PRODUCTIVITY COMMISSION INQUIRY INTO ROAD AND RAIL FREIGHT INFRASTRUCTURE PRICING

Supplementary Submission – Classification of the Road Network for Cost Allocation Purposes

September 2006

National Transport Commission

Prepared by

NTC with Maunsell Australia Pty Ltd

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REPORT OUTLINE

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Abstract: This report identifies the usefulness of different types of road network classifications with respect to heavy vehicle cost allocation and pricing using a qualitative analysis. Quantitative analysis is required for firm conclusions to be reached in this area.

Purpose:	For information
Key words:	Road network classification, cost allocation, differentiating prices, economic efficiency, geographic, construction, functional, funding, traffic volume, traffic composition, road/rail substitutability

FOREWORD

The National Transport Commission (NTC) is an independent body established under an Inter-Governmental Agreement, and funded jointly by the Australian Government, States and Territories. The NTC has an on-going responsibility to develop, monitor and maintain uniform or nationally consistent regulatory and operational reforms relating to road transport, rail transport and intermodal transport.

The NTC's heavy vehicle road pricing work contributes to strategies pursuing transport as a more sustainable activity, and in devising smarter approaches to regulation, provides both increased flexibility and greater certainty about results achieved.

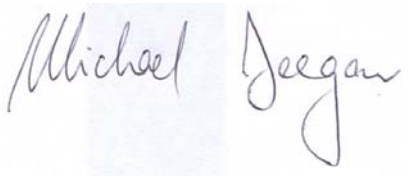
As part of its Inquiry into Road and Rail Infrastructure Pricing the Productivity Commission released an Issues Paper in March 2006. The NTC submitted a main response in May 2006 but noted there were a number of technical issues which it wished to consider further. This paper has been prepared as part of a series of technical supplementary submissions to further inform the Productivity Commission's Inquiry.

One of these issues is the impact that a change in the price structure may have on the road classification currently used for deriving heavy vehicle charges. This paper identifies the various approaches that could be taken to road classification which might better marry with a more direct form of heavy vehicle charges. This is an important implementation issue and the NTC is strongly of the view that a firm understanding of these issues will support the development of practical recommendations.

This project is critically linked to:

- the capability to implement future road pricing systems including incremental pricing and potentially a national direct pricing system; and
- effective extension of Performance-Based Standards to support additional productivity improvements in movement of road freight, which will require an ability to determine charges for additional mass increases based on accurate assessments of the resulting road costs.

The NTC acknowledges the work of Maunsell Australia Pty Ltd as the major contributor to this report, as well as the contributions of the following members of the NTC Transport Pricing Team, Chris Egger, Meena Naidu and Fiona Calvert.



Michael Deegan
Chairman

SUMMARY

The Productivity Commission is currently undertaking an Inquiry into Road and Rail Freight Infrastructure Pricing. As part of the process it released an Issues Paper in February 2006 asking for responses to a number of strategic and technical issues. The National Transport Commission (NTC) responded to the Issues Paper in May 2006. However, it noted that there were a number of technical questions which it wished to consider in more depth and respond to later by way of supplementary submission.

One of these issues is the cost allocation methodology. The Productivity Commission asked what attributes of road are likely to affect road infrastructure costs. Whilst the NTC did respond to this question, it felt the issue needed greater consideration. As such it engaged the services of Maunsell Australia to consider various road classification options for cost allocation purposes under a direct pricing arrangement. The purpose of this report is to investigate the various ways in which the road network could be classified for cost allocation and heavy vehicle road pricing purposes. In doing so it indicates which approaches better marries costs with prices. Although this will not be a driving factor for price reform, it is an important consideration in the development of any new pricing regime as it impacts on practical implementation of a new price structure. It is therefore crucial to understand the underlying limitations of applying the current approach to a different pricing arrangement, identify alternative approaches and assess each approach for appropriateness.

The following questions form the basis of this report:

- Does the current classification and cost allocation process adequately reflect differences in costs associated with categories?
- Do our current assumptions under the current heavy vehicle road pricing cost allocation approach average out too much?
- What are the objectives of differentiating prices?
- What breakdown of the network should be used to cost over?
- What breakdown of the network might you differentially price over?
- How significant is the need to be able to distinguish between different road types for cost allocation purposes?

Averaging under the current PAYGO system

In assessing the value of alternative approaches to network classification it is helpful to first understand to what extent the current averaging process under PAYGO and the existing cost allocation method leads to distortions in cost allocation.

The current assumptions under PAYGO and the existing approach to allocating costs lead to averaging across costing in three different areas:

- Costs incurred by road use of vehicles within one vehicle class only depend on whether roads are local/arterial or rural/urban.
- The share of attributable and non-attributable costs are the same for cost categories of all road types.

- Vehicles within one category all have the same relative shares of local or arterial road use.

As the current PAYGO approach leads to uniform charges for vehicles in one category, the implication is there is also a significant extent of averaging in charges. An overall indication of the extent of averaging and its appropriateness can be obtained by examining the distribution of unit costs of different types of roads. The more dispersed the distribution of unit costs around the mean, the less appropriate averaging is. Hence, an analysis of unit costs of different road types (that are currently not used in the cost allocation approach) could reveal whether averaging is appropriate.

Objectives for differentiating prices

As there is a strong link between the price structure and cost allocation, it is important to understand what objectives are sought through differentiating prices. These will need to be considered in the development of a classification system. Three objectives can be identified:

- enhance economic efficiency;
- contribute to competitive neutrality between road and rail transport; and
- enhance equity.

Economic efficiency is enhanced when prices are aligned more closely with the costs incurred by each heavy vehicle. Price signals then indicate the true cost of using the road and this provide incentives for efficient use of roads. By aligning prices more closely with the actual costs, competitive neutrality between road and rail transport is enhanced as heavy vehicles pay for actual costs of road use. If equity is defined as a situation in which every user pays for the individual costs incurred, differentiated prices can also enhance equity. Other notions of equity might not be achieved by differentiating heavy vehicle road user prices.

Road network classifications for cost allocation and pricing

In order to assess the appropriateness of the various approaches to road network classification, three main questions should be addressed:

- How far does the road network classification account for different relationships between heavy vehicle road use and expenditure on different types of roads?
- How would prices differ across road types?
- Does a further aggregation of the road network lead to significant differences in prices between road types?

In order to assess the appropriateness of road network classifications with respect to pricing, the following four criteria are used:

- equity (social implications of differentiating prices);
- boundaries between classes, stability of future classes;
- informed decision-making and incentives; and
- administrative simplicity such as data availability.

Table ES1 presents the advantages and disadvantages identified for different road network classifications with respect to cost allocation and price determination.

Table ES1. Summary of advantages and disadvantages of road network classifications

Road network classification	Applying road network classification to cost allocation	
	Advantages	**Disadvantages**
Climate, topography	Addresses variation in capital and maintenance costs Addresses variation in attributable cost to a limited extent	Does not reflect variations in externality costs
Urban-rural distinction	Variation in externality costs addressed accurately Variation in non-attributable costs addressed to a limited extent Differences in costs due to economies of scale addressed to a certain degree	Does not address other variations in attributable cost
Construction based classification	Addresses relationship between road wear and road use for different types of roads Road construction type imperfectly related to urban-rural distinction, thus externality costs are addressed to a limited extent	Relationship between road wear and road use not fully established
Functional based classification	Combines different criteria for categorisation Addresses attributable cost Takes account of externality cost to a certain degree	Not meaningful in its own sense Relationship between function of road and other criteria imperfect
Funding based classification	Combines different criteria for categorisation Addresses variations in attributable cost Addresses externality cost to a certain degree	Relationship between function of road and other criteria imperfect Only meaningful with hypothecation and reasonable distribution of revenues

Road network classification	Applying road network classification to cost allocation	
	Advantages	**Disadvantages**
Traffic volume/ Traffic composition	Can improve allocation of non-attributable cost per road Can take account of congestion externalities Can take economies of scale of road provision into account	Not related to wear and tear caused by heavy vehicles on different types of roads Does not address variations in externality costs related to noise and air pollution
Road/Rail substitutability	Useful if priority is to achieve competitive neutrality	Relationship between road/rail criterion and variations in costs imperfect

The need to distinguish between different types of roads

There are a number of reasons why you might want to distinguish between different types of road. The primary reason is the effect of averaging within a category. Road categorising generally requires some form of averaging in order for costs to be estimated for pricing purposes. In doing so, everything within a particular category takes on the average value. If unit costs incurred by vehicle road use for different types of roads are rather close to the average, the need to make a distinction between these roads might be rather small.

The benefits generated by introducing road network classification to differentiate prices are influenced by three factors:

- the share of direct road use costs of total transport costs;
- price elasticity of demand for road use by heavy vehicles; and
- combination of road types used for a typical trip.

Conclusions

The purpose of this report is to identify alternative approaches to classifying the road network and assess the appropriateness of each approach for cost allocation purposes. The analysis undertaken is based on qualitative information, and as such it is difficult to draw firm conclusions without quantitative evidence. It is thus suggested that the conclusions drawn here should be viewed as preliminary and further quantitative investigations are recommended.

The following conclusions emerge:

1. A combination of road network classifications is more useful than a single classification. In order to maximise the benefits of road network classification, a large number of characteristics should be addressed by the classification. This can be achieved by combining different existing road network classifications.

2. Informed decision making by road users and road investors is one of the most important factors to be considered when considering road network classification for pricing. Economic efficiency gains can only be realised when fully informed

decisions can be made. This implies that truck drivers, operators and logistics managers must be able to predict prices for different trips. Consequently, the classification adopted must not be too complex.

3. There may be some overlaps between road classifications. Ideally, in combining road network classifications the amount of overlap should be minimised in order to capture the greatest variations in costs.

4. The impact of averaging within classifications will be important to identify prior to adopting any particular approach or setting boundaries. The wider the unit costs are dispersed from the mean, the less appropriate averaging is, and may require smaller classes within the classification framework. Further quantitative analysis of unit costs per road type will assist in identifying this.

5. It is important to assess the cost effectiveness of using various road network classifications for costing and pricing purposes. Some classifications can be more costly to implement and maintain than others. It will be important to assess whether the accuracy associated with the classification derives sufficient benefit to adopt the approach. To a large degree this will be dependent on the pricing framework – the greater the ability of prices to influence demand and supply of road infrastructure, the greater the importance of an accurate road classification system.

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1. INTRODUCTION

The Productivity Commission has commenced an Inquiry into Road and Rail Freight Infrastructure Pricing. As part of the Inquiry, the Productivity Commission released an Issues Paper seeking stakeholder response to a number of issues it intended to address. The NTC responded to that paper in May 2006. In the Issues Paper the Productivity Commission sought further information about the costing methodology for heavy vehicle charges – both in terms of cost estimation and cost allocation. In addition to providing detailed information on the current methodology in its main submission, the NTC provided a separate supplementary submission on alternative approaches to cost estimation.

The NTC also considers the further exploration of road classification alternatives for cost allocation purposes as increasingly important as there is increasing interest in enabling prices to reflect the individual costs of heavy vehicle usage on road infrastructure. The NTC therefore engaged Maunsell Australia to undertake a study to identify different approaches to road classification that may assist prices in being more cost reflective and address some of the shortcoming of the existing approach.

1.1 Purpose

The purpose of this report is to consider more appropriate classifications of the road network for cost allocation and heavy vehicle road pricing purposes. It therefore considers different types of road network classifications and their usefulness with respect to heavy vehicle cost allocation and pricing.

As a consequence this study also responds to the ongoing debate about competitive neutrality between road and rail freight transport. It is often argued that the current road charging methodology creates a bias for freight to be transported by road. An improved relationship between cost incurred and prices charged for heavy vehicle road use can contribute to competitive neutrality of freight mode choice.

1.2 Scope

As the topic of heavy vehicle road cost allocation and pricing is broad and complex, it is important to clarify the scope and limitations of this study. This report considers the potential benefits of different road network classifications for cost allocation and price determination. It does not review the current cost estimation methodology or the general approach to cost allocation. Further, it does not consider implementation or institutional issues, nor does it comment on price structure. However, the practicality and feasibility of classifications with respect to administrative simplicity and user friendliness are considered.

Finally, this report does not provide a quantitative analysis of the relevant data related to the topic. Instead, it addresses the concepts that are to be considered for classifying the road network. As a result, the majority of findings are of a qualitative nature.

It is important to keep in mind that this report investigates one very specific aspect of the cost allocation and pricing of road use, namely road network classification. It should thus be viewed as part of a wider discussion on heavy vehicle cost allocation and pricing.

The following questions form the basis of this report:

- Does the current classification and cost allocation process adequately reflect costs associated with categories?
- Do our current assumptions under the current heavy vehicle road pricing cost allocation approach average out too much?
- What are the objectives of differentiating prices?
- What breakdown of the network should be used to cost over?
- What breakdown of the network might you differentially price over?
- How significant is the need to be able to distinguish between different road types for cost allocation purposes?

1.3 Outline

This report comprises nine chapters. Chapter 2 provides background information on the current approach to heavy vehicle road use cost allocation and price determination. Chapter 3 discusses the extent of averaging under the current pay-as-you-go (PAYGO) assumptions. Chapter 4 deals with the objectives for differentiating prices for heavy vehicle road users. Chapter 5 describes different road network classifications. The different types of costs to be taken into account are discussed in chapter 6. The criteria to be used to assess the usefulness of each road network classification are derived in chapter 7.

Chapter 8 discusses the advantages and disadvantages of different road network classifications with respect to cost allocation.. Additional issues regarding the need to be able to distinguish between different road types are addressed in chapter 9..

Conclusions are drawn at the end of each chapter.

Figure 1 illustrates the relationships between the different topics to be discussed in each chapter.

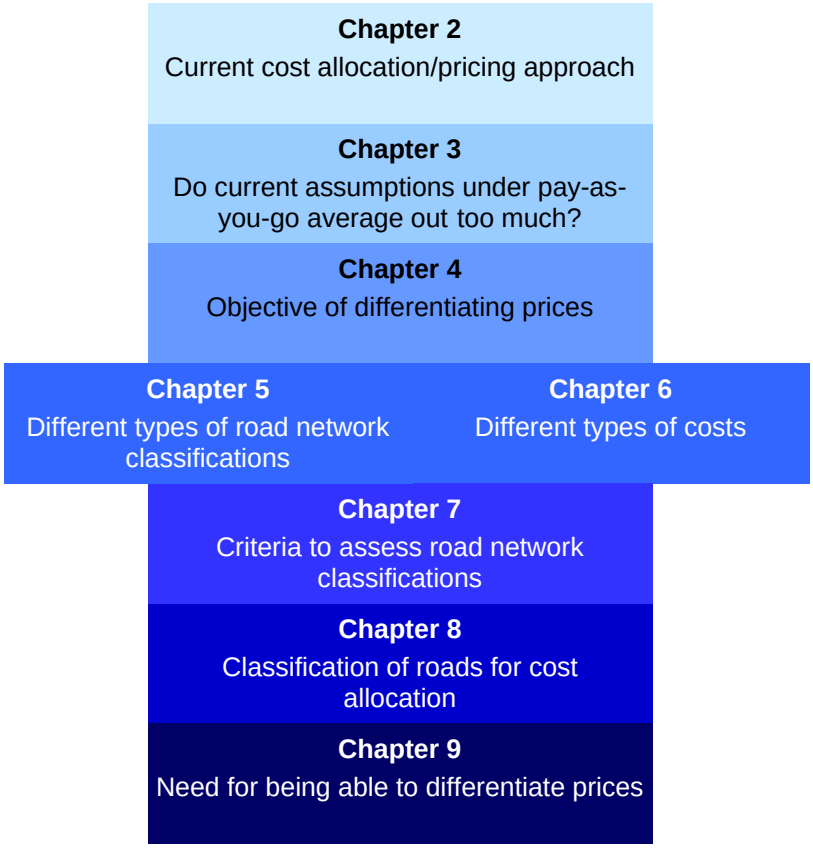


Figure 1. Outline of Chapters

2. THE CURRENT APPROACH TO COST ALLOCATION AND PRICING OF HEAVY VEHICLE ROAD USE

2.1 Introduction

The purpose of this report is to investigate appropriate alternatives to classify the road network for cost allocation and heavy vehicle infrastructure pricing purposes. As the topic of heavy vehicle road cost allocation and pricing is complex, it is important to clarify at the outset the background information that is needed to understand the implications of this report. This chapter thus gives a brief overview of the current approach to cost allocation and pricing of heavy vehicle road use.

The current approach to cost allocation and pricing of heavy vehicle road use is illustrated in Figure 2. The top part of the figure shows the components of the cost allocation, whereas the bottom half shows the process used for pricing.

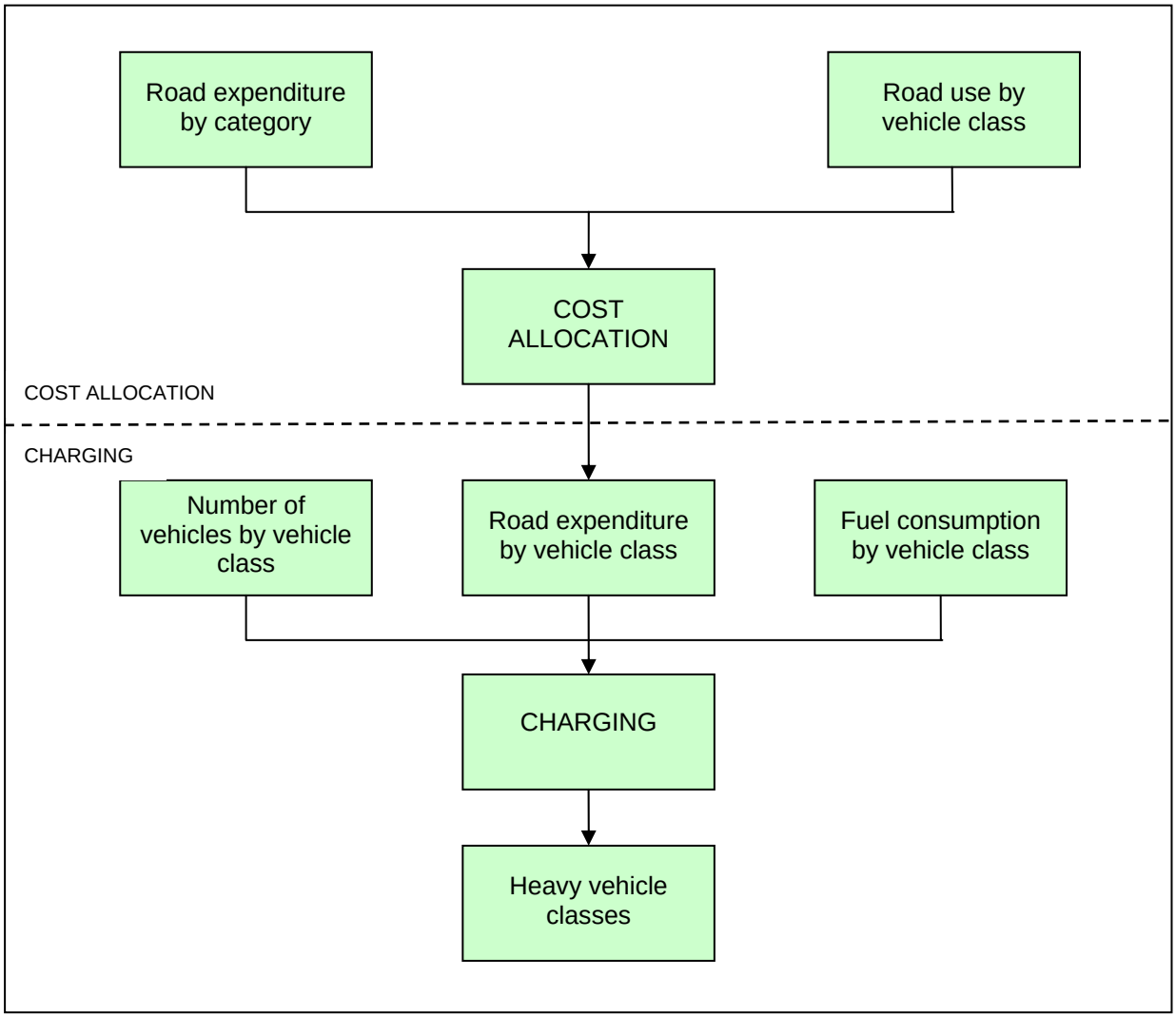


Figure 2. Current approach to cost allocation and pricing of heavy vehicle road use (NTC, 2005, p.6)

It is necessary to acknowledge that the current approach to heavy vehicle pricing and therefore cost allocation of heavy vehicle road expenditure is likely to be altered in the future. It is likely that either an improved PAYGO system or some form of life cycle costing system will be used. However, the major conclusions concerning the most appropriate choice of road network classifications for cost allocation purposes do not vary significantly with different approaches to cost estimation. As a consequence, this report is based on the current approach to cost estimation.

2.2 Cost allocation

The costing approach to heavy vehicle road use has two main inputs. Firstly, different categories of road expenditure separate the cost incurred in each category according to the type of road that costs are incurred for. Two dimensions are applied which relate to the function of the road and the geographic location of the road. As a result of applying a two-by-two matrix, four categories of roads emerge:

- Arterial Urban
- Arterial Rural
- Local Urban
- Local Rural.

Table 1 shows the current template for road construction and maintenance expenditure for arterial roads. The second column shows the different categories for road expenditures.

Table 1. Current NTC Road Construction and Maintenance Expenditure Reporting Template for Arterial Roads

ACTUAL EXPENDITURE ($ million)					
	Expenditure Category	**National Highways**	**Urban Arterial**	**Rural Arterial**	**Total**
A	**Servicing and operating**				
B	**Road Pavement and Shoulder Construction**				
B1	Routine maintenance				
B2	Periodic surface maintenance				
C	**Bridge maintenance/rehab**				
D	**Road Rehabilitation**				
E	**Low-cost safety/traffic**				
F	**Asset Extension/Improvements**				
F1	Pavement improvements				
F2	Bridge improvements				
F3	Land acquisition, earthworks, other extensions /Improvement expenditure				
G	**Other Miscellaneous Activities**				
G1	Corporate services				
G2	Enforcement of HV regs				
G3	Vehicle registration				
G4	Driver licensing				
G5	Loan servicing				
Totals					
H	**Other Road Related Payments**				
H1	Payments of grants and assistance to councils for work on arterial roads managed by councils				
H2	Payments to councils for contract work carried out on State managed roads				
H3	Spending on local access roads in unincorporated Areas				
H4	Direct State/Territory spending on council managed local access roads				
H5	Any other direct State spending on local access Roads				

Generally, three main groups of expenditure can be identified: capital costs, maintenance costs and operating costs. Expenditure category H is designed to better separate local road expenditure from arterial road expenditure. Operating costs compose of category A, G. The remaining categories (B, C, D, E and F) consists of capital and maintenance costs. It is important to note that because all cost categories are currently treated in the same way (i.e. the expenditure is fully recovered in the year it is incurred) the current estimation methodology does not distinguish between the various types of costs. A movement away from the PAYGO approach will require that maintenance and capital expenditure is clearly defined. For example, if capital investment is defined as providing benefits on a long-term basis, categories B, C, D, E and F could be considered as capital costs as they all provide some long-term benefits. However, if maintenance expenditure is defined as repairing existing infrastructure to its original capacity, part of the expenditure in category B, C, D and E can also be viewed as maintenance expenditure.

In addition to the difficulty of clearly establishing whether expenditure categories B, C, D and E should be considered as capital or maintenance costs, categories are also interrelated. For example, if the expenditure on category B (routine and periodic surface maintenance) for a particular type of road is rather high, the need for expenditure on category D (road rehabilitation) can be deferred. Similarly, road improvements that restore pavement strength and at the same time add capacity can be classified as category D or F.

The current cost estimation approach uses a three year average of expenditure to determine the cost to be allocated. The average is based on past expenditure of the last two years and budgeted expenditure for the current year.

The second input used for the cost allocation process is vehicle road use data that distinguishes between different types of heavy vehicles such as rigid trucks, articulated trucks, B-doubles and road trains. Road use data is taken from the Survey of Motor Vehicle Use which distinguishes data by State and Territory and identifies urban and rural road use. Local and arterial road use is estimated using a survey of local government authorities.

Overall, the current approach to cost allocation of heavy vehicle road use is based on the following information:

- expenditure on roads per type of expenditure disaggregated over a two-by-two matrix (urban arterial, rural arterial, urban local, rural local); and
- heavy vehicle road use by type of vehicle over a two-by-two matrix (urban arterial, rural arterial, urban local, rural local).

Given the information on expenditure and road use, the current cost allocation approach determines the share of attributable and non-attributable costs for each expenditure category. Attributable costs are costs that vary with the volume of traffic on roads. These costs would not be incurred if traffic volume fell to zero. For example, repairs to road surfaces resulting from unravelling of surface texture with the passage of tyres are attributable costs. Non-attributable costs are incurred regardless of the volume of traffic. For example, road surface repairs in response to deterioration of the seal from the effects of sunlight fall in the non-attributable cost category.

Table 2 shows the shares of attributable and non attributable costs for each cost category for different scenarios used in the cost allocation approach.

Table 2. Share of attributable and non-attributable cost of heavy vehicle road use expenditure

		Percentage of cost that varies with:					
		Attributable costs					Non-attributable
	Expenditure Category	VKT	PCU-km	ESA-km	AGM-km	Heavy Vehicle VKT	
A	Servicing & Operating Expenses	100	0	0	0	0	0
B	Road Pavement & Shoulder Maintenance	0	0	0	0	0	
	Scenario A&C						
	B1. Routine Maintenance	0	37	0	37	0	26
	B2. Periodic Maintenance	0	10	0	60	0	30
	Scenario B						
	B1. Routine Maintenance	0	50	0	50	0	0
	B2. Periodic Maintenance	0	15	0	85	0	0
	Scenario D						
	B1. Routine Maintenance	0	0	0	50	0	50
	B2. Periodic Maintenance	0	0	0	50	0	50
C	Bridge Maintenance & Rehabilitation	0	0	0	33	0	67
D	Road Rehabilitation	0	0	45	0	0	55
E	Low Cost Safety / Traffic Improvements	80	20	0	0	0	0
F	Asset Extension / Improvements	0	0	0	0	0	
	F1. Pavement Components	0	0	45	0	0	55
	F2. Bridges	0	15	0	0	0	85
	F3. Land Acquisition, Earthworks, Other Extension / Improvement Expenditure	0	10	0	0	0	90
G	Other Miscellaneous Activities						
	G1. Corporate Services	0	0	0	0	0	100
	Base Case						
	G2. Enforcement of Heavy Vehicle Regulations	0	0	0	0	0	0
	Scenario C						
	G2. Enforcement of Heavy Vehicle Regulations	0	0	0	0	100	0
	G3. Vehicle Registration	0	0	0	0	0	0
	G4. Driver Licensing	0	0	0	0	0	0
	G5. Loan Interest	0	0	0	0	0	0

Attributable costs are allocated according to four different variables[1]:

- vehicle kilometres travelled;
- passenger car unit kilometres of travel;
- equivalent standard axle kilometres of travel, and
- average gross mass kilometres of travel.

Table 2 shows that only enforcement of heavy vehicle regulation costs is allocated according to heavy vehicle kilometres travelled. As costs incurred for enforcement of heavy vehicle regulation have not been included in the final scenario for cost allocation, allocation according to heavy vehicle kilometres travelled is currently not applied.

There is an ongoing debate over how non-attributable expenditure should be allocated. Currently, vehicle kilometres travelled is used as the basis for allocation of non-attributable expenditure.

Overall the cost allocation process follows the following steps:

1. Given the shares of local/arterial and urban/rural road use for each vehicle category, these can be combined with shares of local/arterial and urban/rural road expenditure in order to determine total cost to be allocated to each vehicle class. (Note that road use and expenditure data are also available by State/Territory. A separate analysis is conducted for road trains as they mainly use unsealed roads in rural areas of States and Territories that allow road trains.)
2. Different shares of attributable and non-attributable cost are derived for each expenditure category. For attributable costs, the variable that is used for allocation is assigned (see Table 2).
3. Costs are allocated within each cost and vehicle category according to the identified variables.

2.3 Determining heavy vehicle road user charges

A charges regime can be thought of in two parts. The first is the determination of the total costs to be recovered from different road users. This is based on cost estimation and cost allocation. The price structure determines the method by which total costs will be recovered. In the road sector the charges structure also has a relationship with cost allocation as charges vary between various vehicle classes.

The current charges structure consists of a registration charge (that differs for different types of heavy vehicle) as well as an excise tax that is levied on diesel fuel. The first step is to combine fuel consumption of each vehicle class with the excise tax in order to calculate the amount of costs that are covered by the fuel excise revenue. A minimum charge for each vehicle is then applied (to ensure consistency with charges for larger light vehicles). As a last step, the remaining costs are distributed over the number of vehicles within each class to determine the registration charge.

[1] Note that heavy vehicle kilometres travel has been considered as another variable to allocated costs over but is not currently used

The registration charge is uniform across all vehicles within one category. The diesel excise tax burden per vehicle depends on the distance each vehicle travels and its fuel efficiency. The current price determination process is largely dependent on the pricing mechanisms. If other pricing mechanisms were considered, the price determination process would change significantly.

The key aim of this pricing system is to ensure that nationally uniform registration charges apply to heavy vehicles and that these charges are based on full cost recovery for each class of heavy vehicle. As such, differences in costs between different users within a category as a result of differences in costs between road types are not very significant as the current pricing structure is not able to reflect these variations.

2.4 Conclusion

This chapter has provided important background information that is needed to enable a thorough discussion of the appropriateness of different road network classifications. It is important to keep in mind that:

- cost allocation and pricing are rather distinct processes with results from the cost allocation feeding into the price determination;
- road expenditure:
  - is divided into local/arterial and rural/urban road expenditure;
  - different expenditure categories can be grouped into capital, maintenance and operating expenditure;
  - expenditure within each category is either attributable or non-attributable;
- vehicle classes are differentiated for both cost allocation and price determination; and
- the price structure has a strong relationship with cost allocation.

3. DO CURRENT ASSUMPTIONS AVERAGE OUT TOO MUCH?

3.1 Introduction

The previous chapter provided an overview on the current approach to setting heavy vehicle charges. The approach makes a number of explicit and implicit assumptions when allocating costs. This chapter discusses these assumptions in more detail and considers the extent that averaging under the current approach can be viewed as appropriate.

3.2 Assumptions of the current cost allocation approach

The current approach for heavy vehicle road use costing implicitly assumes that:

- the difference in costs incurred by road use of vehicles within one vehicle class depend only on whether roads are local/arterial or rural/urban;
- the share of attributable and non-attributable costs are the same for cost categories of all road types; and
- vehicles within one category all have the same relative shares of local or arterial road use.

Each of these assumptions is discussed in turn.

3.2.1 Averaging across different road types

Even though the current cost allocation approach makes a distinction between urban arterial, urban local, rural arterial and rural local roads, it does not take any other characteristics of roads into account. Thus, it is assumed that the impact of heavy vehicle road use on road expenditure is independent of:

- the location of the road (geographic location, climate, topography);
- construction method and material;
- traffic volume; and
- traffic composition.

However, these factors do affect the amount of costs incurred by heavy vehicle road use. For example, road pavement deterioration models have shown that the damage heavy vehicles cause in terms of wear and tear of the road depends on the method of construction and the material the road is made of. Moreover, the marginal damage caused by heavy vehicles increases with traffic volume (for example the 100^{th} vehicle on a road causes more damage to the pavement than the 10^{th}).

3.2.2 Assuming constant attributable and non-attributable shares for all road types

Costs are currently divided into attributable and non-attributable shares for each road expenditure category. This implicitly assumes that the shares of attributable and non-attributable costs within one category are the same for every type of road. For example, consider the share of attributable and non-attributable routine maintenance costs in row three of Table 2. 37% of costs are attributable to passenger car equivalent kilometres, 37% are attributable to average gross mass kilometres and 26% are considered to be non-attributable. This distribution of attributable and non-attributable is implicitly assumed to hold for all road types. For example, the non-attributable cost share of routine maintenance is assumed to be the same for a road located in the outback and a road located in inner Sydney.

It is also assumed that the share of attributable costs is constant among roads with different traffic volumes. However, it is likely that roads with higher levels of traffic volumes have higher shares of attributable costs as maintenance is likely to make up a greater share of total costs. For roads with low traffic volumes, the share of attributable costs of total costs is likely to be lower.

3.2.3 Averaging relative road use shares across vehicle categories

The third assumption concerns relative shares of road use for different vehicles. Even though the current approach distinguishes road use according to arterial and local roads, it is assumed that all vehicles make similar use of the two types of roads. For example, one heavy vehicle might only drive on local roads. If the average arterial road use of the relevant vehicle class is 40% then the vehicle will be treated as if it spent 40% of its travel on arterial roads and would be allocated some of both arterial as well as local road expenditure. If the cost per unit of use is the same on each set of roads this will make no difference, but as the costs per unit of use vary, there is a significant impact.

3.3 How to determine whether the extent of averaging is appropriate

The question arises of how to determine whether the extent of averaging under the current cost allocation approach is appropriate. There is a general way of determining the degree of averaging. For each of the assumptions, road expenditure is always averaged over a total which can compose of all vehicles or all types of roads. As a first step, it is thus important to identify the subjects that expenditure is averaged over. Second, the distribution over the relevant categories has to be examined. For example, it is assumed that all vehicles within one class use the same share of arterial and local roads. Thus, the distribution of relative road use of all vehicles within this class needs to be analysed. The greater the spread of the distribution around the mean (i.e. the higher the standard deviation), the less appropriate it is to average.

The question of how to determine the extent of averaging can be further investigated by using a hypothetical example. For a given total expenditure within one category of road costs, it can be sensible to identify the distribution of cost incurred for an appropriate set of categories. Figure 3 illustrates the hypothetical distribution of capital and maintenance costs over four different categories of roads (e.g. levels of average annual daily traffic smaller than 3,000; 3,000-10,000; 10,000-20,000 and above 20,000).

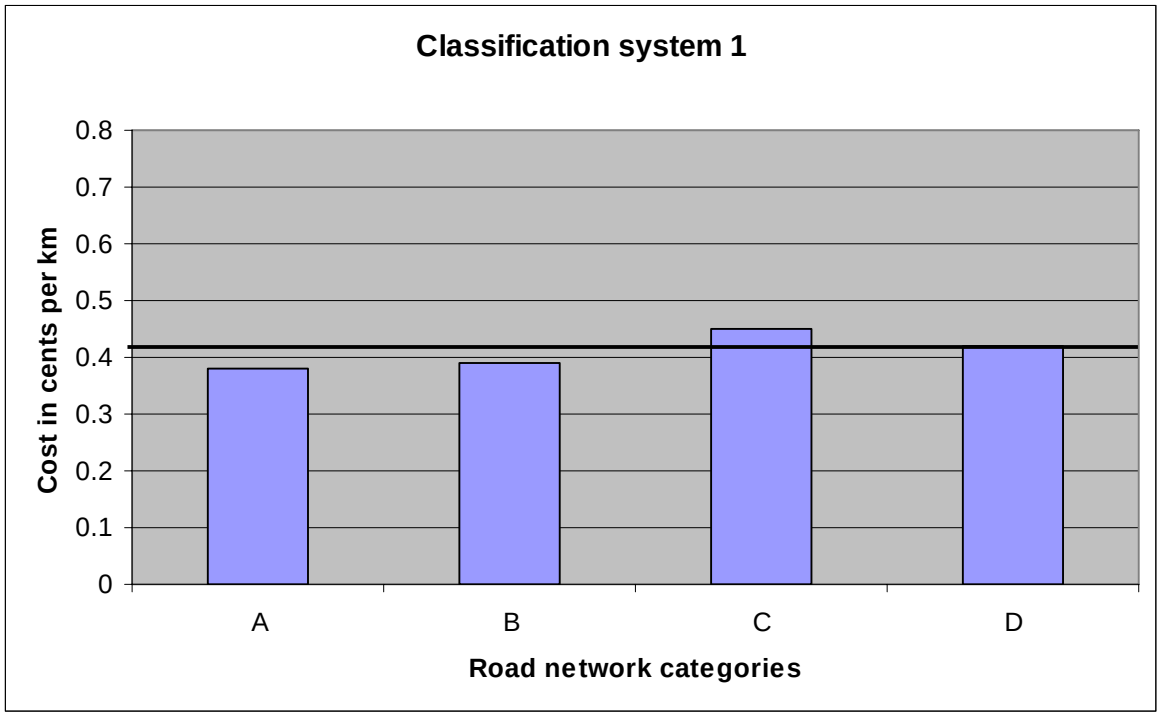


Figure 3. Classification system 1, Averaging across four types of categories

The horizontal black line in Figure 3 indicates that the average cost across all four road network categories is 0.41 cents per km. Expenditure for all four road network categories is distributed closely around the mean. Averaging across the categories illustrated for classification system 1 seems to be appropriate. In fact, it would not be sensible to distinguish the four categories as their unit costs are very much alike. Figure 4 shows the same illustration for a different road network classification (e.g. asphalt roads, chip seal roads, unsealed roads and concrete roads).

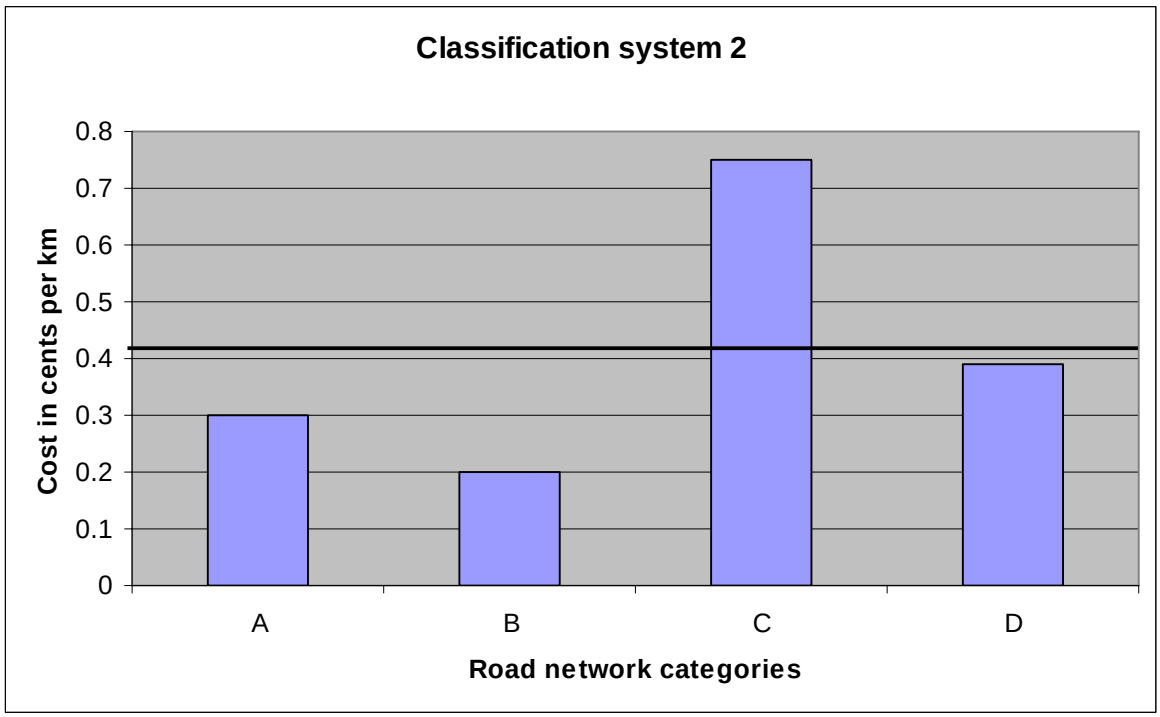


Figure 4. Classification system 2, Averaging across four types of categories

For classification system 2, the average road expenditure per category is also equal to 0.41 cents per km. Clearly, for classification system 2, costs between categories B and D differ enormously. The distance of the costs of all four categories from the mean can be measured by the standard deviation which is clearly higher in classification system 2 than in 1. From this type of analysis it can be determined that averaging over the categories for classification system 1 seems to be relatively more sensible whereas averaging over categories for classification system 2 can lead to larger distortions.

Assuming that data availability is not an issue, identification of the most useful categorisation ideally involves an analysis of the distribution of the cost incurred over the most disaggregated classes. If this analysis shows that some classes are similar in their cost structure, these classes might be combined. However, if an analysis of unit costs shows that unit costs of classes diverge significantly, averaging does not seem to be appropriate.

Two general rules can be derived as a result of the discussion of averaging. These can be applied when choosing classifications:

1. *In order to reduce averaging, categories should be chosen so that differences between categories are maximised.* This rule applies for a broad range of categorisations such as road types or vehicle types. Differences should be compared by using relevant variables. For example, when determining which road network classification is most useful, unit cost per road type should be compared.

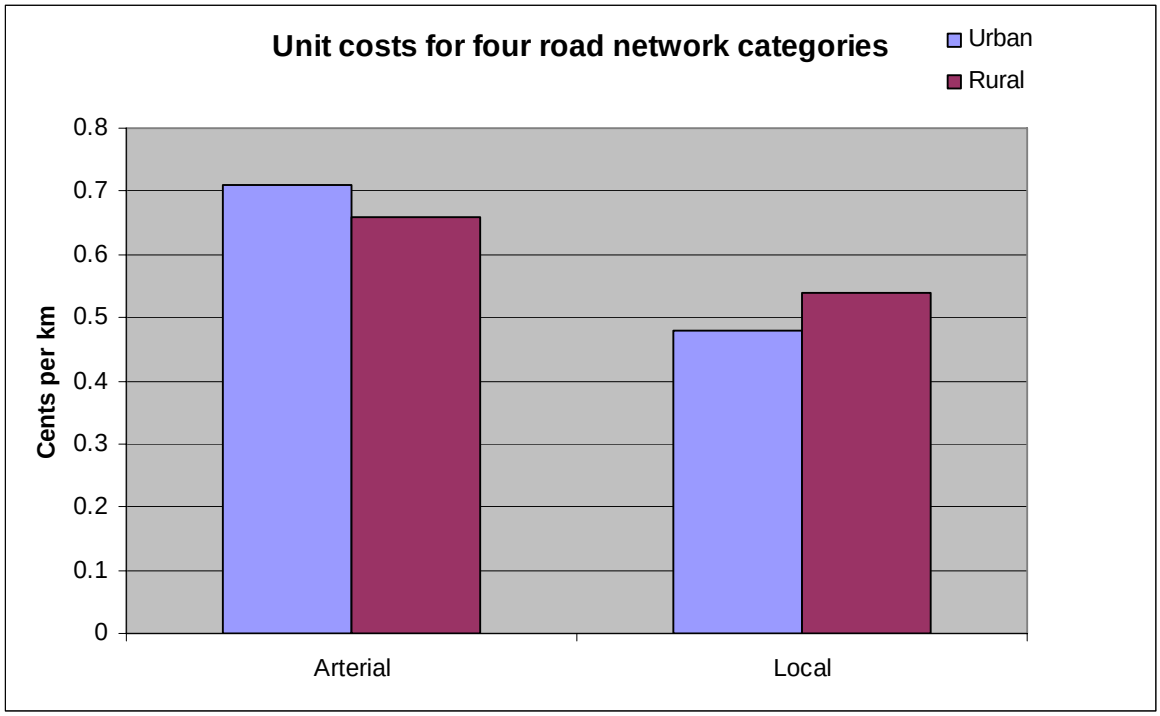
2. *The most useful categorisation should also ensure that differences within categories are minimised.* Not only should the most useful road network classification account for large differences between classes, it should also minimise differences within each class. Referring back to Figure 4 above, this implies that a more disaggregate categorisation will not reveal large differences in the relevant variable.

These two rules can be used for two purposes. Firstly, this method can be used to determine the extent of averaging under the current costing method. Secondly, these rules can be applied for determining the most appropriate classifications to be applied so that the implications of averaging are minimised.

3.3.1 Averaging across the urban and rural classification

The general discussion of averaging can be illustrated by the example of averaging road expenditure across the current road network classification. Figure 5 shows the unit costs per vehicle km travelled for each of the four road types (data provided by NTC).

Figure 5. Unit costs for four road network categories



The cost incurred for urban arterial roads is 0.71 cents per km and the cost for rural arterial roads is 0.66 cents per km (as shown in Figure 5 above). The unit costs incurred for urban local and rural local roads are 0.48 and 0.54 cents per km, respectively. The example shows that averaging across the urban-rural distinction seems to lead to an average unit cost that is still rather close to unit costs for each category.

Figure 5 also shows that averaging across the arterial-local road distinction does not seem to be appropriate as per unit costs for both categories are rather different. In order to determine whether the current pay-as-you-go approach averages out too much, Figure 5 would need to be replicated for the types of road network classification that are currently not being used.

Note that unit costs shown are per vehicle kilometre travelled. Unit costs could also be expressed per equivalent standard axle kilometres, passenger car equivalent kilometres or per tonne-km. In addition to the unit costs of road use, the relative shares of use of each road category matters. In the circumstances where different types of heavy vehicles differ in their share of road use of urban and rural roads, the reason for distinguishing this classification in order to remove averaging is strong. If it was known that road use by one particular category was focussed on urban or rural roads, the distinction becomes very relevant.

The use of rural unsealed roads by road trains, for example, shows that certain distinctions can be relevant in order to align the cost incurred and the cost allocated to each vehicle group. However, if road use differs considerably between vehicles in the same vehicle class, the issue of averaging is a pricing rather than a costing issue. Averaging assumptions for pricing are discussed in the next chapter.

3.4 Assumptions and averaging under the current pricing approach

In addition to averaging when determining costs to be allocated, averaging also occurs when determining prices. Figure 2 in chapter 2 showed how costs allocated and prices are related. For prices to be differentiated, costs have to be differentiated.

It is important to distinguish between the impacts of averaging on estimated costs and the impact on pricing. In contrast to the current cost allocation approach that uses four categories of roads, the price structure itself does not distinguish between different types of roads. The amount of road expenditure to be recovered by each vehicle category is based on average road use on all road types for each vehicle category. The split of this expenditure between registration charge and fuel charge is determined with no reference to usage. Therefore heavy vehicles are not faced with any incentives to avoid roads on which they impose higher costs.

If certain vehicle classes concentrate their travel on certain type of roads, cost allocation should account for an appropriate share of the costs of these roads to be allocated to this vehicle class. If the type of roads used by vehicles within one class differs significantly, it is important to reduce the averaging in prices. Disaggregated costs are a prerequisite for disaggregated prices, however it is only prices that can send signals to the economy.

3.5 Conclusions

It can be concluded that the extent of averaging depends on the spread of the distribution of the relevant variable. As a consequence, it is difficult to determine the appropriateness of averaging under the current cost allocation approach without any detailed data on road use costs of different types of roads. As a general rule, the wider the spread of the distribution (e.g. of costs or road use) over the relevant categories (e.g. road types, vehicle classes), the less appropriate averaging appears.

Furthermore, the discussion on averaging has also lead to two important rules for choosing appropriate classifications in order to reduce averaging:

1. In order to reduce averaging, categories should be chosen so that differences *between* categories are *maximised*.

2. The most useful categorisation will also ensure that differences *within* categories are *minimised*.

These rules can be specifically applied to the choice of road network classification that is discussed in later chapters.

It is important to stress that the addition of any road network classification to costing and pricing will reduce the amount of averaging. It is therefore important to trade off the benefits and costs involved. This issue is addressed in chapter 10.

4. IDENTIFY THE OBJECTIVES OF DIFFERENTIATING PRICES – WHAT ARE YOU TRYING TO ACHIEVE BY THIS DIFFERENTIATION?

4.1 Introduction

As the extent of averaging in the current approach to heavy vehicle pricing and costing is often criticised, the implications of price differentiation is of growing interest. This chapter thus investigates the potential objectives that can be achieved by differentiating heavy vehicle road use prices.

4.2 Objectives for differentiating heavy vehicle user prices

There are three main objectives for differentiating heavy vehicle road user prices:

- increase economic efficiency;
- enhance competitive neutrality; and
- enhance equity.

Improvements in **economic efficiency** of heavy vehicle road transport can be achieved with differentiated prices as currently the individual road user prices do not reflect costs incurred by individual road users. Prices that do not reflect costs can cause a sub-optimal (too high or too low) level of consumption of the road infrastructure. When prices are properly aligned with costs, the true level of scarcity of the good is reflected and thus informed decision-making will be efficient. Markets operate efficiently if prices charged to individual road users fully reflect the costs incurred for each road user. This does not imply that economic efficiency is achieved when all costs are recovered. Instead, a close relationship between costs incurred and prices charged to every individual road user could enhance economic efficiency. Differentiated prices could thus improve the relationship between costs incurred and prices charged for every individual road user.

As discussed in chapter 3, the current cost allocation and price determination approach involves a great extent of averaging. The objective of achieving economic efficiency can thus be translated into the aim of reducing the extent of averaging when allocating costs and determining prices for heavy vehicle road users.

Differentiated prices can also contribute to enhance **competitive neutrality** between road and rail transport. Using a more disaggregated cost allocation, the distribution of costs between different types of roads and vehicles is improved. This implies that the price paid by each vehicle will more closely reflect the costs incurred by each vehicle. For vehicles on routes that compete with rail transport, the improved cost allocation and price determination can reduce the level of distortion in the price paid for freight transport by road.

The third objective of differentiated prices is related to **equity**. In contrast to economic efficiency, the concept of equity can be interpreted from different points of views. On the one hand, from an economic point of view it can be argued that equity is achieved when every heavy vehicle pays for the wear and tear it causes. It can be considered as equitable if the price paid by each vehicle is equal to the cost incurred by each vehicle. This concept of equity is strongly related to economic efficiency.

On the other hand, the notion of equity can be interpreted as a situation in which the price for road use is the same on all parts of the network. In this case, no particular part of the network is disadvantaged by higher costs. For example, individual road user pricing for

rural areas may result in relatively higher prices due to fewer heavy vehicle kilometres over which to distribute fixed costs. Higher road use prices in rural areas could be considered as inequitable given the fact that the standard of these roads may actually be lower than many lower priced higher volume roads in more populated areas. Equitable prices in this sense would imply a similar price level for different types of road so that no particular area is disadvantaged. Using this notion of equity, the current heavy vehicle road use pricing can be considered to be equitable.

4.3 Conclusion

Overall, the objectives of differentiating heavy vehicle road user prices are:

- to improve economic efficiency;
- to contribute to enhancing competitive neutrality; and
- to improve equity.

5. ROAD NETWORK CLASSIFICATIONS

5.1 Introduction

The choice of road network classification is important in order to ensure an appropriate cost allocation and enable efficient pricing. Table 3 identifies a number of alternative classifications which would be used for cost allocation purposes. The remainder of this chapter considers each of these classifications in more details.

Table 3. Road network classifications

Road network classification	Criterion
Geographic	Location of the road
Construction	Material and construction method used to establish the road
Functional	Function of the road
Funding	The agency responsible for management or funding of the road
Traffic volume	Volume of traffic
Traffic composition	Share of different classes of heavy vehicles of total traffic
Road/rail substitutability	The degree to which road and rail freight transport are substitutes on a particular road

5.2 Geographic road network classifications

Road network classification for costing purposes based on geographic characteristics provides numerous options for separating the network. For a given type of road (e.g. chip seal), the costs of construction and maintenance may vary with the location of the road. Geography can be used to classify the road network, using characteristics such as climate, topography and population density.

5.2.1 Climate

Climatic conditions influence the cost of road construction and maintenance. Dryer areas (South Australia and Western Australia) have cheaper construction costs than wetter areas (New South Wales and Victoria). In addition, roads prone to flooding are more susceptible to damage from heavy vehicles and also require maintenance work independent of traffic volume. Other types of extreme weather, such as high temperatures, impact on surface seal longevity, and consequently the vulnerability of the underlying pavement to the impacts of water and traffic loading.

5.2.2 Topography

The topography of the land affects the cost of road construction and maintenance. For example, an alpine road which is steep and exposed is more difficult to access. Therefore it requires more earthworks and extensive safety measures.

5.2.3 Urban/rural road network classification

Roads in remote areas incur higher costs for transportation of materials for construction and maintenance. In addition, they are often characterised by extreme climate and/or topography. Remote roads are generally subject to low traffic levels and are disadvantaged by scale economies. As a result they have higher construction and maintenance costs per user.

Urban roads, by contrast, are generally high traffic roads and can take advantage of economies of scale and of networks to reduce unit costs for users. Economies of scale in this respect refer to decreasing average costs that are associated with increased capacity. For example, doubling the strength of the pavement in order to account for high traffic volumes does not require doubling the cost of road provision. However, as a result of the high traffic levels, the total cost of undertaking road works is increased if the congestion costs associated with unexpected delays resulting from road works are considered.

5.3 Construction based road network classification

The following categories can be used for a road network classification that is based on construction materials and methods.

5.3.1 Concrete

Most concrete pavements are either plain (non-reinforced) or reinforced concrete. Reinforcement is usually provided by steel wire mesh placed approximately at mid slab depth. The reinforcement is intended to limit crack opening and movement in the concrete slab.

Concrete pavements carry traffic loadings in a different way to flexible asphalt pavements. Concrete pavements are designed to act like a beam and use the bending strength of the slabs to carry the load. This requires relatively small depths of unbound base material in construction. As such, concrete roads are preferred over other types of roads in locations where the soil base is not strong.

Pavements constructed from concrete are durable, safe and cost efficient. Freeways, streets and local roads built from concrete pavement offer long lasting and low maintenance surfaces. This leads to lower long term costs associated with maintaining the pavement system. However, initial costs of constructing concrete pavements are high and construction times are longer than any other method of road surfacing. These high construction costs mean that they are generally only warranted where the level of traffic to be carried is relatively high. This demonstrates how the construction based classification might be related to the classification based on traffic volume.

5.3.2 Asphalt

Asphalt roads are generally used throughout the urban area as they can be utilised across a wide range of uses, by varying the depth of asphalt or type of wearing course. Asphalt provides a smooth, quiet and safe ride surface which reduces wear and tear on vehicles. It provides excellent skid resistance in both dry and wet weather. The mixture of aggregate and bitumen can be specified in such a way to provide the skid resistance required for specific locations, such as intersections.

Freeways use deep layers of asphalt to increase overall strength, and then have wearing courses that reduce noise and water spray. While local roads may have thin layers of asphalt as they do not need to carry large numbers of heavy vehicles and therefore do not need increased strength. The cost of asphalt roads varies depending on the function of the road. Local roads are relatively cheap to construct in asphalt, while freeways can cost millions of dollars per kilometre.

As asphalt is a flexible surface, it requires a strong base as a foundation. Freeway standard roads require a deep base in conjunction with deep layers of asphalt to provide their strength, while local roads would use a shallow base as they are not required to carry such heavy loads. Cement stabilisation is often used to improve the overall strength of the base by providing a bound layer for the asphalt to rest on.

5.3.3 Chip seal

Chip sealing is one of the oldest methods and most successful methods of road surfacing in Australia. It is used on some local roads in the urban area, while most rural roads (including rural arterial roads) are constructed using this method.

A chip seal is an application of a binder in the form of an emulsion or hot spray and an application of an aggregate as close to a single size as possible. Chip sealing is comparable to other resurfacing methods in durability and effectiveness, but costs far less, (15-25% of the cost of pavement overlays). As chip seals are a thin layer of emulsion, they require a strong base to provide their strength. This would usually be constructed of a well compacted, high quality aggregate, or of a bound material such as cement stabilised crushed rock, which would be sourced off-site.

While chip seal roads are strong and effective, in high temperatures they have the tendency to ‘strip’ due to the emulsion melting and resulting in the aggregate sticking to vehicle tyres. This drastically reduces the life of the road and requires immediate attention to limit the amount of damage. Once the seal is damaged, the underlying pavement is considerably more vulnerable to damage from the loads imposed by heavy vehicles and from the impacts of water. The combination of the two is particularly problematic.

Chip seals are predominantly used in rural settings; however they are also used on some urban roads. Chip seals are not preferred at intersections as the horizontal forces produced by turning vehicles can strip the aggregate from the surfacing.

5.3.4 Unsealed

Unsealed roads are generally created from off-site material which has been trucked in for the construction of the road. This material which is generally unbound, is formed and smoothed into a drivable surface. These roads are generally found in rural locations, with limited numbers within urban areas.

Unsealed roads are cheap to construct. However maintenance costs can be high dependent on traffic volumes and weather conditions. They can easily suffer from rutting, corrugations and potholes if driven on in wet conditions and require regular grading. The combination of grading, wet weather and traffic can lead to gravel loss. In hot and dry conditions, unsealed roads can create excessive dust which can be dangerous for drivers.

5.4 Functional based road network classification

A functional based classification of the road network is based on the purpose a road serves. The current cost allocation approach uses a distinction between local and arterial roads. Further disaggregation of the functional classification could be considered, such as the road classifications by the former National Association of Australian State Road Authorities (NAASRA)[2] but the discussion in this report is based on the main distinction of local and arterial roads. One practical constraint with functional classifications is that there is no nationally consistent classification in active use.

5.5 Funding based road network classification

The funding based road network classification can be interpreted in two different ways. On the one hand, the relative contributions to road funding by different levels of government could be used to determine which category each road would fall into. For example, categories could be based on the level of government which funds the highest percentage of capital and maintenance costs.

On the other hand, the level of government that is mainly responsible for funding and managing of roads could be determined in order to categorise roads. For example, it can be argued that the federal government is mainly responsible for the AusLink National Network. Projects on local roads are implemented and managed by local government despite the fact that funding sources include state and federal governments.

5.6 Traffic volume based road network classification

Road network classification based on the volume of traffic on roads is a commonly used distinction. The average annual daily traffic (AADT) could be used to distinguish different types of roads. For example, categories such as less than 3000 AADT, 3000-10,000 AADT, 10,000-20,000 AADT and above 20,000 AADT could be used.

5.7 Traffic composition based road network classification

Road network classifications based on the traffic composition distinguish roads according to the share of traffic of different heavy vehicle classes. For each road, the percentage of traffic that is caused by a certain type of vehicle can be used to determine which category should be applied to it.

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[2] NAASRA was the predecessor of Austroads.

5.8 Road/rail substitutability

This classification implies that roads for which rail transport can be viewed as a substitute for heavy vehicle road transport are costed separately from roads where rail is not an alternative option. The degree of substitutability of road and rail or the degree of competition between road and rail transport could be used to classify the road network.

5.9 Relationship among different types of road network classification

The descriptions of the road network classifications in the previous chapters indicated that the classifications are rather distinct. However, it is important to note that there are interdependencies between road network classifications. As the most useful categorisation might indeed be a combination of several criteria, it is useful to investigate the interrelationships between categorisations in detail. Table 4 shows how each of the road network categorisations is related to all other categorisations.

5.10 Conclusion

There are various alternatives for classifying the road network. Many of the road network classification systems are related and it is thus likely that some system will capture the same differences in costs. To assist in achieving efficient pricing, the road network classification needs to enable appropriate cost allocation. The advantages and disadvantages of each road network classification are discussed in chapter 7.

Table 4. Relationships among different types of road network classifications

Geographic based	Functional	Construction	Funding	Traffic volume	Traffic composition	Road/rail substitutability
Geographic based	Not related	Materials and methods used in urban and rural areas differ	Not related, as local government funding/responsibility also applies in both urban and rural areas	Traffic volume is higher in urban areas	Not related	Related as the geographic location of a road determines whether it competes with rail, not related in terms of climate, topography or urban/rural area
	Functional	Arterial and local roads are likely to differ in construction method	Related as funding composition of arterial and local roads is likely to differ	Arterial roads are likely to have higher levels of traffic volume	Arterial roads are likely to have a higher share of heavy vehicles of total traffic	Mainly arterial roads can compete with rail transport (even though local roads provide competitive adv. for road)
		Construction	Not related	The forecast traffic volume influences the choice of method and the materials used to build the road	If a higher share of heavy vehicles is expected, different materials will be used	Not related
			Funding	Not related, e.g. federal funding is used for the AusLink National Network and maintenance of rural roads	Heavy vehicles shares of total traffic are higher for federally funded roads	Unlikely to be related
				Traffic volume	Imperfectly related, in many cases higher traffic volume also implies higher share of heavy vehicles	Not related, interstate routes that compete with rail have high traffic volume, grain lines have low traffic levels but still compete with rail
					Traffic composition	Not related
						Road/rail substitutability

6. DIFFERENT TYPES OF COSTS IN ALLOCATION PROCESS

6.1 Introduction

The cost allocation process uses different types of expenditure categories that can be grouped into maintenance, capital and operating costs. In addition to these costs, the objective of economic efficiency is only fully achieved if prices reflect all social costs. However, there are a number of practical constraints to the inclusion of externalities in cost allocation and pricing for roads at present and as a consequence the inclusion of externalities is not advocated by the NTC at this point in time.

This chapter gives an overview of the nature of different costs that can be considered. It also identifies the variables that influence different types of costs. Figure 8 illustrates the different types of costs to be considered.

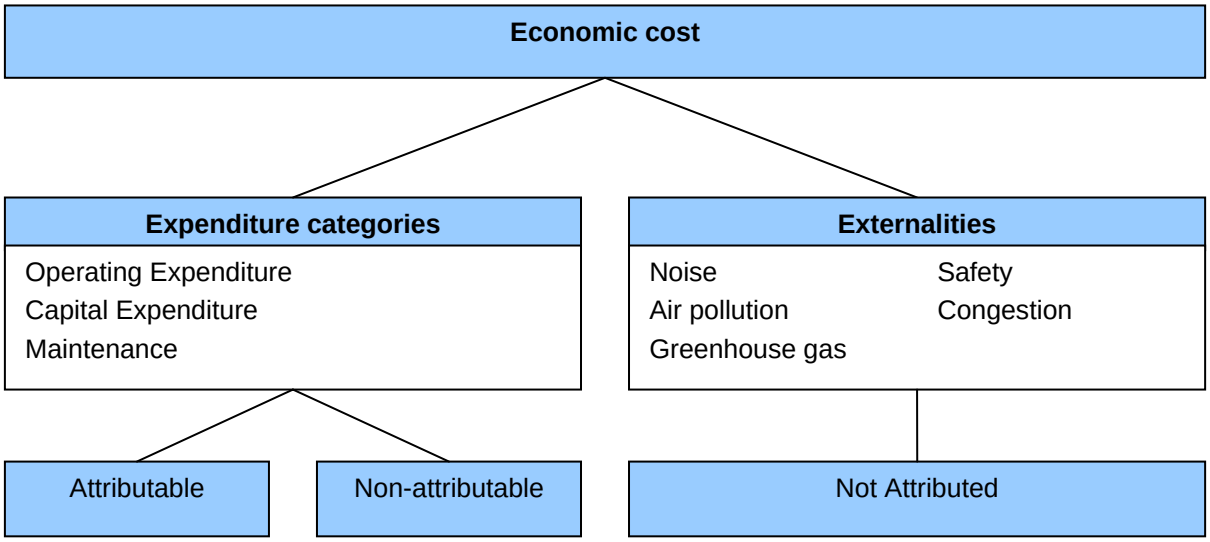


Figure 6. Economic costs

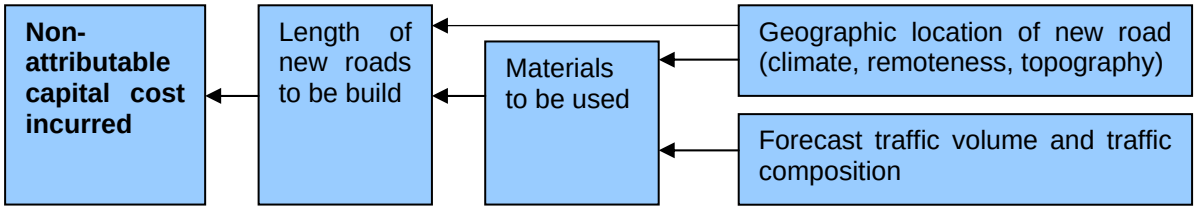
6.2 Capital, maintenance and operating costs

The current approach of allocating cost for road use by heavy vehicles only takes capital, maintenance and operating cost into account. These include relevant expenditure incurred by local, state and federal government. Both capital and maintenance cost can be divided into their attributable and non-attributable shares.

Capital costs are incurred when new infrastructure is built (or infrastructure is rehabilitated). The current determination of heavy vehicle charges considers most of the capital costs as non-attributable (NTC, 2005, p.38 table 17, row F3 and F1). Despite the fact that non-attributable costs cannot easily be allocated, the factors influencing the level of non-attributable capital cost can be investigated. The volume of non-attributable capital costs incurred primarily depends on the amount of new roads to be built.

However, for a given type of road the costs of construction vary with the type of materials used and the geographic location of the road. Roads in remote areas with adverse climate and extreme topography are likely to incur higher construction costs. The construction cost also depends on the estimated traffic volume and traffic composition. Unsealed roads in the outback are located in remote areas that suffer an extreme climate. However, as forecast traffic volumes are low, the construction of the road may be relatively inexpensive. Figure 7 illustrates how factors such as geographic location and forecast traffic volume can influence the level of non-attributable capital cost incurred.

Figure 7. Factors influencing non-attributable capital cost



The debate about how to allocate non-attributable cost is ongoing. Even though road network classification cannot solve the problem of how to allocate non-attributable costs, it can potentially improve cost allocation of non-attributable capital cost. It can be argued that a relatively high share of the cost of constructing a new road should be borne by the future users of the new road. As non-users still derive utility from the existence of a road that they might make use of in the future or that guarantees access to a certain area, the argument is that a higher share should be borne by users. This is not to say that the full cost should be allocated to the vehicles using the new road but relative to non-users the utility of users is very likely to be higher. Assuming that the argument holds, classification of the road network according to factors that influence non-attributable capital costs can potentially improve the relationship between non-attributable capital cost incurred and allocated.

The attributable share of capital costs is low (see Table 2). As a consequence, a marginal improvement in the relationship between attributable capital cost incurred and allocated is unlikely to have any significant impacts. By definition attributable costs vary with the traffic volume and composition as explained above.

For **maintenance costs**, the share of attributable costs is rather high as most of the routine and periodic road maintenance works are related to the traffic volume and composition. Non-attributable maintenance costs vary with:

- geographic location (climate, population density, topography);
- traffic volume; and
- construction type.

Similar to non-attributable capital cost, some maintenance cost are incurred regardless of the traffic volume. These include activities such as repairing seals affected by exposure to ultra violet light (sunlight) or re-gravelling unsealed roads affected by run off. The level of costs vary with geographic location as the climate, degree of population density and topography can increase such costs for a given task. Factors affecting how much of maintenance costs are non-attributable also include traffic volume as there are significant economies of scale in pavement design and repair. This means for example, that the average costs of providing a road with stronger pavement may be lower compared to the average costs of providing a road with average pavement strength. Construction type of the road also influences maintenance costs. For example, maintenance on a concrete road is very different to that on chip seal pavement. Different construction types are also affected by heavy vehicle road use in different ways.

6.2.1 Operating costs

Operating costs include expenses such as provision of road lighting. Some of the operating costs vary with the function or geographic location of a road. For example, lighting is generally only used in urban areas. Roads in rural areas are less likely to be illuminated. Overall, operating costs are considered to be rather independent of the road type.

6.3 Externality costs

In addition to capital and maintenance cost, economic cost also takes externalities into account. Economic costs thus do not only include direct wear and tear of the road caused by heavy vehicles but also the disutility to the wider society. The following are typically discussed when considering externality cost[3]:

- greenhouse gases;
- air pollution;
- noise;
- congestion; and
- safety.

Each of these aspects refers to economic costs that are incurred by the operation of heavy vehicles[4]. These costs are currently not included in the allocated costs in the current approach. Economic theory would suggest that these costs should be taken into account to reflect the true cost of heavy vehicle usage. However, there are a number of practical constraints to their inclusion which on balance means that it is preferable not to include externalities for road network classification and pricing. These include:

- relatively little research on externalities in Australia much of the research done in this area has been done in Europe and the United States;
- uncertainty as to the degree to which some externalities may in fact be internalised;

[3] It should be noted that most of these externalities result from the operation of vehicles as opposed to the provision of road infrastructure. Therefore there is some debate as to whether these costs should be included in infrastructure pricing.

[4] The externality costs are also incurred by cars. This implies that including externality costs for heavy vehicles would require cost allocation for private vehicles to be based on equivalent considerations.

- the appropriateness of recovering externalities through infrastructure charges rather than freight charges;
- the lack of a charging regime which would effectively incorporate externality costs; and
- no policy decision in terms of the objective of including externality costs in charges – if the objective is to reduce the externality, then regulations may be a more appropriate mechanism.

There are a number of other issues that also need to be considered when looking at externalities.

- When considering costing and pricing of externalities other factors such as the price elasticity of demand and competitive neutrality have to be taken into account. If the price elasticity of demand is rather inelastic (i.e. a small increase in the price could lead to a large decrease in demand), the inclusion of externality costs might be undesirable. The decision on whether to include externality costs then depends on the socially optimal level of use.
- Externalities might only be included in the price of one particular good and the price of its substitutes might not reflect externality costs. In this case, introducing externality costs in one market can create competitive distortions.
- The practicality of including externality costs might be limited as determining costs to be included is rather complex.

It can be argued that all externality costs are attributable as they are not incurred in the case of zero traffic volume. However, it is also important to note that the relationship between the size of the externality cost and variables such as traffic volume is not linear as some externalities only pose costs when a certain threshold is reached. For example, air pollution in the case of very few heavy vehicles can be absorbed by the environment. It only becomes an externality cost from a certain level of traffic onwards. Ideally, vehicles should be charged the difference between the marginal social cost and the marginal private cost at the market equilibrium in order to ensure an optimal allocation of resources.

Moreover, some of these externalities only apply when there are a significant number of individuals in close proximity of the heavy vehicle. It is thus important to identify conditions that have to be fulfilled for these externality costs to be incurred.

Greenhouse gases pose an externality cost that is incurred no matter on what type of road or geographic location heavy vehicles are travelling. Standard ways of calculating the cost incurred by greenhouse gases exist and can be applied to every truck. The amount of greenhouse gases emitted depends on the fuel consumption and the type of engine the heavy vehicle uses. Fuel consumption per kilometre is generally higher in urban areas than on open highways. This is due to urban congestion and stop-start conditions. It can thus be argued that greenhouse gas emissions per kilometre of travel are higher in urban areas. Besides the location of the road, fuel consumption is also dependent on the fuel efficiency of the heavy vehicle engine. [5]

[5] The current fuel excise applied to diesel can be viewed as an appropriate mechanism of addressing greenhouse gas emission. However, the level of the tax may need to be reviewed in order to reflect the cost of greenhouse gas emissions.

Air pollution is caused by burning fuels in vehicle engines. In contrast to greenhouse gases, these are localised pollutants such as nitrogen oxides, sulphur oxides and carbon particles. This type of air pollution has a negative health effect in highly populated areas[6]. It can thus be assumed that air pollution is only an externality cost of any significance on urban roads. As a consequence, the degree to which road network classifications align with an air pollution externality is expected to vary. It also depends on the geographic location of the road as the nature of airflow within different urban air sheds can impact on air pollution.

Noise can pose externality costs that materialise in similar situations to air pollution as individuals have to be in close proximity to the heavy vehicle to be affected by noise. Externality costs associated with noise are thus only expected to be incurred in urban areas. They will be related to traffic volume and possibly functional road classifications.

Congestion cost can be considered another externality effect caused by heavy vehicles. Heavy vehicles contribute to congestion as they increase delays in stop-start conditions. Consider two identical traffic jams with stop-start conditions. The traffic jam with the higher share of heavy vehicles will cause a higher increase in travel time due to slow stop-starting of heavy vehicles. However, it is important to point out that due to the commercial nature of heavy vehicle trips, there are already financial incentives to avoid peak hour traffic and thus to avoid congestion.

Congestion depends on the timing of travel. Unless heavy vehicle trips can be tracked not only with respect to location but also with respect to time, congestion cost cannot be internalised effectively.

Safety externalities caused by trucks are another group of costs that could potentially play a role in cost allocation. Generally, in 1999 articulated truck drivers were assessed by coroners to be either fully or partially responsible for about 25% of multiple vehicle fatal crashes that involved articulated trucks (Australian Transport Safety Bureau, 2003). In order for safety externalities to be internalised, the cost each truck poses on a certain type of road has to be quantifiable. The current state of research is unlikely to lead to a robust estimate of the safety externalities costs of trucks. These costs vary between urban and rural areas, and are understood to vary significantly with road design type (not pavement) such as divided/undivided, dual/single lanes, curvature, passing opportunities, etc.

6.4 Conclusion

This chapter has provided a detailed overview of the different types of costs to be considered in the cost allocation and price determination process. Moreover, the factors that influence different levels of costs have been discussed. Overall, it is important to keep in mind that the appropriate road network classification should take all types of costs into account. However, there are a number of practical constraints which inhibit the inclusion of externalities at this point in time.

[6] See Melbourne mortality study: http://www.epa.vic.gov.au/Air/health.asp.

7. CRITERIA TO BE USED TO IDENTIFY SUITABLE ROAD NETWORK CLASSIFICATION

7.1 Introduction

In order to determine which road network classification is the most appropriate, it is useful to assess against a number of criteria.

Road network classification should enable differentiated costing and pricing so that objectives identified in chapter 4 (economic efficiency, competitive neutrality and equity) can be achieved. These objectives can be considered in two parts: 1) the usefulness of each road network classification for cost allocation; and 2) the usefulness of road network classifications with respect to pricing. Both parts overlap; the road network classifications that are useful for cost allocation should also be useful for pricing as the costs allocated are inputs to determining prices.

Further, the criteria determined in this chapter relate to the two rules identified in chapter 3:

1. In order to reduce averaging, categories should be chosen so that differences between categories are maximised.

2. The most useful categorisation will also ensure that differences within categories are minimised.

These two rules can be applied to the case of road expenditure for different types of roads.

7.2 Criteria to identify suitable road network classifications for cost allocation

In order to determine the criteria to identify the most useful road network classification for cost allocation, the relationship between expenditure and cost allocated has to be considered. As discussed in chapter 2, the current approach to cost allocation distinguishes different cost categories. For each cost category the share of attributable and non-attributable costs is determined. Furthermore, for attributable costs the variable that they are dependent on is identified.

7.2.1 Attributable costs

The current cost allocation approach identifies which variable (kilometres travelled, passenger car equivalent kilometres, Average Gross Mass kilometres (AGM-km), equivalent standard axle kilometres or heavy vehicle kilometres travelled) influences each cost category (e.g. category A servicing and operating cost). The share of average kilometres travelled in each vehicle category, passenger car equivalent kilometres, etc. is used to determine the share of cost to be allocated to the respective vehicle category.

For example, if B-doubles account for 20% of total kilometres travelled, they should be allocated 20% of the cost for servicing and operating (as shown earlier in Table 2, the current cost allocation system for this cost category is 100% attributable to kilometres travelled). With respect to low cost safety and traffic improvements, B-doubles should pay 20% of 80% of the total cost. The reason is that 80% of low cost safety and traffic improvement costs are allocated on the basis of kilometres travelled and 20% are allocated on the basis of passenger car equivalent kilometres. Hence, if the share of B-doubles of

passenger car equivalent kilometres is 30%, B-doubles should pay an additional 30% of 20% of the total cost.

The current approach distinguishes different vehicle classes, and four different types of roads. Figure 8 illustrates the variables and expenditure categories.

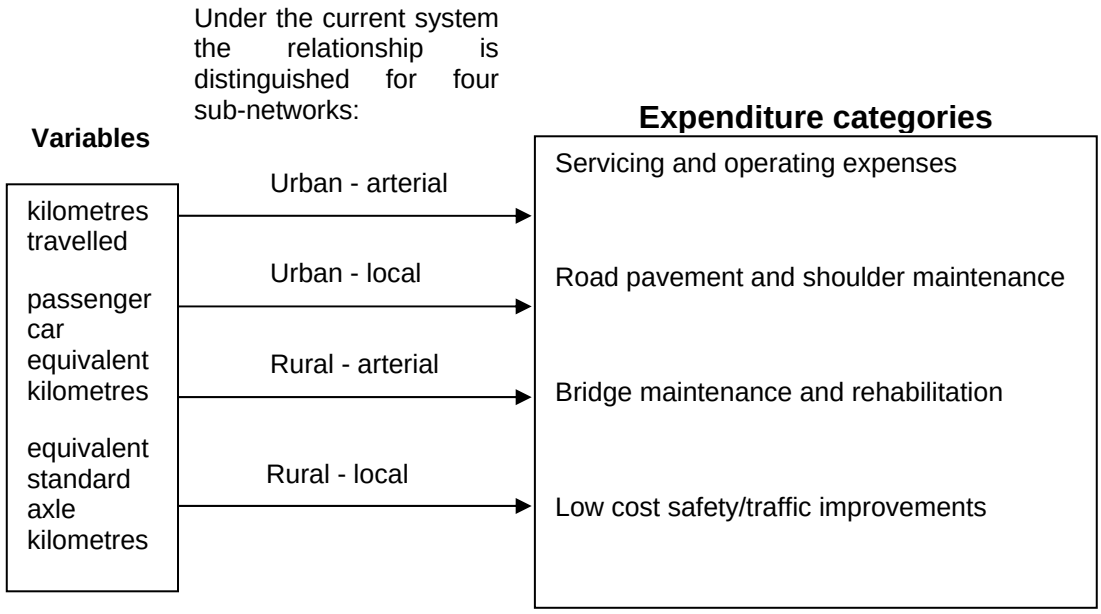


Figure 8. The relationship between different variables and expenditure categories

Using a road network classification for the cost allocation approach can reduce the amount of averaging. This means that road network classifications can account for the differences in relationships between heavy vehicle road use and expenditure. For a given level of road use, some types of roads might incur more costs than others. Thus, the most important criterion to assess the road network classification is:

How far does this road network classification account for the different relationships between heavy vehicle road use and expenditure on different types of roads?

It is important to point out that for some road classes the relationship between heavy vehicle use and expenditure is generally the same. Nevertheless, the cost incurred by vehicles driving on each road type could still be rather different as each road type might be utilised differently (i.e. be subject to different traffic volumes). As relationships between cost incurred by heavy vehicle road use and expenditure are not linear but subject to economies of scale and network economies, the utilisation of roads should also be taken into account.

To demonstrate whether a particular road network classification is useful the following scenario can be considered:

Assume that we know the amount of expenditure for each cost category and also for each road network category. This implies that the total cost of each expenditure category could

be split up according to the road category. Assuming that we also know the proportions in which total kilometres travelled, passenger car equivalent kilometres, equivalent standard axle kilometres, AGM-km and heavy vehicle kilometres travelled are distributed over the different types of roads, we can calculate the expenditure per kilometres travelled, etc. for every type of road. The resulting expenditure per kilometres travelled or other variable could give important insights as a large difference in prices indicates rather dispersed costs over different categories. As a consequence, a criterion for assessing the usefulness of road network classification is:

How much would prices per kilometres travelled, passenger car equivalent kilometres, etc. differ for each road network type?

This criterion specifically addresses rule number 1 as identified in chapter 3.

Apart from the fact that differences in expenditure per kilometres travelled, etc. should vary, rule number 2 states that differences within categories should be minimised. This implies that if each road network category was to be disaggregated further, no significant differences in expenditure per km could be revealed. A third criterion to be used is:

Does a further disaggregation of the road network lead to significant differences in prices between categories?

All three criteria need to be considered to ensure the appropriate attributable share of each expenditure category.

7.2.2 Non-attributable costs

Under the current pricing arrangements, all road infrastructure costs are aggregated and shared among road users. As previously discussed there is not universal agreement on how best to allocate non-attributable costs (which do not vary with usage). Currently, non-attributable costs are allocated according to kilometres travelled. However, the approach used is arbitrary and different approaches can be argued.

The aggregate nature of the existing cost allocation approach and pricing mechanisms means that it has not been necessary to examine whether non-attributable costs for specific parts of the road network should be recovered from just those who use that part of the road network or whether they should continue to be aggregated and consequently shared and recovered across all users of the road network.

If it is argued that non-attributable costs should be recovered in proportion to the benefit or utility derived from this expenditure, then a disaggregated approach to allocating non-attributable expenditure may be needed. It can be expected that those who use a particular part of the road network are likely to derive the most benefit from its existence. However, others will also benefit from the existence of that part of the network. These benefits, albeit smaller in total than for direct users, are likely to be greater for those who are closer to the part of the network being considered. For example, a road user in southern Tasmania may not use a particular nearby road link, but is likely to derive more benefit from its existence than for a road in a remote part of the Northern Territory or northern Queensland (it is also worth noting that non-road users may benefit from the existence of parts of the road network, with these benefits also likely to be related to their proximity to the roads concerned). On this basis, a geographic division of non-attributable costs may be appropriate.

An alternative argument is that non-attributable costs should be treated on a network basis. In this case, there is no reason to disaggregate these costs across any classification of roads.

A further consideration is that non-attributable costs may differ with design capacity and type of the road. That is, non-attributable costs for a low traffic, unsealed road may be a very different proportion of total costs and level to those on a high capacity concrete or asphalt road. This might influence the judgements made as to whether non-attributable costs should be recovered at a network level or in proportion to the benefits derived. The NTC and Austroads are jointly undertaking a substantive research programme to help address whether the proportion of costs for each category of road work that is non-attributable varies, and by how much. Regardless, a judgement is still required as to how these costs are treated.

7.3 Criteria to identify suitable road network classifications for determining prices

Although important, allocating costs can be viewed as the intermediate step between the cost incurred by each vehicle and the prices charged for each vehicle. It is only when allocated costs are transferred into prices that the economy receives price signals.

Generally, it can be argued that in order to align costs incurred and prices charged, the same road network classification should be used for cost allocation and pricing. The number and type of categories used for road user pricing have a relationship with those categories used for cost allocation. Certainly, if prices are to vary with a specific set of road classes, it will be important to use these same classes in cost allocation in order to arrive at differential prices that are cost reflective. Therefore, additional criteria are considered for pricing of heavy vehicle road use are:

- equity;
- boundaries between classes, future stability of classes;
- informed decision-making; and
- administrative simplicity such as data availability.

Equity may be deemed as an important principle underlying pricing. As has been already discussed in this paper, there are different definitions of equity. Under either of the definitions available, the principle is likely to have an important implication for road classification. For example if it is considered equitable for all heavy vehicle road users to pay the same price for access and use of the road network it may be questionable as to whether a road network classification is required or not. If prices are based on detailed categorisations, it can be identified which group of heavy vehicles is paying for another group of heavy vehicles.

Boundaries are also an important consideration to ensure that distortions and perverse incentives in the pricing regime are minimised. Whilst it is desirable for boundaries to be well defined for simple application, it is important to note that in some cases the setting of boundaries can effectively be arbitrary. This is the case where there is a natural continuum such as with traffic volume. In these cases it will be important to consider the impacts of each alternative of where the boundary could be set. In setting boundaries, future requirements resulting from new infrastructure should be considered.

The third point requires that the price structure provides accurate signals to operators to enable them to make informed decisions as to how best to transport their freight task. Truck operators are likely to substitute cheaper roads for more expensive ones whenever the cost savings exceed the cost of choosing another route (which can comprise longer travel times for example). However, as most road network cost allocation approaches only account for variations in one of the cost categories, it is possible that some of the classifications will lead to inappropriate signals.

The fourth point is one of major importance as it addresses administrative simplicity. Not only is it necessary to have a manageable number of categories within the road network classifications, but it is also important to ensure that the associated data requirements are manageable. The availability of data is likely to be the major obstacle to adopting many of the road network classifications.

Due to the uncertainty of data availability, this paper identifies the ideal road network classification assuming no data constraint. Broadly, the data requirements can be described as:

- data to assess which road belongs in which class (that must sit alongside nationally consistent definitions of each road class and consistent approaches to categorising roads into these classes);
- costs and/or expenditure for each road class; and
- road use information for each road class.

When examining the appropriateness of road network classification systems with respect to heavy vehicle road user pricing, these three requirements need to be considered.

7.4 Conclusion

This chapter has derived criteria that can be applied in the following chapters in order to assess the usefulness of road network classifications with respect to cost allocation and price determination of heavy vehicle road use. In summary, the criteria to assess the appropriateness of road network classifications with respect to cost allocation are:

- Attributable cost
  - How far does this road network classification account for the different relationships between heavy vehicle road use and expenditure on different types of roads?
  - How far would prices per kilometres travelled, passenger car equivalent kilometres, etc. differ for each road network type?
  - Does a further disaggregation of the road network lead to significant differences in prices between categories?
- Non-attributable cost
  - To what extent variations in non-attributable costs are reflected by the road network classification?

With respect to heavy vehicle road user pricing, four criteria are to be applied:

1. equity;
2. boundaries between classes, future stability of classes;

3. informed decision-making; and
4. administrative simplicity such as data availability.

8. WHAT NETWORK BREAKDOWN NETWORK SHOULD BE USED TO APPLY COSTS?

8.1 Introduction

This chapter deals with identifying the most suitable road network classification in order to allocate costs in a way that enables the objectives of differentiated prices to be achieved.

The previous chapter identified the main criteria to be used:

- Attributable cost
  - How far does this road network classification account for the different relationships between heavy vehicle road use and expenditure on different types of roads?
  - How far would prices per kilometres travelled, passenger car equivalent kilometres, etc. differ for each road network type?
  - Does a further disaggregation of the road network lead to significant differences in prices between categories?
- Non-attributable cost
  - To what extent are variations in non-attributable costs reflected by the road network classification?

As a consequence, road network classifications that address the variation of different dimensions of costs are likely to be the most useful ones. In contrast, road network classifications that only take one aspect that influences cost into account are likely to be of less use. The following chapters discuss each road network classification and its advantages and disadvantages for cost allocation.

8.2 Geographic based road network classifications

Geographic road network classifications can be constructed according to different categories such as climate, topography and urban/rural location of the road.

Part of the variations in attributable cost are addressed with road network classifications based on climate and topography. This is because the extent of wear and tear caused by truck movements on roads located in areas with a wetter climate are generally larger compared to the average road. However, this road network classification does not address varying externality costs as the number of people in proximity of passing heavy vehicles does not vary with the climate. Urban and rural areas can be found in any climatic zone in Australia.

Climate and topography mainly influence the maintenance and capital cost. Roads located in hot areas might deteriorate more quickly and thus need more frequent maintenance. Also, roads located in mountainous or very remote areas are likely to be more expensive to construct as all the equipment has to be transported to the relevant area, with more earthworks or longer, more circuitous routes needed. The advantage of this type of classification is that it addresses the factors that influence the non-attributable share of costs.

A geographic road network classification that is based on a distinction between urban and rural roads has slightly different advantages and disadvantages. This classification does not address the variations in attributable cost. For two identical roads in urban and in rural

areas, a given number of heavy vehicles does not cause different damage in terms of wear and tear. An urban-rural distinction of roads does not reflect differences in the impact of heavy vehicles on road maintenance expenditure. Nevertheless, the urban-rural distinction can take account of scale economies in the provision of roads as they will be highly correlated with use levels.

The urban-rural distinction strongly reflects the variations in externality costs of road use. An urban-rural distinction also addresses some of the variations in non-attributable costs as maintenance and construction are likely to be more expensive (for a given type of road) in remote areas.

Overall, the geographic classifications do not seem to be very useful when considered in isolation. Nevertheless, when considering a combination of road network classifications, the geographic classifications can add specific value in addressing road wear and externality costs. Table 5 summarises the advantages and disadvantages of different types of geographic road network classifications.

Table 5. Summary of advantages and disadvantages of geographic classifications

Category	Advantages	Disadvantages
Climate, topography	• addresses variation in capital and maintenance costs • addresses variation in attributable cost to a limited extent	• does not reflect variations in externality costs
Urban-rural distinction	• variation in externality costs addressed accurately • variation in non-attributable costs addressed to a limited extent • differences in costs due to economies of scale addressed to a certain degree	• does not address other variations in attributable cost

8.3 Construction based road network classification

The construction based road network classification appears to best address the allocation of attributable cost. This classification acknowledges that the wear and tear caused by road use of heavy vehicles depends on the type of construction and material the road is made of. The advantage of this classification is that it takes into account the different relationships between road use and road wear.

The extent to which the construction–based network classification takes externalities into account is debatable. Some types of construction–based classes can be closely related to an urban-rural distinction of roads. For example, unsealed roads are mainly found in rural areas whereas asphalt roads are predominantly located in urban areas. However the relationship between the construction–based and urban-rural classifications for concrete and chip seal roads is not aligned. Concrete and chip seal roads can be found in both rural and urban areas. The extent to which the construction–based classification addresses variations in externality costs is thus limited.

The most significant disadvantage relating to the construction–based classification is the lack of understanding of road use and wear relationships. Knowledge about the relationship between maintenance and road wear and tear of different types of roads are generally not considered to be robust. Furthermore, construction types can vary considerably along a route, which could result in confusing price signals if reflected in prices. Further research would be necessary to enhance the degree of reliability so that the pricing system can be based on established relationships.

Table 6 summarises the advantages and disadvantages of the construction based road network classification.

Table 6. Summary of advantages and disadvantages of construction based road network classification

Advantages	Disadvantages
• takes account of relationship between road wear and road use for different types of roads • road construction type imperfectly related to urban-rural distinction, thus externality costs are addressed to a limited extent	• relationship between road wear and road use not fully established

8.4 Functional based road network classification

The current road classification is partially based on this approach. The distinction of arterial and local roads itself does not address any of the variations in cost components. The function of the road in terms of its role for users is not inherently related to any of the cost categories. It is only when the relationship between the function of a road and other characteristics are considered, that the classification becomes useful. Figure 9 shows the relationship between the function of a road and other classifications.

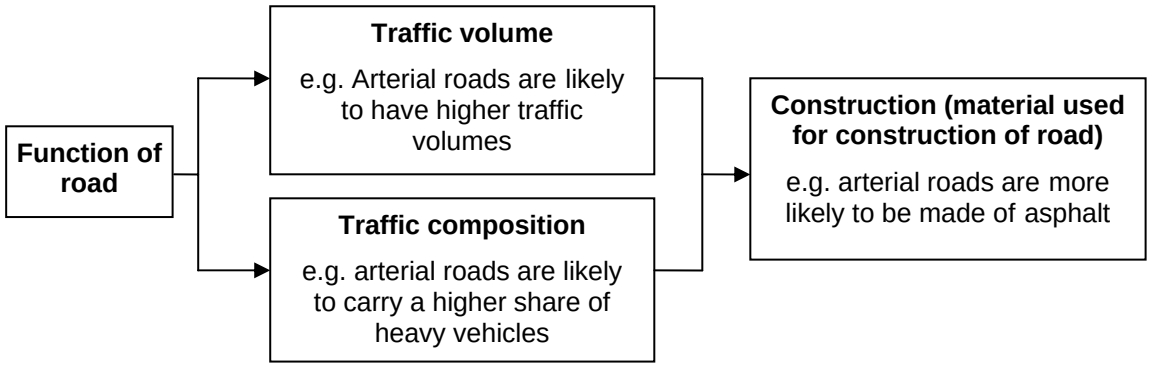


Figure 9. Relationship between function of road and other classifications

Figure 9 shows that the function of a road is related to three other classification criteria: traffic volume, traffic composition and construction (although this last relationship is much less direct). Arterial roads are likely to carry larger traffic volumes and greater shares of heavy vehicles. As a consequence, designs, design standards, materials and methods of construction are likely to differ. Arterial roads therefore benefit from economies of scale, while local roads often suffer from their inability to extract economies of scale.

Considering that the function of a road is related to traffic volume, traffic composition and is loosely linked to construction material , it takes account of variations in attributable costs.

The attribution of externality costs is less clear. Some externality costs are likely to be higher for arterial roads while others are higher for local roads. Noise and air pollution (save greenhouse gases) are only considered a cost when people are close enough to the road to suffer from the externality. Although arterial roads are usually located within highly populated areas, mitigation measures are often applied. For example, urban freeways are likely to be equipped with noise barriers and there are few people in direct proximity. These externality costs are thus likely to be higher on local roads as these people are generally closer to the road. The same relationship is unlikely to be true for greenhouse gas, congestion or safety. It is therefore difficult to draw a conclusion on the relationship between externality costs and the functional road network classification.

Overall, it is important to realise that the functional classification is useful as it combines different classifications. However, because these relationships are not perfect, the classification is likely to incorporate an element of inaccuracy. Table 7 summarises the advantages and disadvantages of functional road network classification.

Table 7. Advantages and disadvantages of functional classification

Advantages	Disadvantages
• combines different criteria for categorisation • addresses attributable cost • takes account of externality cost to a certain degree	• not meaningful in its own sense • relationship between function of road and other classifications imperfect

8.5 Funding based road network classification

There is a very loose correlation between, on the one hand, the mix of functional classifications, traffic volume and composition and design standards and, on the other hand, a classification of roads on the basis of funding sources. This correlation is possibly stronger for roads receiving Auslink funding but weaker as the mix of State or Territory and local government funding is considered. Consequently, funding source is not likely to provide a useful mechanism of distinguishing between high and low cost roads in terms of heavy vehicle usage. As a result, it provides little benefit in a direct pricing arrangement where prices are intended to be more closely aligned with each individual's costs.

Nevertheless, it may be necessary to distinguish between roads on the basis of funding in order to return revenues from the use of each road to those responsible for managing

and/or funding it. This will depend on the institutional arrangements within which a direct pricing system is established.

Table 8 summarises the advantages and disadvantages of the funding based classification.

Table 8. Advantages and disadvantages of funding based classification

Advantages	Disadvantages
• combines different criteria for categorisation • addresses variations in attributable cost • takes account of externality cost to a certain degree	• relationship between funding of road and other criteria imperfect • only meaningful with hypothecation and reasonable distribution of revenues

8.6 Traffic volume based road network classification

The outcome based classification uses the traffic volume on roads as the category by which to classify roads. Roads are grouped according to the traffic volume they carry. This road network classification can address economies of scale in road provision.

Variations in attributable costs can also be addressed by the traffic volume based road network classification, as the share of costs that are attributable is likely to vary, expected to be higher for roads with higher traffic volume. Moreover average costs of road use (and most likely marginal costs of road use) decrease with higher traffic volume. This is due to the economies of scale in road provision.

While roads with higher traffic volumes are generally constructed out of durable material, this relationship is rather imperfect. Further, the link to externality costs is relatively weak as not all externalities are driven by traffic volumes on particular roads. In particular, the geography of the location of the road is a significant factor in determining the magnitude of externality costs (including population level, wind patterns and so on).

This classification may be useful to allocate non-attributable cost. For roads with higher volumes of traffic the share of non-attributable cost per vehicle is likely to be lower, while for roads with low traffic volumes the share of non-attributable cost per vehicle is likely to be higher. These differences would be able to be reflected if traffic volume formed the basis of the network classification.

Overall, this classification can address non-attributable cost but fails to properly account for variations in attributable and externality costs.

Table 9. Advantages and disadvantages of traffic volume based classification

Advantages	Disadvantages
• can improve allocation of non-attributable cost per road • can take account of congestion externalities • can take economies of scale of road provision into account	• not related to wear and tear caused by heavy vehicles on different types of roads • does not address variations in externality costs related to noise and air pollution

8.7 Traffic composition based road network classification

The advantages and disadvantages of this classification are similar to those for the traffic volume based road network classification. The advantage of this categorisation is that for each category of roads, the share of non-attributable cost for each vehicle class can be determined. This classification could thus improve the share of cost to be allocated to each type of heavy vehicle.

The disadvantage of this classification is that the wear and tear caused by a heavy vehicle is only very loosely related to the share of heavy vehicles on each road. While the share of heavy vehicle traffic is related to the construction material used for each road, it still only approximates this road network classification. The variations in externality costs are also not addressed by this classification as roads with a higher share of a certain class of heavy vehicles are not likely to impose higher externality costs per vehicle.

8.8 Road/rail substitutability

This classification implies that roads for which rail transport can be viewed as a substitute for heavy vehicle road transport are costed separately from roads where rail is not an alternative option. The degree of substitutability of road and rail or the degree of competition between road and rail transport could be used to classify the road network. This distinction could improve the cost allocation for certain routes. More accurate costing of these routes can provide advantages when determining issues related to competitive neutrality.

However, this classification does not address varying relationships between heavy vehicle road use and road wear and tear. The impact of a heavy vehicle on the road would not differ between roads that compete with rail transport and roads that do not. Using the criteria established above, this classification does not account for the variations in attributable, non-attributable or externality costs.

If the objective of achieving competitive neutrality is a major priority, this classification could be the most appropriate. As the issue of competitive neutrality only concerns a small fraction of the total road network, this classification will be of little assistance in optimising efficiency within or across the road system.

8.9 Conclusion

The appropriate choice of road network classification for cost allocation is important in order to ensure that differentiated heavy vehicle road user prices contribute to economic efficiency. This chapter discussed the advantages and disadvantages of different ways of classifying the road network. The appropriateness of road network classification depends on the extent to which different classification address variations in cost categories.

It can be concluded that each of the road network classifications address specific cost components. For example, the construction based classification is most useful for addressing the varying relationships between heavy vehicle road use and wear and tear of roads. The geographic classification can address variations in non-attributable costs. Traffic volume based classifications can take into account cost differences due to economies of scale.

Overall, it can be concluded that it seems most useful to apply either a combination of road network classifications or a classification that takes various characteristics into account (such as the functional classification). In cases where priorities are clearly defined (e.g. to improve the cost allocation of non-attributable costs), a single road network classification can also be of use.

It is important to point out that a more quantitative analysis of unit costs per type of road should be undertaken in order to confirm the qualitative investigation.

9. HOW SIGNIFICANT IS THE NEED TO BE ABLE TO DISTINGUISH BETWEEN DIFFERENT ROAD TYPES FOR COST ALLOCATION PURPOSES?

9.1 Introduction

The previous chapter has assessed different types of road network classifications against specific criteria to ascertain their appropriateness for cost allocation purposes. The appropriateness of each classification is closely related to the need to be able to distinguish the particular types of roads addressed by the classification. The better the classification is able to meet the criteria for cost allocation and pricing purposes, the stronger is the case for its implementation.

In assessing the appropriateness of each classification, it is important to consider two additional aspects. First, the costs and benefits of introducing such a system need to be assessed. Second, the potential effects on users should be understood. Both issues are addressed in this chapter.

9.2 Costs and benefits of road network classification

In order to assess the need to distinguish different types of roads for cost allocation purposes, the costs and benefits should be weighed up. If benefits largely exceed costs, the need to improve cost allocation and price determination can be considered to be demonstrated.

There are various types of costs involved with distinguishing different types of roads for cost allocation. First, additional administrative costs may be incurred if a more disaggregated road network classification system was used. The extent of this cost depends largely on the pricing not the costing mechanism. If a particular type of road network classification was applied to heavy vehicle road costing in the same way in which the urban-rural and arterial-local road distinction is applied, additional administration costs are likely to be small. However, if the road network classification system was used to implement individual user charging, administration costs are likely to increase significantly.

Second, as mentioned in chapter 9, there are considerable data requirements to enable a more disaggregated road network classification. The costs involved in data collection are dependent on the classification applied and current data availability.

Third, costs of ensuring compliance with the pricing mechanism have to be taken into account.

A benefit of road network classification for cost allocation is greater transparency. Even if road network classification is not applied to pricing, costing over different types of roads can still contribute to transparency as prices can be based on more disaggregated costs.

Applying a road network classification for pricing can provide large benefits in terms of economic efficiency. Heavy vehicle road users that are faced with disaggregated prices will use roads in a more efficient way and providers of these roads will receive more meaningful investment signals.

9.3 Expected effects on heavy vehicle road users

Applying a more cost reflective road network classification for heavy vehicle road user pricing purposes will result in overall efficiency gains for the heavy vehicle industry. More accurate prices will encourage changes in behaviour so that heavy vehicle operators utilise roads in a manner which minimises their costs. Most of this benefit will be captured at the margin where the elasticity of demand by transport operators is highest. However the low profitability margins that currently prevail in the trucking industry is expected to support this sort of outcome.

For operators with no alternate routes and relatively inelastic price elasticity of demand any efficiency gains are expected to be small.

9.4 Conclusion

It can be concluded that the need for road network classification depends strongly on the costs and benefits associated with each classification. An estimate of costs and benefits can also provide more information on the usefulness of each road network classification. A distinction should be made between using road network classification for cost allocation only, or for cost allocation and pricing.

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