lower (some costs may also exclude attributable salaried staff costs).

Source: Derived from relevant annual reports.

APPENDIX V—LIST OF PARTICIPANTS

Participant	*Organisation and address*
J. Alford	Research & Publicity Officer Australian Railways Union (Vic Branch) 636 Bourke Street MELBOURNE VIC 3000
R.G. Anderson	Executive Officer Urban Transport Policy Section Department of Transport Australia Civic Permanent Centre Allara Street CANBERRA CITY ACT 2601
D.P. Bowyer	Senior Research Scientist Australian Road Research Board PO Box 156 (Bag 4) NUNAWADING VIC 3131
P.A. Brogan	Managing Director R. Travers Morgan Pty Ltd PO Box 1162 NORTH SYDNEY NSW 2060
G. Carkeek	M&MTB PO Box 4528 MELBOURNE VIC 3001
V.J. Crowe	Vice President NSW Taxi Council 152 Riley Street EAST SYDNEY NSW 2000
P. Ferrari	Director (Transport Planning) Transport and Traffic Branch Department of the Capital Territory PO Box 158 CANBERRA CITY ACT 2601
S. Gunner	Officer-in-Charge (Information Analysis) Systems and Information Branch Bureau of Transport Economics PO Box 367 CANBERRA CITY ACT 2601
L.J. Harper	Passenger Development Manager State Rail Authority NSW 17-31 York Street SYDNEY NSW 2000

L. Henning	Principal Research Officer Financial Analysis Branch Bureau of Transport Economics PO Box 367 CANBERRA CITY ACT 2601
D.A. Hensher	Associate Professor of Economics Macquarie University NORTH RYDE NSW 2113
K.A. Hine	Executive Officer Metropolitan Transit Council Ministry of Transport 570 Bourke Street MELBOURNE VIC 3000
M. Howell	Research Economist Australian Automobile Association 212 Northbourne Avenue CANBERRA CITY ACT 2600
D. Iverach	Co-ordinator (Research and Planning) NSW Ministry of Transport GPO Box 2626 SYDNEY NSW 2001
A. Kinloch	Director Strategic Planning and Resource Allocation Division Department of Transport Australia PO Box 367 CANBERRA CITY ACT 2601
K. Loong	Engineer Planning and Technology Branch Bureau of Transport Economics PO Box 367 CANBERRA CITY ACT 2601
B.J. Lynch	Director Transport Policy Unit—Tasmania GPO Box 1002-K HOBART TAS 7000
R.F. Morris	Operations Manager, Bus Urban Transit Authority 11-31 York Street SYDNEY NSW 2000
K.J. Mungoven	Executive Director (Policy) Department of Motor Transport 50 Rothschild Avenue ROSEBERY NSW 2018
K.W. Ogden	Principal Research Officer Australian Railway Research and Development Organisation 576 Lonsdale Street MELBOURNE VIC 3000
P.G. Pak-Poy	Director P.G. Pak-Poy and Associates 323-325 Wakefield Street ADELAIDE SA 5000

J.P. Paterson	Deputy Director NSW Department of Planning and Environment PO Box 3927 SYDNEY NSW 2001
N. Potter	Director, Urban Transport Policy Department of Transport Australia PO Box 367 CANBERRA CITY ACT 2601
A.J. Richardson	Lecturer in Transport Department of Civil Engineering Monash University Wellington Road CLAYTON VIC 3168
A.B. Robertson	Assistant Secretary, NSW Branch ATMOEA Suite 1, Floor 5 TLC Building 377 Sussex Street SYDNEY NSW 2000
A.D. Rooney	Planning Engineer SA Highways Department PO Box 1 WALKERVILLE SA 5081
D. Short	Officer-in-Charge (Pricing and Regulation) Economic Assessment Branch Bureau of Transport Economics PO Box 367 CANBERRA CITY ACT 2601
J.C. Usher	Managing Director Invicta United Bus Services PO Box 281 CROYDON VIC 3136
M. Veitch	Head of Planning and Research Metropolitan Transit Authority Transport House Wickham Street FORTITUDE VALLEY QLD 4006
J. Walton	Convenor Action for Public Transport, NSW 15/10 Leichhardt Street GLEBE NSW 2037
F.A. Wayte	Project Director Northeast Busway Department of Transport, SA GPO Box 1599 ADELAIDE SA 5001
H. Wildermuth	Senior Transport Planner Office of the Director-General of Transport, WA 68 St George's Terrace PERTH WA 6000

B. Wilkins	NSW Taxi Council 152 Riley Street EAST SYDNEY NSW 2000
R.W.L. Wyers	Acting Deputy Director Bureau of Transport Economics PO Box 367 CANBERRA CITY ACT 2601

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