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# **Searching for Policy Priorities in the Formulation of a Freight Transport Strategy: An Analysis of Freight Industry Attitudes**

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## **Abstract**

An efficient and effective freight transport strategy can be aided by early professional contributions from key stakeholders. One broad group who have historically been given limited opportunity to influence the drafting of a freight strategy, are commercial road users and shippers who manufacture and distribute goods. Utilising a data set collected in Australia in 1996 from a sample of organisations involved directly and indirectly in road freight transportation, views were sought on road infrastructure changes, new road infrastructure, non-road infrastructure needs, and transport policies. An optimal scaling approach using non-linear canonical correlation is implemented to search for structural relationships between the underlying policy and infrastructure dimensions and the various industry categories. This framework provides a powerful mechanism for identifying differences among stakeholders in terms of their support for or opposition to specific policies. Results reveal the considerable differences in attitudes associated with the component parts of the freight industry.

*Acknowledgements.* The data used in this study was collected by ITS(Sydney) as part of a larger study funded by the NSW Roads and Traffic Authority (RTA). Permission to reanalyse the data is appreciated. The support of Raeburn Chapman and Pravin Raniga of the RTA is gratefully appreciated. Jenny King and Garland Chow contributed to the original study and are thanked for their advice throughout the study.

## INTRODUCTION

Those seeking policy input for aspects of transport planning and management that impact goods movement must be aware that the freight industry does not speak with one voice. For example, the interests of common carriers and those involved in retail/wholesale/distribution need not be aligned and may indeed be diametrically opposed. Up until now, not only has the freight industry been largely ignored for road planning purposes, but they have also been referred to in passing as the “freight industry” with a presumed homogeneity of interests. This work reveals much more complex insights into differences in attitude between components of the freight sector. These findings would suggest that those interested in formulating freight transport strategies, should be sensitive to the need to investigate the interests of the various sectors of the industry in depth and relate the findings to the markets that each sector operates in. Using the methods described would allow policy makers to identify firstly the policy issues on which there is consensus and also identify those policies that appear to be negatively perceived by certain sectors of the freight industry. Explaining and understanding individual sector responses should lead to policy development that represent a more subtle approach to the complex and diverse needs of the freight industry.

In 1994, the New South Wales (NSW) State Road Network Strategy was developed and released for public discussion. The objective of the Strategy was to provide directions and a framework for road transport planning and management in New South Wales for the next 20 to 30 years (RTA, 1994). Strategies proposed include developing the strategic road network for the State based on economic and community transport needs, maintaining the road network to achieve maximum economic benefit and to provide acceptable levels of access, meeting transport needs in an environmentally responsible way; encouraging moderated traffic growth in urban areas through increasing private vehicle occupancy, increasing use of safety and speed reduction devices, improving facilities for pedestrians, bicyclists and public transport, reviewing parking provisions; and providing efficient road links to the major ports, airports and rail freight terminals.

A very specific item highlighted in the strategy was the recognition that freight and commercial vehicle activities contribute substantially to the traffic as well as playing an important role in defining the State road network. What was missing, however, as inputs into the development of the Strategy, was an appreciation of freight-related industry needs, perceptions and expectations.

In recognition of a gap in the ‘methodology’ used in Australia to establish policy priorities in the formulation of a freight transport strategy, we sought input from a sample of major organisations whose efficiency is influenced by the quality of the road system. These organisations operate at various points in the supply chain, and include firms in manufacture and extraction, retail, wholesale and distribution, freight hauliers, contract carriers and freight forwarders. Senior management responsible for logistics, operations, warehousing and transport were interviewed by telephone to gain a broad understanding and assessment of (1) the industry’s perceptions and responses with regards to infrastructure and transport issues, (2) various scenarios for future

infrastructure investment priorities and policy options for the management of freight and commercial vehicle travel, (3) the freight movement problem, issues of the past and specific barriers to transport and distribution productivity, (4) the underlying demand for freight-related transport, and (5) industry's preferences for road infrastructure improvements.

The following sections present the evidence obtained from the sample of stakeholders. An optimal scaling approach using non-linear canonical correlation is implemented to search for structural relationships between the underlying policy and infrastructure dimensions and the various stakeholders representing specific business sectors. This framework provides a powerful mechanism for identifying policy priorities supported or otherwise by specific business sectors. Results can feed directly into a road network strategy.

## THE SURVEY DATA

The stakeholders for this study have been identified as the organisations involved in manufacturing, retailing, warehousing and distribution as well as those involved in providing general (utility) services (e.g., electricity, telecommunications), contract distribution, freight hauling, and freight forwarding. A sample size of 150 was pre-specified as a stratified random sample drawn from ITS's industry data base for the Sydney Metropolitan Area. Stratification was based on business sector - manufacturing, retailing/wholesaling, contract distribution, freight hauling, utility provider and freight forwarding.

A Computer-Aided Telephone Interview (CATI) was administered between October 3 and October 21, 1996. A minimum of 10% of each of the 12 successful responses for each interviewer was validated by calling the respondent back and confirming name of respondent, title or position of respondent and the industry that the organisation is in. Table 1 indicates the response rate to the telephone survey. The response rate was 43% from the subset of individuals contacted. This is generally considered a good level of response to a telephone survey. Interviews with organisations are somewhat more difficult than those with households, given the difficulty in making contact with the appropriate person to interview in the organisation. This explains the high proportion of call backs. Each interview averaged 23 minutes in length.

**[Table 1 about here]**

The survey sample of 150 companies is broken down in Figure 1 by six industry types. There were too few (three) utility service companies to include this category in our analysis, so the final sample ( $n = 147$ ) consisted of five types of freight industries.

**[Figure 1 about here]**

In this paper we concentrate on the responses to a series of attitudinal questions in which each respondent was asked to respond on a 5-point scale, indicating whether they thought the initiative was a good or bad idea. Other aspects of the study are reported in Hensher et al (1996). Each item is discussed below where we use nonlinear canonical correlation to map attitudes related to business sector in the search for priorities in the formulation of a freight transport strategy. Before presenting the findings, we briefly describe the analysis method.

## METHODOLOGY

Our objective is to summarize the opinions of business sectors concerning the priorities of various policies for transport planning and management. The available survey data measure attitudes in terms of overall opinions about the worthiness of each of a series of infrastructure investment priorities and policy options. These attitudes are measured on a five-point scale, with the scale point descriptors being (1) “very bad idea,” (2) “bad idea,” (3) “neither good nor bad idea,” (4) “good idea” and (5) “very good idea.”

There are three important aspects in the analysis of these data: First, attitudes can only be measured on ordinal scales. That is, favor or disfavor is monotonically related to the scale value, but it should not be presumed that the intervals between adjacent scale points are equal. For instance, there is no reason to believe that the difference between “very good idea” and “good idea” is the same as the difference between “good idea” and “neither good nor bad idea,” because the former interval measures the difference between two degrees of a formed positive attitude, and the latter interval measures the difference between a positive attitude and an indifferent attitude. Consequently, linear statistical analyses applied to the raw data (such as product-moment correlations, linear regression, and principal components factor analysis) will not necessarily yield accurate conclusions about relationships in the data because such methods assume equal intervals on the measurement scales.

Second, we wish to determine to what extent there are natural groupings of policies in terms of similarities and differences in attitudes of business sectors. The comprehensive survey presents a fairly large number of policy options and respondents are likely to judge many of these options as being similarly good or bad for their organisations. Because the attitude scales are ordinal, we must measure associations without simply using product-moment correlations calculated from the raw data.

Third, we wish to determine how similarities and differences in attitudes towards policy options are associated with a business sector. To what extent do respondents from the same class have consistent opinions, and how do these patterns of opinions vary across the business sectors? The method we use for determining these patterns should summarise attitudes as a function of business sector

Our objective is to thus find the best explanation of patterns in attitudes, measured on ordinal scales, as a function of industry type. If the variables were measured on an interval scale, this could be treated as a principal components problem, followed by an analysis of factor scores as a function of business sector. The analysis of factor scores could proceed either by regressing the scores on dummy variables identifying the business sectors, or by using cluster analysis to find homogeneous factor segments, followed by discriminant analysis or other techniques to determine how the segments relate to business sectors. All of these conventional approaches to the problem employ sequences of multivariate statistical methods. The success in terms of “fit” or explanatory power is difficult to assess because of the transfer of results across methods.

More directly, the problem can also be treated most elegantly in a single step using canonical correlation analysis (CCA). In CCA, there are two sets of one or more variables, and the objective is to find a linear combination of the variables in each set so that the correlation between the linear combinations is as high as possible. The



linear combinations are defined by optimal variable weights. In the present case, we have one set of explanatory variables (industry types) and one set of dependent variables (attitudes), so CCA can be viewed as an extension of regression to more than one dependent variable. Depending on the number of variables in each set and their scale types, further linear combinations (called canonical variates) can be found that have maximum correlations subject to the conditions that all canonical variates are mutually orthogonal or independent. Because analysts are usually in search of parsimony, and practical reasons associated with interpreting the results, the number of canonical variates is usually limited to two or three. CCA is generalisable to more than two sets of variables.

Here we have a nonlinear CCA problem with an explanatory variable matrix defined by a single nominal (industry type) variable and a dependent variable matrix defined by a series of ordinal attitude scales. The linear combination on the explanatory variable side is undefined, because we have no metric to quantify the categories of each nominal variable. The linear combination of the variables on the dependent side is also undefined, because the categories of each variable can be re-scaled by any nonlinear function that preserves monotonicity. Thus, we need to optimally scale or quantify the variables while simultaneously solving the traditional linear CCA problem of finding weights for each explanatory variable.

An efficient solution to the nonlinear CCA problem was first proposed by researchers at the Department of Data Theory of Leiden University in the Netherlands. The Leiden team (publishing under the *nom-de-plume* "Albert Gifi") developed a method for conducting canonical correlation analysis with variables of mixed scale types: nominal, ordinal, and interval. The method was operationalised in a program called CANALS (Canonical Analysis by Alternating Least Squares), which was later extended to generalised canonical analysis with more than two sets of variables. The generalised nonlinear canonical analysis program, called OVERALS, is available in the SPSS CATEGORIES program suite (SPSS, 1990).

The Leiden method for nonlinear CCA is described in De Leeuw (1984), Van der Burg (1988) and (most extensively in) Gifi (1990). The method simultaneously determines both (1) optimal re-scalings of the nominal and ordinal variables and (2) explanatory variable weights, such that the linear combination of the weighted re-scaled variables in one set has the maximum possible correlation with the linear combination of weighted re-scaled variables in the second set. Both the variable weights and optimal category scores are determined by minimizing a loss function derived from the concept of "meet" in lattice theory.

A geometric perspective is most useful in describing the nonlinear CCA "meet loss" objective function. Geometrically, if we have  $n$  observations, each of the two sets of variables defines a subset of  $n$ -dimensional space. In the case of linear CCA, each subset is defined by all linear combinations of the variables, so its dimensionality cannot be larger than the number of variables in the set. However, with nonlinear (nominal and ordinal) variables, the subset is defined by all nonlinear transformations, so its dimensionality can be as large as the number of different values assumed by all the variables in the set. In other words, the maximum dimensionality is determined by

the number of non-empty cells in the multidimensional cross-tabulation of all of the variables in the set.

In a CCA problem with  $p$  canonical variates, the objective is to find  $p$  orthogonal vectors in  $n$ -space that belong to both subspaces. The rank of the meet is defined as the largest subspace that is contained in both subspaces. Meet rank is equal to  $p$  if there are  $p$  different transformations and combinations with a canonical correlation equal to one. With real data, this never happens. Meet loss defines the departure from meet rank =  $p$ . Minimization of meet loss in a space defined by the optimal category transformations and the variable weights then become a problem of singular value decomposition. Most linear multivariate methods, such as principal components analysis and discriminant analysis, also employ singular decomposition (eigenvalue) solutions. Nonlinear CCA is just a more complicated formulation, because category quantifications for each variable, as well as the variable's weight, are parameters in optimization of the objective function. The objective function can be shown to have a unique optimum under most circumstances.

The meet loss objective function is minimized by means of an algorithm that alternates back and forth between adjusting the category scores of the ordinal and nominal variable, and adjusting the variable weights, subject to appropriate constraints. The algorithm called alternating least squares (ALS), is similar to the power method in conventional singular value decomposition (Gifi, 1990; Israëls, 1987). The properties of this algorithm and the general advantages and limitations of objective functions based on least squares are discussed in Gifi (1990). In particular, all least squares techniques are prone to be over-sensitive to outliers, and the outliers problem is manifested in nonlinear CCA in a terms of variable categories with small numbers of observations (small usually being defined as less than about five observations). Thus, it is prudent to combine categories with low frequencies; we have done this with adjacent categories on several of the attitude scales.

When computing the optimal category scores in nonlinear CCA, nominal variables, such as industry type in the present application, can be treated as having either multiple or single optimal scaling. That is, the category scores can be different for each canonical variate (multiple), or the same for all variates (single). Multiple scaling always improves the fit between the two sets of variables, and the program partitions meet loss so that the analyst can assess the reduction in fit due to the use of single scaling for any nominal variable. Ordinal and interval-scaled variables, such as our ordinal attitude scales, can have only a single optimal scaling. We choose to treat industry type as a multiple nominal variable, because we are looking for the best possible explanation of differences in attitudes.

An important aspect of the Leiden ALS nonlinear CCA is that it reduces to other linear and nonlinear multivariate statistical methods in special cases. When all variables are linear, it produces the traditional linear canonical correlation solution with two or more sets of variables, and the principal components version of factor analysis with one set of variables. When there is one set of nominal variables it produces homogeneity or correspondence analysis (Benzécri, 1973). With one set of variables of mixed scale types, it produces a nonlinear version of principal components factor analysis.

A nonlinear CCA solution involves, for each canonical variate, weights for all the variables, optimal category scores for all ordinal and nominal variables, and a canonical correlation. Graphical representations are very important in interpreting this plethora of results. In fact, several authors have argued that graphical representations are even crucial in understanding the results of linear multivariate methods, particularly linear CCA, because patterns in the data can best be detected by the eye (Cailliez and Pagès, 1976; Ter Braak, 1990).

### **Interpreting CCA Solutions in Mapping Attitudes and Industry Stakeholders**

To interpret the results of a nonlinear CCA solution for our data with  $p$  canonical variates, it is useful to generate a  $p$ -dimensional plot of the weights of the optimally scaled attitude variables and the weights of the nominal industry-type variable quantified for each canonical variate. Because we have only one nominal variable on the explanatory-variables side of the problem, the axis of this  $p$ -dimensional plot can coincide with the weights of this nominal variable on the canonical variates, because the vector of weights will be orthogonal and the  $p$ -dimensional space can be arbitrarily rotated. The upper bound on  $p$ , the number of canonical variates, is the minimum of the number of attitude variables and the number of industry types (categories of the nominal variable). Analysts generally aim for a two-dimensional canonical solution ( $p = 2$ ) due to the interpretative convenience of two-dimensional plots (Gifi, 1990); solutions in higher dimensions generally require multiple pair-wise plots. Optimal dimensionality of a CCA solution is determined by comparing canonical correlations and by further criteria detailed in Gittins (1985). Such plots are commonly referred to as plots of component loadings.

The square of length of the vector from the origin of the component loadings plot to the coordinates of a given variable indicates how much of the dependent variable was explained by all canonical variates in total, and the square of the projections of the vector on the axes reveal how much of the explanation was due to each canonical variate. For any two variables, the inner (dot) product of the two vectors is a close approximation of the correlation between the two optimally scaled variables (Ter Braak, 1990). <sup>1</sup>Thus, in the present application, the inner product of the vectors for two dependent variables on the component loadings plots indicates the degree of correlation between attitudes towards two different policy initiatives. The inner product of the vector of a dependent variable and the vector of the quantification of the explanatory variable on a given canonical variate gives the correlation between the attitude toward a policy initiative and one quantification of the industry type variable. Each of the quantifications of the explanatory variable aligns with one of the coordinate axes.

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<sup>1</sup> An inner product is defined as the product of the lengths of the corresponding vectors and the cosine of the angle between them. Correlation is positive if the angle between two vectors is sharp, negative if the angle is obtuse, and zero if the angle is perpendicular

A second plot or series of category score plots provides the remainder of the information we need to interpret a nonlinear CCA solution in the present application. Multiple treatment of the industry type variable results in different category scores on each canonical variate for this nominal explanatory variable, so a plot of the category scores in the space of the canonical variates allows us to visualise which industry or industries are associated with high or low values of each canonical variate. By comparing the component loadings and category scores plots we can then relate industries directly to attitudes towards policy initiatives.

## RESULTS

We divided the infrastructure investment priorities and policy options (hereafter referred to as policy initiatives) into four classes - existing road infrastructure, new road infrastructure, other proposed infrastructure, and broad-based policy initiatives. A total of twenty initiatives, listed in Table 2, were evaluated. The location of specific initiatives is summarised in the footnote to Table 2. The optimal scaling method was implemented separately in each of the four classes of policy initiatives.

**[Table 2 about here]**

### Road Infrastructure Initiatives

The responses to the five potential road infrastructure initiatives are graphed in the bar charts of Figures 2 through 6. Roundabouts with wider lanes receive the greatest overall support, with 79% of the respondents telling us that this was either a good or very good idea, with almost a majority (49%) thinking that this was a very good idea (Figure 6). In contrast, only 48% of the respondents thought that B-double access to the local road network was either a good or very good idea, while 32% thought that B-double access was in fact a bad or very bad idea (Figure 3).

**[Figures 2 – 6 about here]**

Most (70%) of the respondents thought that daytime parking restrictions on major roads was a good or very good idea, while 20% thought that it was either a bad or very bad idea (Figure 2). The remaining two road infrastructure changes, freight vehicles on bus lanes during peak periods and freight vehicle only lanes, received support of about 65%. However, a substantial minority of respondents (28%) felt that freight vehicles on bus lanes was a bad or very bad idea. Relatively few respondents (only 9%) had no opinion.

We conducted a non-linear CCA to determine how the different business sectors viewed the potential road infrastructure changes. The two-dimensional nonlinear generalized canonical analysis yielded canonical correlations of 0.394 for the first dimension and 0.280 for the second. A three-dimensional solution was rejected, as the canonical correlation for the third dimension drops to 0.198. The first canonical dimension explains 70% of the variance of its object scores, while the second dimension explains approximately 64% of the variance in its object scores. These statistics indicate that a two-dimensional canonical solution provides fairly strong relationships between the two sets of variables, the optimally scaled ordinal attitude

scales on one hand and the quantified five-category business sector variable on the other (Gittins, 1985).<sup>2</sup>

The key results from the CCA are graphed in Figures 7 and 8. The component loadings graphed in Figure 7 reveal that attitudes towards the five potential operational changes align along two approximately orthogonal dimensions through the origin. The first dimension, rotated about fifteen degrees from the first canonical variate, passes between “freight vehicle-only lanes” and “roundabouts with wider lanes” in its negative domain and close to “freight vehicles on bus lanes during peak periods” in its positive domain. Note that these three policy instruments load much more on dimension 1 than do the other two policy instruments, which load more on dimension 2. This shows that optimally scaled attitudes towards freight vehicle-only lanes and roundabouts with wider lanes are strongly positively correlated, and attitudes towards both are strongly negatively correlated with optimally scaled attitudes towards freight vehicles on bus lanes during peak periods. One can best visualize the correlations by outlining the orthogonal projection of one vector on another, or in the case of negative correlations, the projection of one vector on another rotated 180 degrees (flipped over).

### **[Figures 7 and 8 about here]**

Referring to Figure 8, the first canonical variate (ie the horizontal axis) separates contract carriers from retail, wholesale and distribution firms and, to a lesser degree, manufacturing and extraction companies. Thus, contract carriers are more in favor of operating freight vehicles on bus lanes during peak periods, while freight vehicle only lanes and, to a lesser degree, roundabouts with wider lanes are favored by retail, wholesale, distribution, manufacturing and extraction firms.

The second (vertical) canonical variate is closely aligned with a dimension that distinguishes two negatively correlated policy initiatives: daytime parking restrictions, on the positive side of the dimension, and B-double access to local roads on the negative side (Figure 7). Freight hauliers, as indicated by their negative category score on the second dimension, tend to be more in favor of B-double access, while contract carriers, and to a lesser extent, retail, wholesale and distribution firms, prefer daytime parking restrictions (Figure 8). This is intuitively plausible given the dominant amount of urban goods movement on arterial roads by contract carriers.

Of the five categories of firms, freight forwarders exhibit the least strong opinions about these five road infrastructure initiatives, as indicated by the position of this category near the origin of the category scores plot in Figure 8.

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<sup>2</sup> A comparative analysis conducted with the five attitude scales treated as numerical (linear), rather than ordinal, scales yielded canonical correlations of only 0.252 and 0.206. This improvement in canonical correlations demonstrates that treating the attitudinal scales as ordinal substantially improves the explanation of differences in attitudes among the five business sectors.

These results for the road infrastructure initiatives are summarised in Table 3. Support for parking restrictions on major roads between 6am-9pm is negatively correlated with support for B-double access on local roads, demonstrating that when one improves the capacity of major roads by introducing parking restrictions, one has less need to use local roads. Contract carriers are more in favour of parking restrictions and less in favour of B-double access to local roads. An opposing view is that of freight hauliers, who support access to local roads over parking restrictions. Freight forwards also lean toward parking restrictions, but not as strongly as contract carriers.

### **[Table 3 about here]**

Support for freight vehicle only lanes is positively correlated with support for roundabouts with wider lanes, and both are negatively correlated with allowing freight vehicles on bus lanes during peak periods. Both of these policies provide for greater capacity to improve the movement of freight vehicles. Greatest support for such increased capacity is among retail, wholesale, and distribution firms, and among manufacturing and extraction firms. The weakest support for such increased capacity is among contract carriers. Contract carriers prefer instead the policy of allowing freight vehicles on bus lanes during peak periods. Retail, wholesale, distribution, manufacturing, and extraction firms are less in favour of allowing freight vehicles on bus lanes.

### **New Road Infrastructure**

Respondents were also presented with four potential new road infrastructures. The evaluations of these policies are graphed in the bar charts of Figures 9 through 12. Most respondents (71%) think that extension of the M5 east is a very good idea, and over 90% think it is either a good or very good idea (Figure 11). There are more diverse opinions about the other three new road infrastructure initiatives, and opinion is fairly even split about the merits of an orbital road around Sydney about 40 kms. out from the CBD.

### **[Figures 9 – 12 about here]**

The results of the non-linear CCA linking business sector and attitudes towards four potential new road infrastructure policies are graphed in Figures 13 and 14. A two-dimensional solution was again chosen, in this case with canonical correlations of 0.358 for the first dimension and 0.262 for the second. In a three-dimensional solution

the canonical correlations are 0.348, 0.290, and 0.144, showing a substantial drop-off in explanatory power for the third orthogonal dimension<sup>3</sup>.

The nonlinear CCA reveals that there is one dimension of policy support (ie almost equal loadings on both vertical and horizontal axes for all policy instruments) skewed to the axes of the canonical variates, that has extension of the M5 east and an orbital road around Sydney 30 kms. out at opposite poles (Figure 13). An orthogonal dimension measure aligns with support for an eastern distributor. The pattern on the category scores plot (Figure 14) contrasts contract carriers against retail, wholesale, and distribution firms, and freight forwarders against manufacturing and extraction firms. As in the previous case of road infrastructure initiatives, freight hauliers represented the segment with the least conspicuous pattern of attitudes.

**[Figures 13 and 14 about here]**

An interpretation of the key results plotted in Figures 13 and 14 is listed in Table 4. Once again, contract carriers and the retail, wholesale and distribution sector are at opposite ends of support for and against three of the new infrastructure policies, specifically the two orbital roads and the extension of the M5 Motorway east to Port Botany and the Kingsford Smith Airport. However these two industry types do not have outstanding views on a new Eastern Distributor Route. Freight forwarders support an Eastern distributor, while the manufacturing and extraction sectors are least in favour of this new road infrastructure.

**]Table 4 about here]**

### **Other Proposed Infrastructure**

Seven potential new non-road infrastructures were also presented to respondents, and their evaluations are graphed in Figures 15 through 21. About half of the sample views the development of railheads and inland ports as a good or very good idea, but a substantial percentage (37%) are neutral on such a policy (Figure 15). Opinions are fairly evenly split regarding whether location of a third Sydney airport at Badgery Creek is a good idea (Figure 16), and similarly whether location of an airport at Holdsworthy is a good idea (Figure 17). The Badgery Creek location receives support from a greater proportion of the sample.

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<sup>3</sup> A comparative analysis conducted with the four attitude scales treated as numerical yielded canonical correlations of only 0.334 and 0.192. The performance of the first dimension is similar, but the second dimension is much more effective in explaining attitude differences when the scales are treated as ordinal rather than numerical.



**[Figures 15 – 21 about here]**

A proposed rail terminal at Chullora is generally thought not to be a bad idea (Figure 18), but most attitudes are not well developed on proposed rail terminals at Bathurst (Figure 19) and Blaney (Figure 20), both of which are a considerable distance from Sydney. Finally, there is a skewed distribution of support for a common user terminal at Port Botany (Figure 21).

The results of the non-linear CCA linking business sector and attitudes towards the seven potential new non-road infrastructures are graphed in Figures 22 and 23. Once again, a two-dimensional solution was chosen, with canonical correlations of 0.404 for the first dimension and 0.342 for the second. The canonical correlations for the three dimensional solution were 0.386, 0.330, and 0.208, demonstrating a substantial falloff of explanatory power for the third dimension<sup>4</sup>.

The plot of the optimal component loadings in Figure 22 shows that attitudes towards the two locations for the third Sydney airport are highly negatively correlated<sup>5</sup>. Also, attitudes towards a proposed rail terminal at Chullora are positively correlated with attitudes toward inland railhead and ports in general. Attitudes towards development of the current rail interchange terminal at Blaney are relatively independent of attitudes towards all of the other infrastructure policies. It loads very (negatively) high on both dimensions but has no corresponding correlated attitudes in the bottom left quadrant of the top right quadrant (in contrast to the two airport sites) There are no differences among the industry types in terms of attitudes towards a common user terminal at Port Botany.

**[Figures 22 and 23 about here]**

The differences in attitudes toward new infrastructure uncovered in the analysis are summarized in Table 5. On these non-road infrastructure policies, support of freight forwarders is diametrically opposed to support of the manufacturing and extraction sectors, and support of freight hauliers is opposed to support of freight forwarders.

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<sup>4</sup> A comparison of CCA results also revealed that an ordinal treatment is very important for these seven attitude scales, as the canonical correlations for a two-dimensional solution with numerical scales fall to 0.296 and 0.206 (versus 0.386 and 0.330), indicating a large reduction in explanatory power if the attitude scales are forced to be linear.

<sup>5</sup> The location of the new airport is a highly political and emotional issue, with very active residents groups publicly opposing one or both locations on social and environmental grounds in favour of a site away from the Sydney metropolitan area.

**[Table 5 about here]**

### **Policy Changes**

In the final analysis, we analyze the four potential policy changes that were presented to respondents. The raw data from the evaluations are graphed in Figures 24 through 27. All of the distributions were skewed in the direction of “very good idea,” especially opinions concerning a policy of improved education of car drivers (Figure 26). However, the mode of the distribution of opinions concerning a policy of priority to intermodal linkages (especially rail) indicates that many respondents had not formed positive or negative attitudes (Figure 27).

**[Figures 24 – 27 about here]**

The results of the final non-linear canonical analysis linking business sector and attitudes towards four potential policy changes are graphed in Figures 28 and 29. The two-dimensional solution yielded canonical correlations of 0.346 and 0.194, indicating that the second dimension is not nearly as effective as the first. The explanatory power of these dimensions are much higher when the scales are treated as ordinal rather than numerical, because the canonical correlations fall off to 0.256 and 0.136

**[Figures 28 and 29 about here]**

The only fairly strong positive correlation of attitudes, discernible from the component loadings plotted in Figure 28, is between education of car drivers (re trucks) and planning for 24-hour needs. Extending each vector in the 180 degree direction, we see a negative correlation (a little less than the aforementioned) between 24-hr needs and intermodal linkages, and two other lesser negative correlations (about one-half the magnitude of the one positive correlation.) between open 24-hrs and intermodal linkages and between open 24-hrs and educate drivers. The correlation between 24-hour needs and open 24-hrs is almost perfectly zero, and the negative correlation between intermodal linkages and educate drivers is pretty small compared to the others.

On the industry type-side of this analysis (Figure 29), the attitudes of contract carriers are opposed to those of the retail, wholesale, and distribution sectors, and attitudes of freight hauliers are opposed to those of the manufacturing and extraction sectors.

The results of this last analysis are summarized in Table 6. No industry sector is directly aligned with support for the policy of planning for the 24-hour needs of people and freight, and the weakest support for this policy is from the manufacturing and extraction sectors and from freight forwarders. Contract carriers are more in favour of regulatory changes to allow collection and distribution centres to be open 24 hours, while the

weakest support for this policy is from the retail, wholesale, and distribution sector. Improved education of car drivers to improve attitudes towards trucks is favored, as one would expect, by freight hauliers, with weakest support from the manufacturing and extraction sector. Finally, a policy of assigning priority to intermodal linkages (especially rail) is most favoured by the retail, wholesale, and distribution sector, by the manufacturing and extraction sector, and by freight forwarders.

[table 6 about here]

## SUMMARY AND CONCLUSIONS

Increasingly, governments in a number of countries such as Australia are recognising that they have not paid enough attention to the urban transport infrastructure needs of the freight sector. Typically, freight vehicles are given a pre-determined allocation of road capacity in a passenger-based travel model system and then essentially ignored. In addition, government agencies rarely involve the major freight and logistics players in the early phases of the planning process; rather opportunities are provided to comment *ex post* on infrastructure options via an Environmental Impact Assessment public hearing.

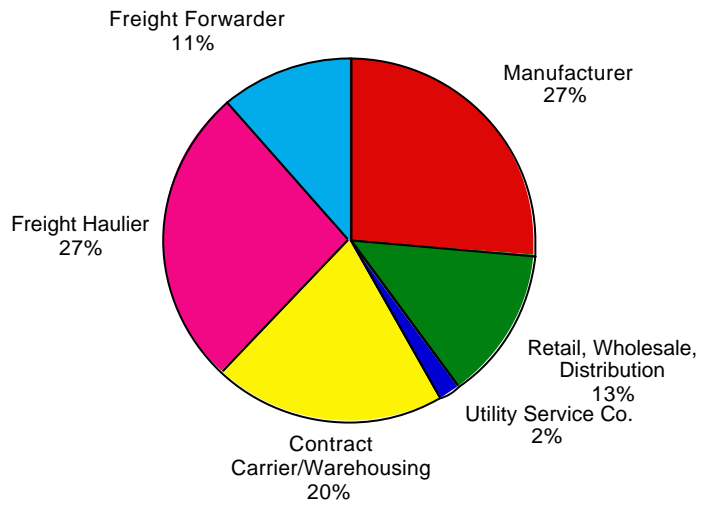
In this research we analysed attitudes towards alternative policy initiatives of senior management responsible for logistics, operations, warehousing and transport in 147 companies in five sectors: (1) contract carriers, (2) freight forwarders, (3) freight hauliers, (4) manufacturing and extraction, and (5) retail, wholesale, and distribution. The method we used, nonlinear canonical correlation analysis, succeeded in identifying clear patterns in attitudes that revealed how support for various policies varied across industry sectors. We believe that this method is new to the field of transport research.

The approach reinforces the importance of establishing a mapping between the views on specific potential policy and strategic issues and the stakeholder domain from which various degrees of support and opposition might evolve. Government agencies can use this information in positioning specific strategies and developing marketing plans to ensure that stakeholder support is maximised. Such a formula is likely to be attractive to the political process.

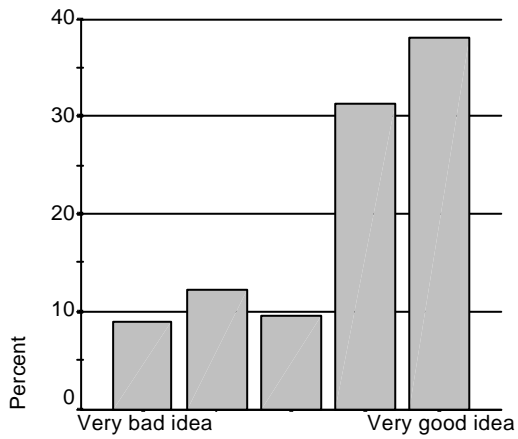
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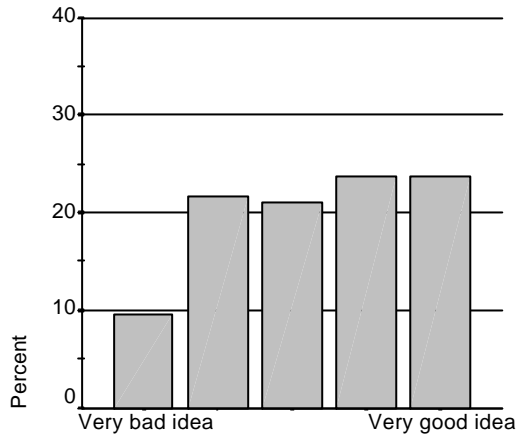
**FIGURES**



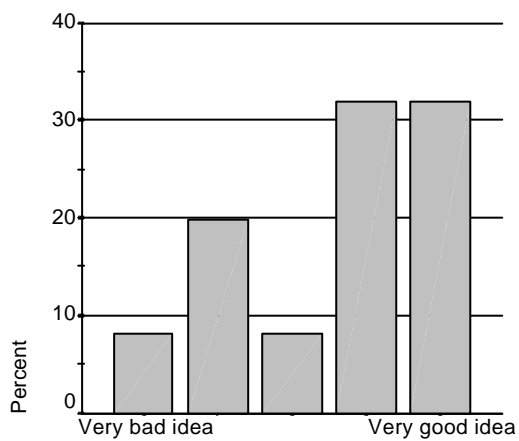
**Figure 1** Breakdown of Sample by Industry Type



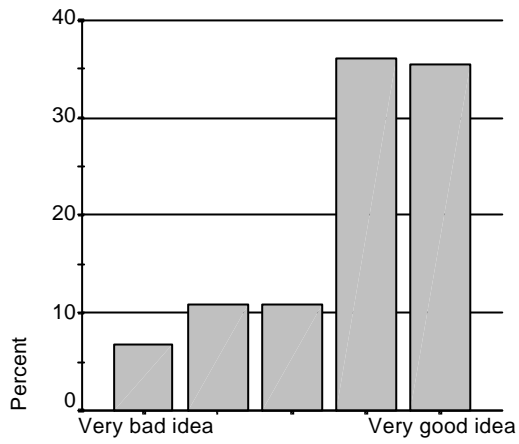
**Figure 2** Evaluation of "Parking restrictions on major roads from 6am-9pm"



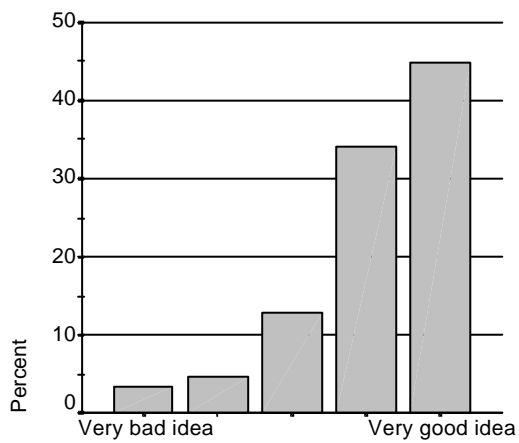
**Figure 3** Evaluation of "B-double access to local road network



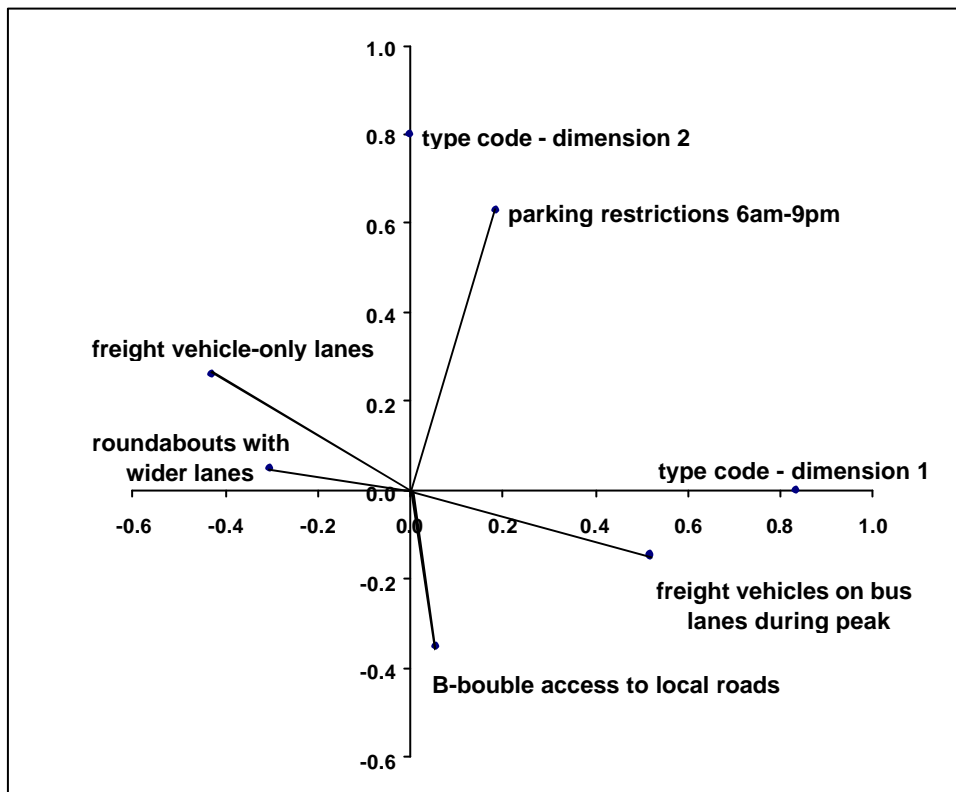
**Figure 4** Evaluation of "Freight vehicles allowed on bus lanes during peak periods



**Figure 5** Evaluation of "Freight vehicle only lanes"

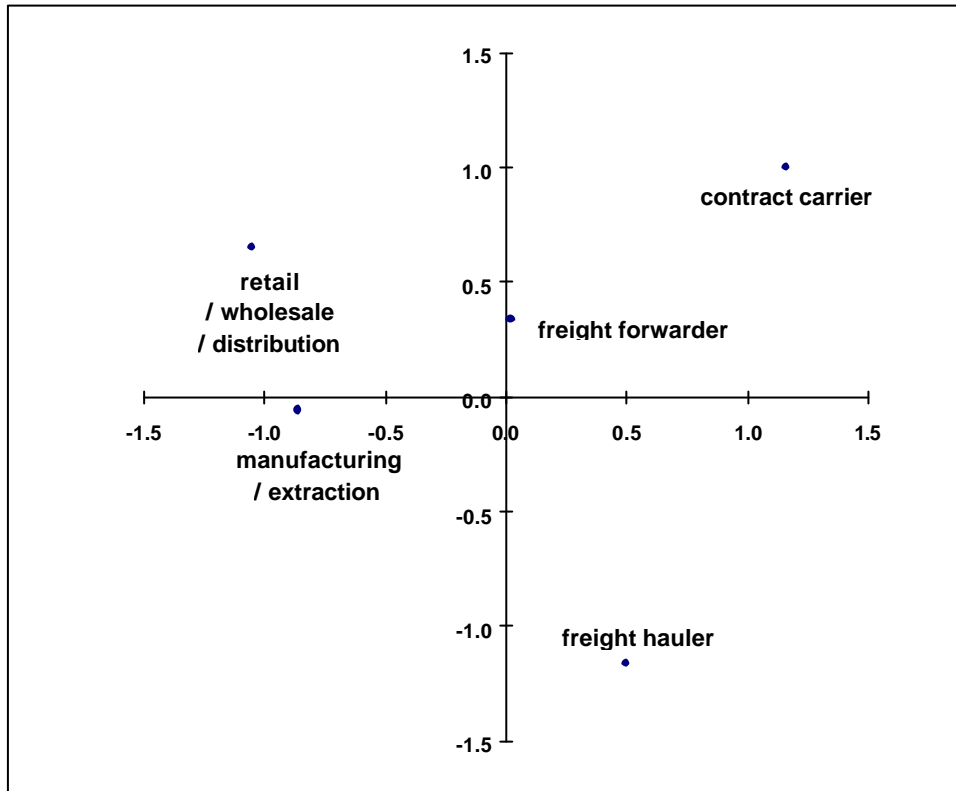


**Figure 6** Evaluation of "Roundabouts with wider lanes"

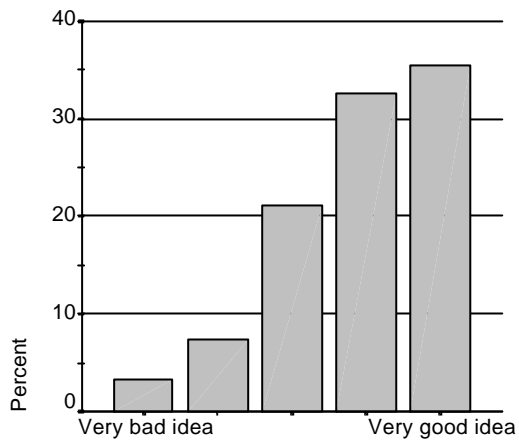


**Figure 7** Component loadings for the optimally quantified attitudes towards road infrastructure initiatives

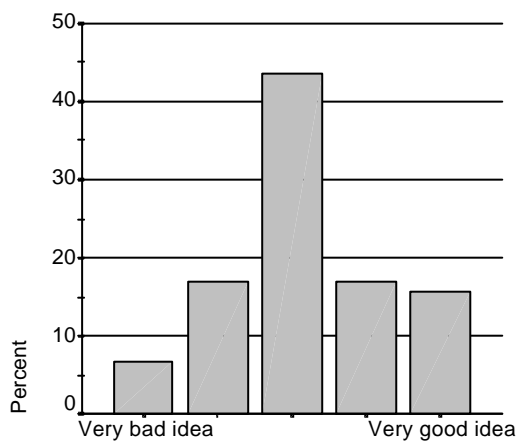




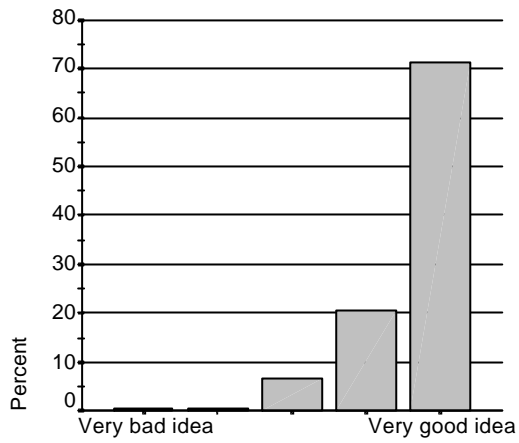
**Figure 8** Optimal category scores for the business sector variable in explaining attitudes towards road infrastructure initiatives



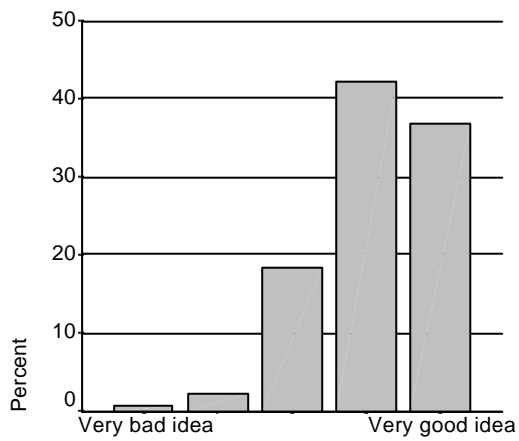
**Figure 9** Evaluation of "An orbital road around the Sydney CBD about 30 kms out"



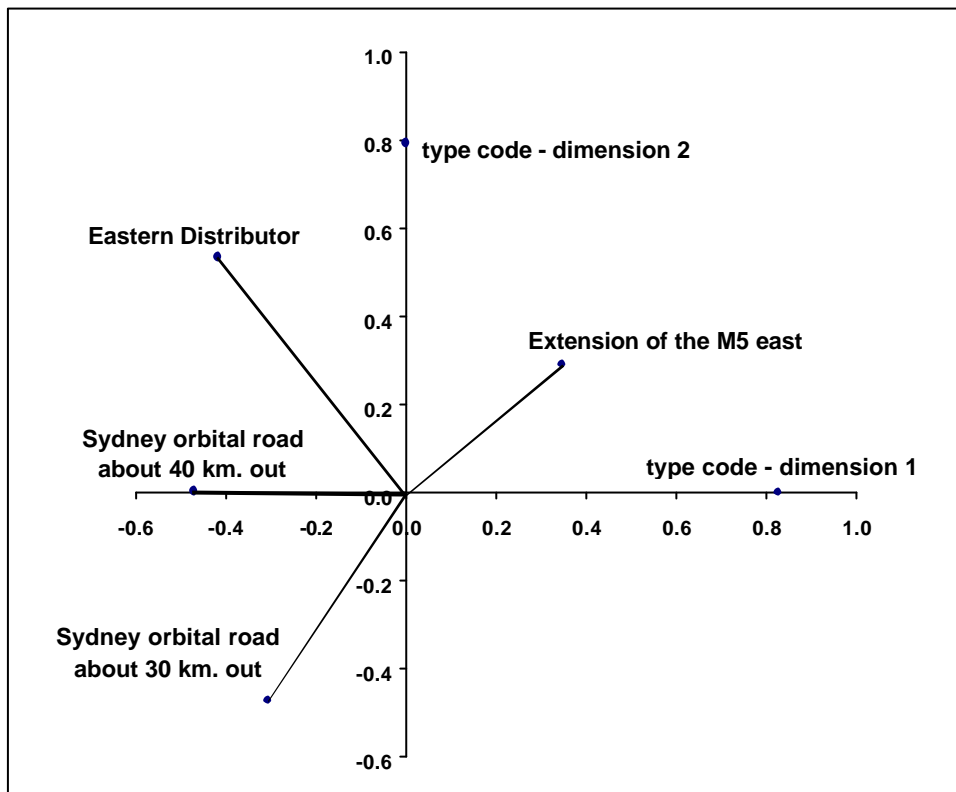
**Figure 10** Evaluation of " An orbital road around the Sydney CBD about 40 kms out"



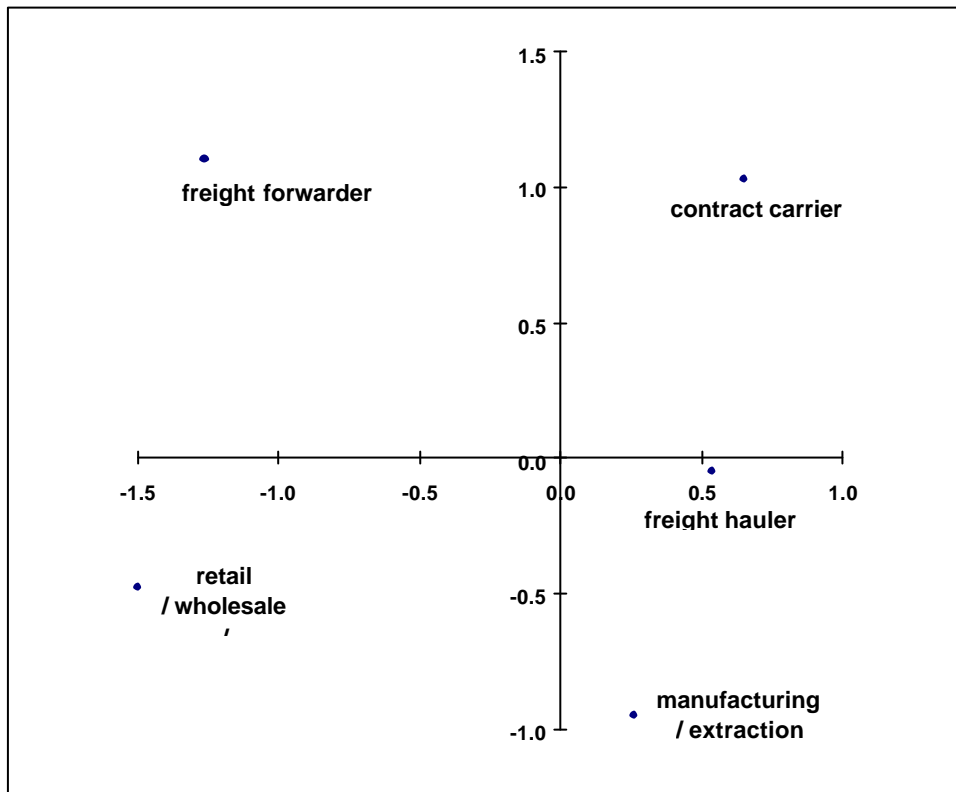
**Figure 11** Evaluation of "Extension of the M5 east to Port Botany and Kingsford Smith Airport"



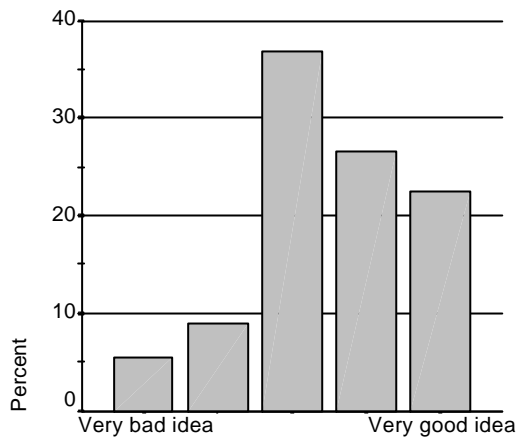
**Figure 12** Evaluation of "Eastern Distributor"



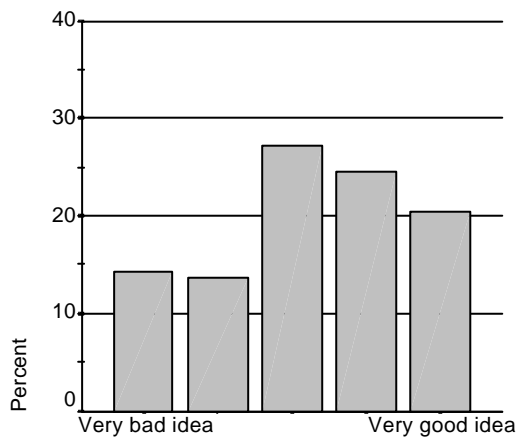
**Figure 13** Component loadings for the optimally quantified attitudes towards new road infrastructure



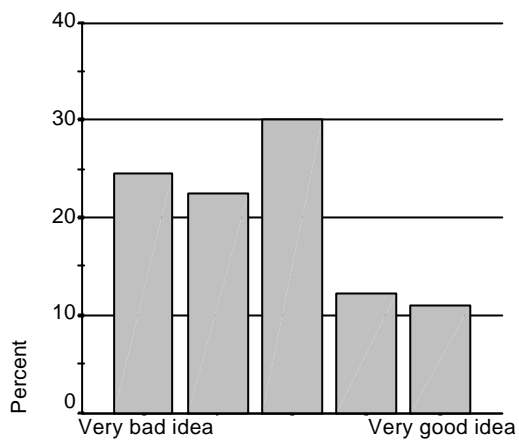
**Figure 14** Optimal category scores for the business sector variable in explaining attitudes towards new road infrastructure



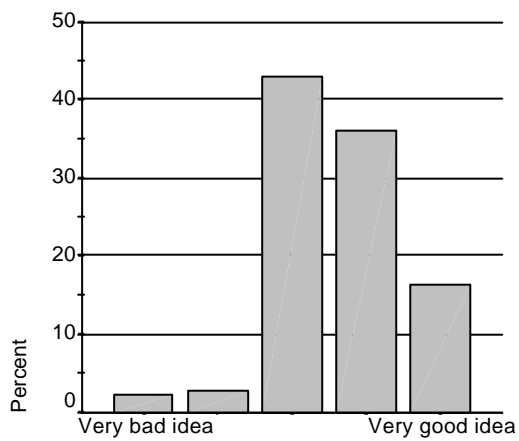
**Figure 15** Evaluation of "Railheads and inland ports"



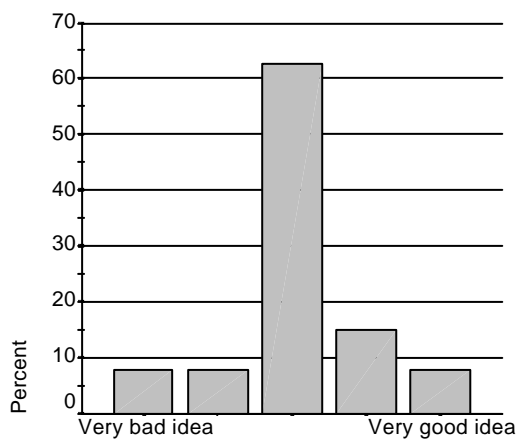
**Figure 16** Evaluation of "Location of Sydney's third airport at Badgery Creek "



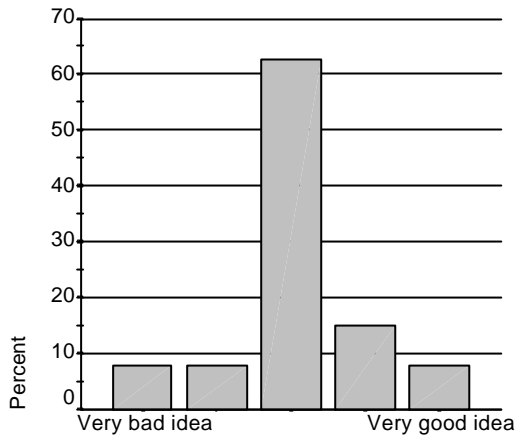
**Figure 17** Evaluation of "Location of Sydney's third airport at Holdsworthy"



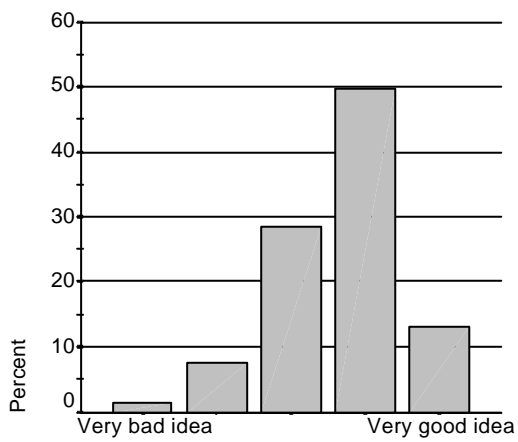
**Figure 18** Evaluation of "Proposed rail interchange terminal at Chullora"



**Figure 19** Evaluation of "Proposed rail interchange terminal at Bathurst "

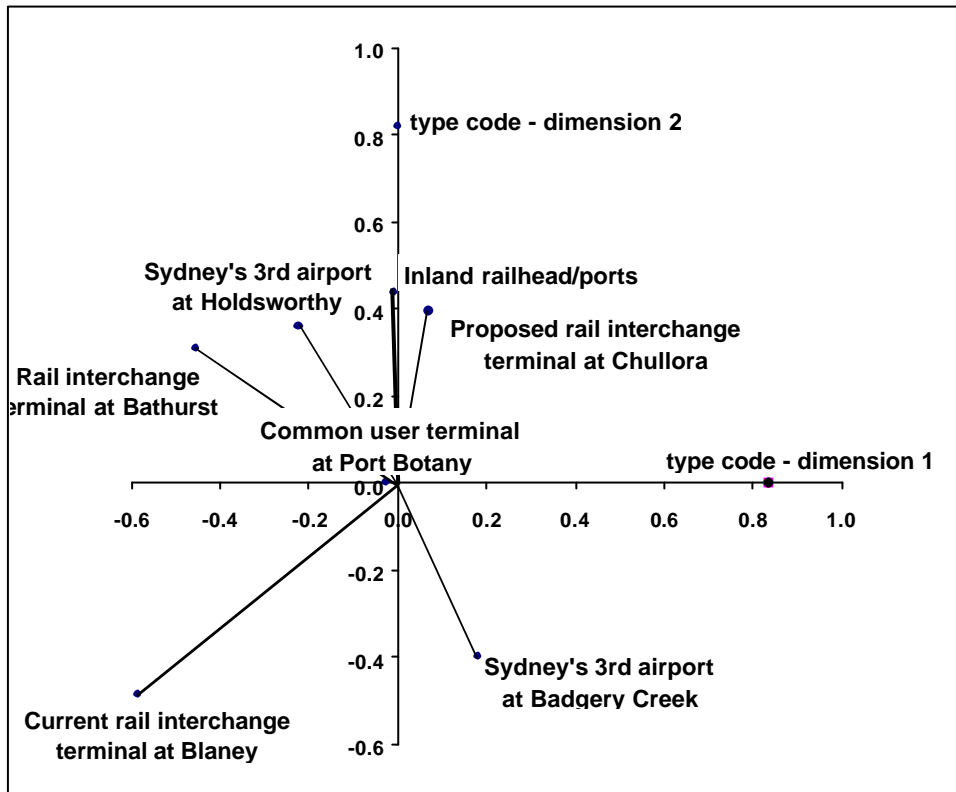


**Figure 20** Evaluation of "Current rail interchange terminal at Blaney "

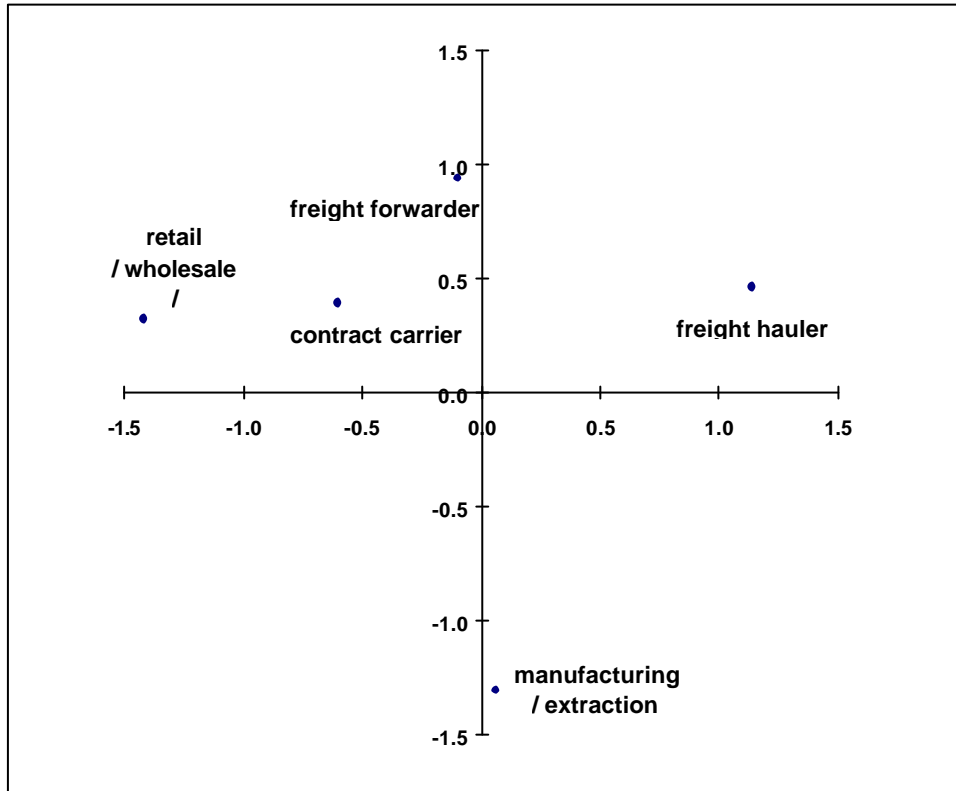


**Figure 21** Evaluation of "Common User terminal at Port Botany"

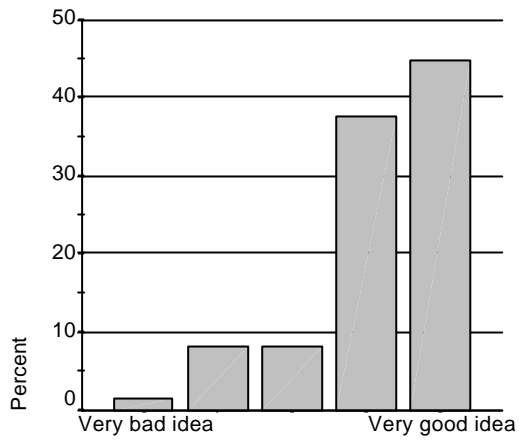




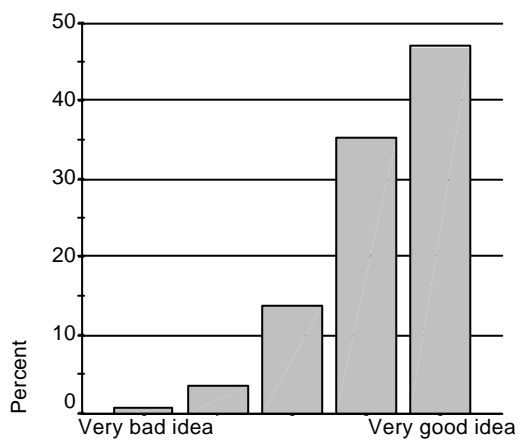
**Figure 22** Component loadings for the optimally quantified attitudes towards new infrastructure



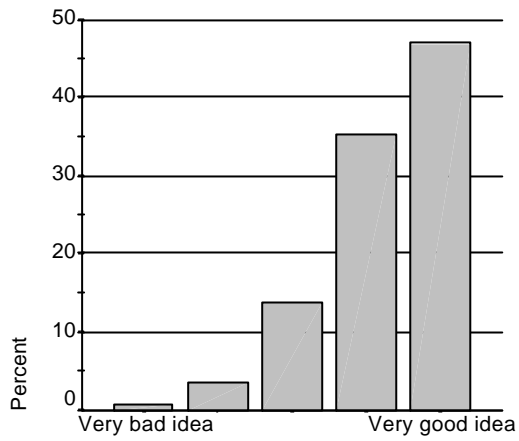
**Figure 23** Optimal category scores for the business sector variable in explaining attitudes towards new infrastructure



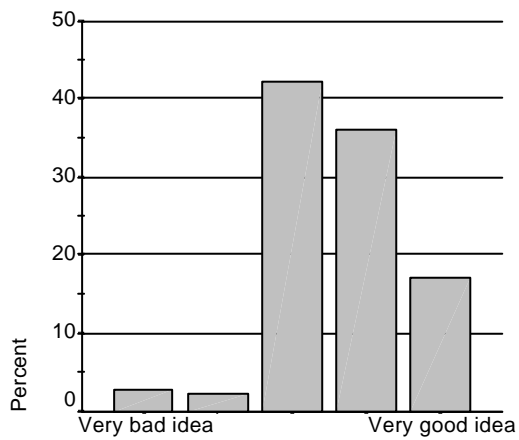
**Figure 24** Evaluation of "Plan transport for 24-hour needs of people and freight rather than peak period demand for cars "



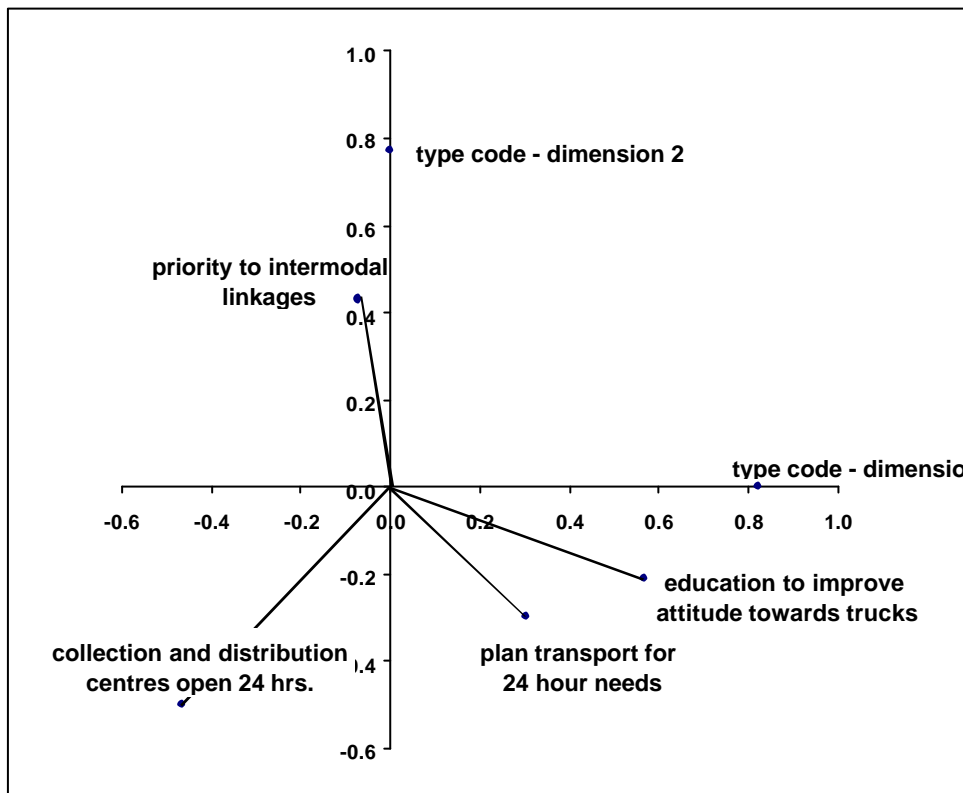
**Figure 25** Evaluation of "Regulatory changes to allow collection and distribution centres to be open 24 hours"



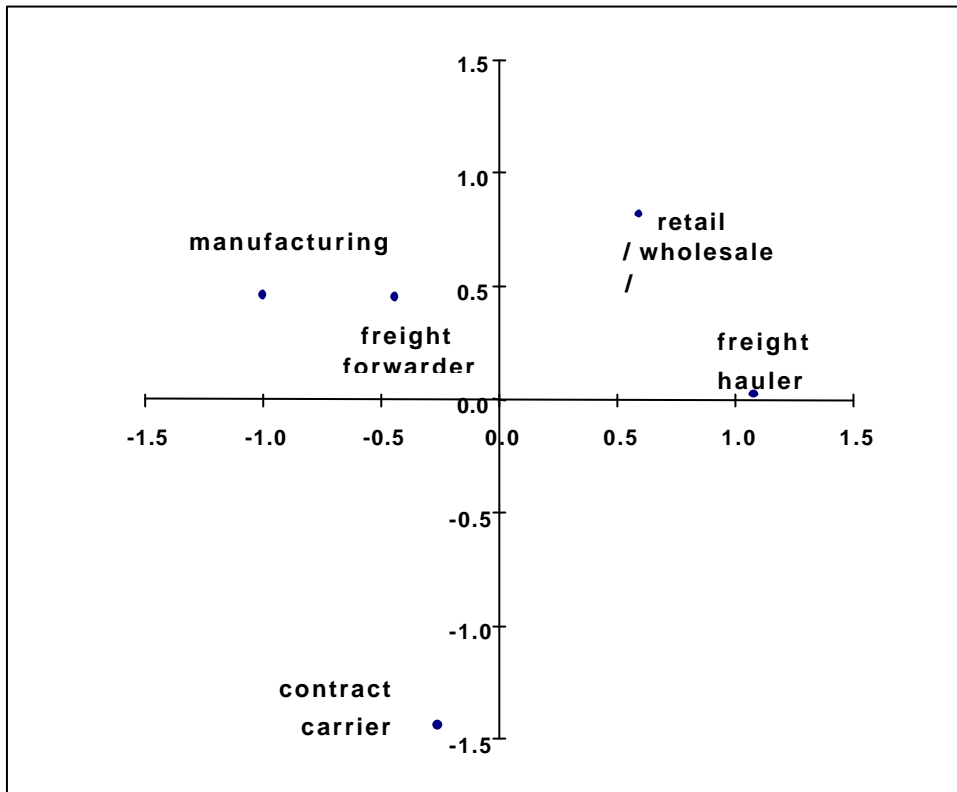
**Figure 26** Evaluation of "Improved education of car drivers to improve attitudes towards trucks"



**Figure 27** Evaluation of "Priority to intermodal linkages, especially rail "



**Figure 28** Component loadings for the optimally quantified attitudes towards policy changes



**Figure 29** Optimal category scores for the business sector variable in explaining attitudes towards policy changes

**TABLES**

**Table 1** CATI Response Rates

<b>Description</b>	<b>Response</b>	<b>Percent</b>
No Answer	248	16.8%
Refusals	112	7.6%
Call Backs	861	58.6%
Fax	14	1.0%
Screened Out (Non-quota)	85	5.8%
Actual Interviews	150	10.2%

**Table 2** Proposed policy initiatives tested in the survey

<b>Policy Initiatives (Scale: 1=very bad idea, .... 5=very good idea)</b>
<p><b>Existing Road Infrastructure Initiatives:</b>                      parking restrictions on major roads from 6am - 9pm                      B-double access to local road network                      freight vehicles allowed on bus lanes during peak periods                      freight vehicle only lanes                      roundabouts with wider lanes</p>
<p><b>New Road Infrastructure Initiatives:</b>                      an orbital road around the Sydney CBD about 30 kms out                      an orbital road around the Sydney CBD about 40 kms out                      extension of the M5 east to Port Botany and Kingsford Smith Airport                      Eastern Distributor</p>
<p><b>Other Proposed Infrastructure:</b>                      railheads and inland ports                      location of Sydney's third airport at Badgery Creek                      location of Sydney's third airport at Holdsworthy                      proposed rail interchange terminal at Chullora                      proposed rail interchange terminal at Bathurst                      current rail interchange terminal at Blaney                      common user terminal at Port Botany</p>
<p><b>Policy Changes:</b>                      plan transport for 24-hr. needs of people and freight rather than peak period demand                      regulatory changes to allow collection and distribution centres to be open 24 hrs.                      improved education of car drivers to improve attitudes towards trucks                      priority to intermodal linkages, especially rail</p>

Notes: The M5 East Extension is a major freeway in the South West connecting into the M5 - a private tolled road. Badgery Creek and Holdsworthy (near Liverpool) are locations in Sydney's West. Chullora is near Enfield

approximately 10 km from the Sydney CBD; Blaney and Bathurst are over the Blue Mountains at least 2 hours from Sydney CBD.



**Table 3** Summary of results of non-linear canonical analysis of attitudes towards road infrastructure initiatives versus business sector (most prominent results underlined)

Policy	Strongest support	Weakest support
parking restrictions on major roads from 6am - 9pm	<u>contract carriers</u> retail/wholesale/distribution freight forwarders	<u>freight hauliers</u>
B-double access to local road network	freight hauliers	contract carriers
freight vehicles allowed on bus lanes during peak periods	<u>contract carriers</u>	<u>retail/wholesale/distribution</u> manufacturing/extraction
freight vehicle only lanes	<u>retail/wholesale/distribution</u> manufacturing/extraction	<u>contract carriers</u>
roundabouts with wider lanes	retail/wholesale/distribution manufacturing/extraction	contract carriers

**Table 4** Summary of results of non-linear canonical analysis of attitudes towards new road infrastructure versus business sector (most prominent results underlined)

Policy	Strongest support	Weakest support
an orbital road around the Sydney CBD about 30 kms out	<u>retail/wholesale/distribution</u> manufacturing/extraction	<u>contract carriers</u>
an orbital road around the Sydney CBD about 40 kms out	retail/wholesale/distribution freight forwarders	contract carriers freight hauliers
extension of the M5 east to Port Botany and K.S. Airport	<u>contract carriers</u> freight hauliers	retail/wholesale/distribution
Eastern Distributor	<u>freight forwarders</u>	<u>manufacturing/extraction</u>

**Table 5** Summary of results of non-linear canonical analysis of attitudes towards new infrastructure versus business sector (most prominent results underlined)

Policy	Strongest support	Weakest support
railheads and inland ports	<u>freight forwarders</u>	<u>manufacturing/extraction</u>
location of Sydney's third airport at Badgery Creek	<u>manufacturing/extraction</u>	freight forwarders contract carriers
location of Sydney's third airport at Holdsworthy	freight forwarders contract carriers	<u>manufacturing/extraction</u>
proposed rail interchange terminal at Chullora	freight forwarders	manufacturing/extraction
proposed rail interchange terminal at Bathurst	<u>retail/wholesale/distribution</u> contract carriers	manufacturing/extraction freight hauliers
current rail interchange terminal at Blaney	manufacturing/extraction	<u>freight hauliers</u>
common user terminal at Port Botany	(none)	(none)

**Table 6** Summary of results of non-linear canonical analysis of attitudes towards policy changes versus business sector (most prominent results underlined)

Policy	Strongest support	Weakest support
plan transport for 24-hr. needs of people and freight rather than peak period demand		manufacturing/extraction freight forwarders
regulatory changes to allow collection and distribution centres to be open 24 hrs.	contract carriers	retail/wholesale/distribution
improved education of car drivers to improve attitudes towards trucks	<u>freight hauliers</u>	<u>manufacturing/extraction</u>
priority to intermodal linkages, especially rail	retail/wholesale/distribution manufacturing/extraction freight forwarders	