

WHAT IS SUSTAINABLE TRANSPORT INFRASTRUCTURE?

A MARSAY

Senior Transport Specialist, Johnstaff Africa, Level 1, B2 House, 8 Tyrwhitt Avenue,
Rosebank, Johannesburg

Tel: 072 176-8592; Email: marsayecon@mweb.co.za

ABSTRACT

This paper commences with a review of economic growth theory noting the key role of technology, deployed via appropriately regulated institutions. It applies these insights to the transport infrastructure sector in order to answer the question: how can transport technologies, or modes, be deployed most sustainably in terms of their contribution to economic growth and prosperity? Sections follow which explore how transport technologies and the institutional forms by which they are delivered, differ in terms of the efficiency with which they are able to transmit economic value.

Reference is made to time series data comparing rail and paved roads investment in South Africa from 1875-2005 to GDP data showing that the economic impact of rail investment has declined relative to that of road from about 1930, despite protection of the rail sector.

This GDP impact differential is explained in terms of the positive economic externalities of road transport technology relative to rail technology. The externalities include: ability to elicit viable economic activity: at smaller scales, in a wider range of locations, and in support of more efficient manufacturing technologies, than rail transport could sustain.

The role of institutional form in the procurement and delivery of transport infrastructure is then considered, noting how reforms in the rail sector in different parts of the world have generally occurred in order to redeploy rail transport technology to sectors in which it can continue to transmit economic value efficiently. It is reported that when such reform has been resisted, the economic role of rail becomes increasingly unsustainable.

Finally, a definition of a sustainable transport infrastructure strategy is offered as one in which each transport infrastructure technology, or mode, is used where its technological strengths can be effectively deployed, and requiring institutional forms that are mandated to ensure that positive externalities are optimised and negative externalities minimised.

1. INTRODUCTION

1.1 Background

In the introduction to a paper presented at the 2005 SATC conference the present author stated that: 'it would be much more efficient in economic terms if the majority of the expected growth in South Africa's general cargo freight were accommodated by expanding the national road network rather than by trying to significantly expand the capacity of the rail network' (Marsay, 2005). The reason given for this assertion was that: 'the railway mode is technologically inferior to road transport technology for the majority, though not all, of today's transport needs' (Marsay, 2005).

The paper went on to motivate the assertion by reference to economic growth theory, which shows that new technologies, deployed via efficient institutional and regulatory frameworks, are the primary explanatory factor of all economic growth. This conclusion was then applied to the transport sector which, it was argued, will make an optimal contribution to economic growth only when each transport technology is deployed in its most effective application and via the most effective institutional / regulatory frameworks.

The rationale of the argument in the 2005 paper was that the decline in the use of rail in South Africa as elsewhere in the world, was best explained by its being replaced in many of its former applications by a newer, more efficient technology, that of road transport, and that the correct response to the trend should be to discover uses in which it can still offer an economically sound transport solution. The paper mentioned various countries (the Netherlands, Sweden, the UK, Japan, the USA) that had introduced reforms into their rail sectors in order to reduce losses caused by inefficient application of the rail mode and allow rail to be refocused on business sectors where it can operate more viably.

In most countries, the United States being a significant exception, rail reform has entailed significant public investment in rejigged infrastructure and sometimes also on-going public subsidies for rail operations. It is generally only high volume bulk mineral applications that have been able to operate viably without recourse to public subsidy. To illustrate the point in South Africa, Marsay included a case study showing that, for general freight purposes, it would be far more economical to accommodate increased volumes on the Gauteng-Durban corridor by expanding road capacity than by investing to attract freight back to rail.

The paper concluded by outlining the transport policies that would need to be applied in order to achieve the necessary changes in investment priorities in order to realise the asserted efficiencies. For rail transport these policies were to:

- Identify market sectors in which rail does have an economic advantage;
- Invest in these sectors only and disinvest from sectors with no such advantage;
- Create a regulatory environment that incentivises this prioritisation,

and for road transport, to:

- Acknowledge road freight's intrinsic technological advantages more candidly;
- Allow infrastructure investment priorities to be fully shaped by this knowledge;
- Create a regulatory framework that supports the technological efficiencies of road transport, but strongly mitigates its negative environmental externalities.

1.2 Problem statement

The problem addressed in the present paper is that South Africa itself and many other African countries have not yet faced up to fact that rail transport is unsustainable when deployed in circumstances which do not allow it to operate to its technological strengths, or where its viability depends on support from economically unsustainable institutional arrangements. The economic consequences of continuing to invest in rail in such circumstances can potentially be very serious, as illustrated in the following examples.

1.2.1 Transnet's operating mandate is economically and institutionally unsustainable

South Africa's state owned freight rail and ports operator, Transnet, is committing billions of Rand to upgrading rail infrastructure. But, with no regulatory framework requiring it to demonstrate intrinsic viability, its investment priorities are now skewed away from its more viable, but low margin, businesses such as bulk mineral transportation in favour of general freight operations, including containers, which are less viable but generate more revenue.

Transnet is only able to sustain these investment priorities by allowing the high priced ports sector, which it also controls, to provide the collateral to secure bond financing. This, in turn, occurs only because Transnet has failed to corporatize the National Ports Authority as proposed in the National Ports Act. (Government Gazette, 2005, Chapter 4, para 27).

The consequence is that high port dues (mainly for the containerised and other unitised cargoes) are stymying South Africa's trade and economic growth; minerals exports are being hampered by underinvestment in heavy-haul corridors, and at the same time money is being spent on intrinsically unviable general freight projects like the Swazi rail corridor.

An opportunity to remedy this situation lies with the DOT's Green Paper on National Rail Policy, (DOT, 2012) which could develop a more sustainable mandate for Transnet.

1.2.2 PRASA's investment programme may be institutionally unsustainable

PRASA is committed to large scale spending on new passenger rolling stock. While this investment is urgently needed, the absence of a regulatory framework to hold the operator, Metrorail, to account there is a real danger that the new equipment will not be able to be deployed efficiently. Moreover, PRASA is under no obligation to consider alternative service delivery options such as international service providers when it fails to deliver.

Again, however, an opportunity to remedy this situation may be emerging with plans to devolve DOT operating subsidies to metropolitan governments, starting with Cape Town.

1.2.3 Most African railway concessions have proved to be economically unsustainable

Many African governments have entered into concession agreements to try to lever private sector investment into rail infrastructure and attract freight back to rail. Most concessions have either badly disappointed (Zimbabwe, Zambia, Malawi) or failed (Tanzania, Kenya).

While some, (Phipps, 2009, 2011) point to weak concession agreements as a major factor in the failures, SADC (SADC, 2010) concedes that there is more to it than this. The World Bank, (de Longchamps, 2012) has reviewed its own involvement in some failed African rail concessions, noting now that rail can only operate without subsidy in high volume mineral projects, while passenger and lower volume freight rail, requires on-going public funding.

Encouragingly, the African Development Bank (AfDB, 2012) is soon to review all African rail concessions in order to understand what is needed for sustainable rail investment.

1.3 Aim and scope of this paper

Each of the above cases illustrates elements of unsustainable transport infrastructure. In all cases the unsustainability has already had, or could potentially have, serious economic consequences for governments and in many cases private investors too. The aim of this paper, therefore, is to offer pointers for use by governments and private sector businesses to make better rail and road infrastructure investment decisions. Pointers distil lessons, firstly about the differential economic impact over time of road and rail investment, and also about why transport infrastructure procurement methods have changed over time.

Section 2 of the paper reviews historical data in South Africa showing the economic impact of rail investment declining relative to road from about 1930. The reason offered is that the positive economic externalities of the newer, road technology are much higher than for rail.

Section 3 then considers the changing institutional forms through which infrastructure has been procured over time and how this affects the economic value that transport technology is able to deliver. A brief review of the history of transport infrastructure procurement in South Africa and, to some extent, the United Kingdom also, concludes that changes in the institutional forms over time reflect attempts to reduce losses from no longer viable uses of a transport technology, or finding new ways to restore economic value creating potential.

Section 4 pulls together conclusions into a definition of sustainable transport infrastructure.

2. THE ECONOMIC IMPACT OF RAIL AND ROAD INVESTMENT IN SOUTH AFRICA

In 2008 the Department of Transport let a research project entitled 'The Direct Impact of Key Transport Infrastructure', (DOT, 2008). The main concern of the project was that economic growth in South Africa might be being constrained by transport infrastructure inadequacies. The project aimed to review the long-term relationship between transport infrastructure and economic growth. It also considered the different approaches to the procurement of infrastructure over time, the objective being to establish how spending on transport infrastructure could be increased in the most sustainable way possible.

This section of the paper reports what was found about the differential impact on GDP growth of rail and road infrastructure investment respectively, while Section 3 looks at the implications of the procurement issues for sustainable transport infrastructure investment.

2.1 Technological change and the impact of rail and road transport

The DOT report commenced with a review of literature about the relationship between transport infrastructure and economic development, benefiting from the findings of a major survey of the subject contained in a UK Government inquiry published in December 2006, 'The Eddington Transport Study', (UK Department for Transport / HM Treasury, 2006).

In terms of the long term relationship between transport and economic development, Eddington pointed to periods in history when new transport technologies have led to ‘step changes’ in levels of economic activity, increasing the efficiency with which goods and passengers can be moved. Eddington cites the 19th Century railway revolution and 20th Century paved roads expansion along with internal combustion technology as examples of technological change accelerating economic growth and allowing its benefits to permeate ever more widely in societies both spatially and, by extension, socially.

Figures 1 – 4, below, (Marsay, 2012) seek to illustrate these step changes in levels of economic activity, from a subsistence economy without wheeled transport, to an ox-wagon economy; then a railway age economy and, finally, a modern economy supported mostly by road transport. The point being illustrated is that successive transport technologies affect the scale, and spatial penetration, of economic activity. In economic terms, the new technologies generate successively greater positive externalities, in effect, enhancing the ‘gearing ratio’ with which economic activity can be transmitted. Thus, even if the unit costs of transport rise, benefits rise faster because of a more efficient transmission mechanism.

Following these introductory findings about the role of transport technologies, the bulk of the Eddington report consists in detailed cost benefit analysis (CBA) appraisal of road and rail infrastructure investments, with a final section about improving institutional delivery of major transport infrastructure projects. The main conclusions of the CBAs were:

- Smaller investments to enhance the performance of existing infrastructure elements usually have the greatest economic benefits (except where total capacity is an issue);
- Many of the large transport infrastructure projects tested had high benefit to cost ratios;
- Large multi-modal packages of investment had greater economic impacts if expensive rail projects were left out, even allowing for rail’s positive environmental externalities.

Overall, the evidence presented by Eddington indicated that road projects almost always yielded greater economic benefits than rail projects. This finding went against the grain of prevailing policy and also against public support for rail projects. Yet it confirmed the findings of earlier work in the UK (Faber Maunsell and NERA, 2002), which also revealed generally lower economic impacts of rail infrastructure investments relative to road. The Eddington and Faber Maunsell conclusions support the general view that technological change, in transport as in other areas, is a primary explanatory factor of economic growth.

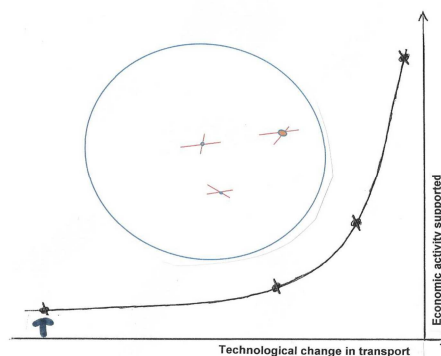


Figure 1: Subsistence economy: very low economic activity; no spatial connection.

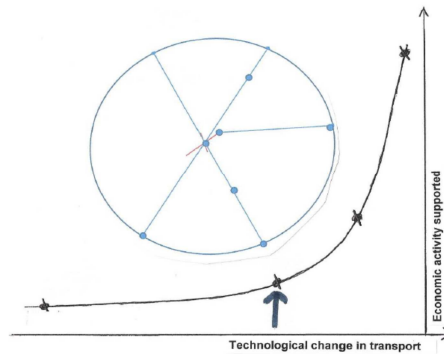


Figure 2: Ox wagon economy: economic nodes emerging; spatial connections forming.

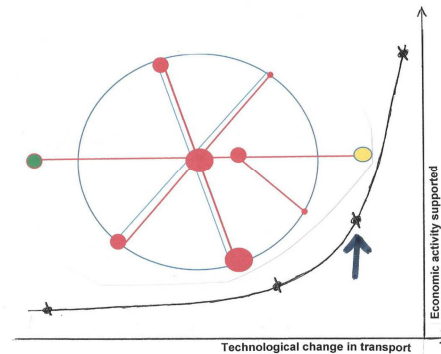
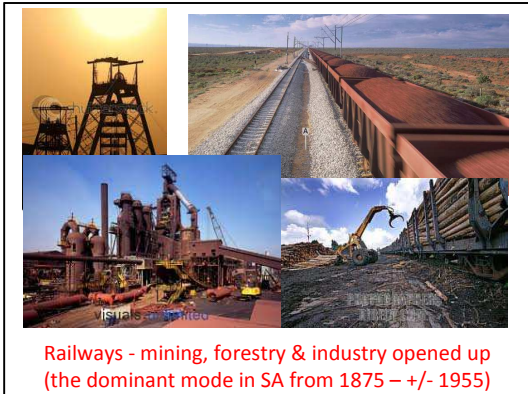


Figure 3: Rail supported economy: major economic nodes; strong spatial connections.

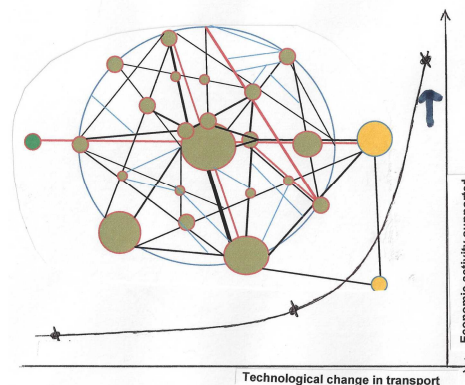


Figure 4: Road dominated economy: *myriad* economic nodes; *myriad* spatial connections.

The aim of the studies was to implement the policy commitment of the new (1997) Labour Government of reducing roads investment and increasing rail and public transport investment. While most of the studies followed the policy encouragement and turned in proposals with over 60% of investment in rail and other public transport projects, the Faber Maunsell review found that most road infrastructure projects scored high economic Benefit to Cost Ratios, some being as high as 10:1, while rail projects typically could not even meet the National Treasury's cut off ratio of 3:1 for BCRs that included social benefits also. This finding led to the Eddington Transport Study with the brief to thoroughly investigate the issue of the relationship between transport investment and economic development. Eddington, as has been seen already, broadly confirmed the evidence produced by Faber Maunsell and NERA for the Commission for Integrated Transport.

It was against this background that the 2008 DOT research project then went on to look at a long-term time series based analysis of the impact of transport infrastructure investment.

2.2 Long term time series analysis of economic impact of transport in SA

After reviewing the above general economic findings about the relationship between transport and economic development, the DOT report (DOT, 2008) presented the findings of a statistical exercise carried out by statistician, Peter Perkins and colleagues; (Perkins, 2003; Perkins, Fedderke & Luiz, 2005; Fedderke, Perkins, Luiz, 2006).

Perkins et al assembled time series data for investments in rail, roads, ports, electricity and telecommunications infrastructure for as far back as records could be constructed. These were set alongside data for GDP, with the data based to a common year and presented in per capita terms to moderate for population growth. Statistical analyses were undertaken to characterise the dependence of GDP growth on infrastructure investment and vice versa. The following more general conclusions were drawn:

- Transport infrastructure investment (together with electricity and telecommunications investments) in South Africa is strongly correlated with economic growth;
- The data also supported the consensus from the literature, namely that transport infrastructure investment facilitates economic growth - where that potential exists.

The more interesting finding related to the respective economic impacts of roads and rail investment, presented graphically in Figures 5 and 6. Before noting the researchers' tentative inferences from the statistical analysis, the following ought to be noted:

- The GDP (per capita) growth line is the same in both Figures;
- Rail data is from about 1910; paved roads data commences in the late 1930s;
- Taken over the whole period the rate of growth of investment in rail declines relative to GDP growth (Figure 5) while that in roads rises relative to GDP growth (Figure 6).

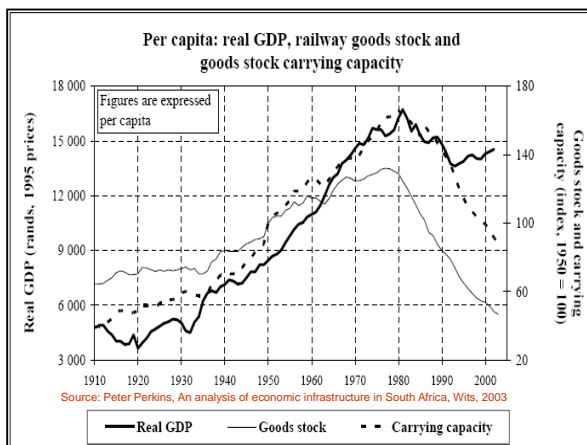


Figure 5: Rail investment and GDP.

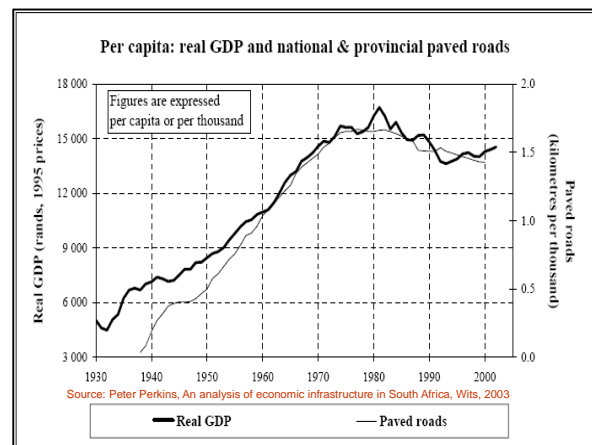


Figure 6: Road investment and GDP.

Based on statistical correlation techniques, Perkins et al noted that the direction of causality between investment and GDP varies between the different types of transport infrastructure. For paved roads, the direction of causality was stronger from roads to GDP suggesting a 'forcing' effect; while for railways, GDP appeared to 'lead' investment.

In attempting to explain the statistical finding that rail investment may have had a weaker aggregate impact on GDP growth over the decades tested, Perkins et al suggest that the typically bulk carrying strengths of the rail mode mean that its development is more closely associated with the particular requirements of key industries or commodities – rather than rail being a means of facilitating the development of a wider range of other industries not necessarily associated with the original development of the freight carrying capacity.

The implication is that road investment is typically associated with economic activities that go well beyond any specific economic activity with which an investment might initially have been associated. This in turn is a consequence of the independent relationship between road vehicles and road infrastructure, which gives greater distributional flexibility, and the much wider geographical penetration that, has been attained by roads infrastructure.

2.3 Transport policy implications – the issue of positive externalities

In economic theory terms, both the Eddington and Perkins et al work points to the fact that road transport generates greater positive economic externalities than rail transport does; certainly in the case of suboptimal applications of rail transport. Positive economic externalities occur when the activity of one party results in benefits to a third, unconnected party. Negative externalities, such as environmental impacts, also impact third parties. Rail transport is often viewed as being more generally sustainable than road transport on the ground of its lower environmental externalities. Yet the evidence presented here suggests that road transport may well be more broadly sustainable than is often assumed.

Examples of the positive economic externalities of road transport include economies of locational or small scale, and economies of manufacturing efficiency. Taking the location / small scale viability case first: a new road facilitates improved access to a large scale, rail supported business. Immediate benefits accrue as the existing user takes advantage of road's flexibility and is able to access new markets. But the road also stimulates new businesses previously unable to trade because of the high cost of investing at the scale of activity required to make rail viable. Road access permits business viability at smaller scale, with lower total start-up costs. The externality is the new value-add at this location.

Road transport also generates *manufacturing externalities*. The motor industry previously used rail transport for many of their requirements, and so had to locate nearly all activities at one central location. This meant long production runs and costly changes to penetrate new markets. Modern plants, however, are much smaller with components being delivered in varying quantities and at varying times. This facilitates a nimble production profile able to respond at short notice to market changes. Road transport's technical and contract flexibility is largely responsible for such value creating manufacturing innovations.

From a sustainable transport policy point of view, investments in transport infrastructure should consider the potential for externality production and not just transport cost impacts. It may only be by taking note of insights based on long-term analyses that more sustainable infrastructure investment decisions can be made. In the case of Transnet and the African rail concessions, it is possible that planners have underestimated the economic externalities of road transport, with the result that rail does not achieve the market share anticipated by planners even when, by institutional or other means, a lower tariff is offered.

The policy implication is that rail freight investments should generally only be considered where they are linked to a secured high volume trade. Where rail competes head to head with road transport, it may only succeed in a financially protected institutional environment.

3. THE ROLE OF INSTITUTIONS IN DELIVERING TRANSPORT INFRASTRUCTURE

3.1 A brief history of transport infrastructure procurement

3.1.1 *Rail in South Africa*

Procurement of transport infrastructure in South Africa has involved both private and public sector arrangements. In South Africa was initially developed by private sector companies, but then taken over by the public authorities as public and strategic value in the transport system was perceived, and for which private owners were no longer able to achieve satisfactory private returns. In the UK, private sector ownership persisted until 1945 when the ravages of war requisition together with weakening private sector ability to invest, led to nationalisation of the rail industry in that country.

But, from the late 1970s onwards, public sector rail operators in the UK and other countries experienced financial stress themselves mainly in the face of competition from road transport. Several models of reform followed with the aim of finding a better balance between the costs and benefits of the rail sector. Successful rail reforms have involved both public and private sector solutions, with success being tied to controlling costs and focusing on business sectors where rail technology's natural advantages can be realised.

In South Africa, the 'De Villiers Report' (South African Transport Services, 1986) noted these global trends and recommended that commuter rail with its mandate to provide urban access to lower income people be separated from freight rail. De Villiers also noted that in the freight rail sector, state protection had led to misalignment of investment from rational economic signals with the greater part of investment being channelled into the least viable sectors of the business. The creation of a commercial entity, eventually Transnet, was recommended, and with state supported investment in rail deferred until it should become apparent in which business sectors rail could still perform effectively.

In the event, Transnet's monopoly control of the ports has allowed it to sustain an economically untested investment programme with the result that it continues to invest more in its less viable general business than it does in its profitable heavy haul sectors.

From an economic perspective this is institutionally supported irrational investment and is unsustainable. If Transnet is to support a sustainable increase in infrastructure spending, a new mandate is needed requiring it to test the economic value of all its investments.

3.1.2 *Roads in South Africa*

Paved roads in South Africa have been publicly procured from the 1920s and delivered through Roads Boards with some maintenance being out-sourced to private contractors. From the late 1980s onwards the DOT experimented with larger scale private contracts, leading eventually to a number of toll-funded concessions starting with the N4. In 1998 the national roads management was placed in the hands of a state owned company, SANRAL which now procures highway works through a variety of public procurement, in-house and purely private toll concessions. By request it manages some provincial roads.

Although SANRAL already offers a financially sustainable framework for national roads procurement, evidence showing the very high economic benefits for highway investment (SANRAL, 2010) indicates that higher levels of public investment in roads is warranted.

3.2 The role of institutions in transmitting the value of transport investments

A general conclusion from the way that rail and roads, respectively, have been procured in South Africa is that while road sector institutions have adapted procurement approaches to meet changing economic realities, the rail sector has resisted the pressures that in other parts of the world have led to reform of the sector. There is a misperception within the rail sector that the interests of its public institutions coincide with the interests of the country.

Unless there is institutional change in the freight rail sector in particular, current investment plans will lead to a situation in the near future in which the industry is no longer sustainable other than by recourse to large-scale state subsidy. One current example is the Swazi rail link designed to divert general freight off the Richards Bay line to create additional capacity for coal exports. The 130 km link will have the *capacity* to carry 15 million tons of freight. The present writer's preliminary cost benefit appraisal of the project is shown in Table 1.

Table 1: Outline cost benefit appraisal of Swazi rail link.

20 year cost	R 60 bn (Capital + operating and maintenance)
20 year revenue	R 20 bn (15 mtpa x R 0.50 rail tariff x 130 km x 20 years)

The above is based on line capacity only and not on any realistically expected volume of freight traffic. At a more realistic average annual tonnage of 5 mtpa, the revenue would be about R 7 bn. This means that to be viable the value of additional coal capacity released, plus the value of environmental benefits of transferring some freight to rail, would have to exceed actual general freight revenue by a factor of almost 10, which is most improbable.

The point of this example is to highlight how an institutional structure that is not mandated to determine true economic value, can lead to massive economic value loss, even as public spending on infrastructure increases. Spending on infrastructure is not in and of itself a measure of economic value or of economic sustainability.

Sustainable transport infrastructure, that delivers sustainable economic value, requires institutional forms that are deliberately designed to achieve such sustainability.

4. WHAT IS SUSTAINABLE TRANSPORT INFRASTRUCTURE?

In the light of the theoretical and evidence based considerations reviewed in this paper, a sustainable transport infrastructure investment strategy will be one that results in each mode of transport being deployed only in circumstances where its technological strengths can be optimised and thus be more likely to achieve positive economic externalities. It will also entail measurement and management of positive economic externalities in a way in which their scale can be compared fairly with the negative environmental externalities.

For this to be achieved, institutional change is needed with the objective of delivering sustainable public value, and with indifference to whether this value is delivered by public or private agency, or both together.

For rail this will involve:

- Selecting investments for which traffic is already committed in advance, rather than relying on forecasts that depend on transfer of freight from road to rail, and / or
- Developing a new institutional mandate that entails independent testing both of freight projections and cost benefit performance (as is already required in the roads sector);
- Measuring environmental externalities and instituting programmes for their mitigation.

For road this will involve:

- Continued testing of all major infrastructure projects by national cost benefit appraisal, but with greater attention to historical evidence of positive economic externalities;
- Continued experimentation with innovative, alternative approaches to procuring and funding highway infrastructure;
- Measuring environmental externalities and instituting programmes for their mitigation.

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