



1. The Sishen Saldanha ore railway - an economic application of rail technology.

Sustainable transport infrastructure investment: A case study for South Africa

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A South African Government commission to investigate “what is needed to bring about a sustainable increase in spending on transport infrastructure” yielded conclusions about relationships between infrastructure provision and sources of investment that have implications beyond the borders of that country.

Introduction

Q. How does one motivate increased spending on infrastructure at a time when one of the longest periods of sustained growth in recent history has come to an abrupt halt?

A. By understanding that the longevity and economic value of infrastructure greatly transcend any swings in business cycles.

While sharp business downturns can drastically reduce the time horizon of specific investment decisions, long periods of sustained economic growth may concentrate minds on the long-term role that infrastructure plays in sustaining such growth.

This article is about what Arup has been doing in one country, South Africa, to help create a more robust appreciation of the economic role of transport infrastructure and how this role can be sustained. To place this in context, however, it is worth noting how some other countries have responded to the long-term relationship between transport infrastructure and economic growth.

When economic growth recommenced in 1993 following Britain’s last real recession, the instinctive response was to manage existing infrastructure better and make greater use of public transport technologies for both freight and passengers. But the scale of transport demand growth eventually led to the realisation that a major expansion in transport

infrastructure could be required, leading to the publication in December 2006 of the Eddington transport study¹, the most thorough examination ever undertaken in Britain of the role of transport infrastructure in economic development.

Eddington's aim was to establish a "case for action" by determining how enhancements of transport infrastructure can offer the most economically, socially, and environmentally sustainable solutions to transport demand. The report was innovative in that it sought to widen the scope of quantitative cost/benefit appraisal by developing techniques to place monetary values on factors such as improved efficiency of urban economies, and a wide range of environmental impacts. Some of Eddington's findings are reviewed later in this article.

The USA likewise has had to revisit its understanding of the role of transport infrastructure in its economic development. As rail, road, and ports infrastructure progressively became congested, it was realised there too that more efficient management of existing facilities could not be the whole solution. Published in December 2007, "Transportation for tomorrow"² mapped out a strategy for responding to massive growth in transport demand.

Interestingly, the commissioners responsible were divided in their response to the situation the USA faces. Most adopted a view similar to that implemented in Britain in the late 1990s and early 2000s - broadly a demand management/multi-modal response entailing significant public intervention and funding, with strong emphasis on public transport. However, a minority report was also included representing the views of three study team members, among them Mary Peters, the Secretary of State for Transportation, which argued for investment that is more directly informed by economic appraisal and with greater private sector involvement.

South Africa also experienced unprecedented sustained economic growth in the past 12 years. The fact that these years of growth coincided, almost to the year, with the country's transition to democracy in 1994 intensified the rest of the world's surprise at this sustained period of growth. The understandable uncertainties associated with the transition meant that very few people would then have predicted a decade and more of sustained and even accelerating growth. South Africa was unused to being part of global trends and is now waking up rapidly to the huge implications for telecommunications, electricity generation, and transport demand.

Significant investment in SA's transport infrastructure started to tail off from the early/mid-1980s when sanctions began to impact and investment priorities were diverted to security. Then, in the first 10 years after 1994, priorities turned to social infrastructure investment in the health, housing, and education sectors.

Meanwhile the economy was starting to boom, and with GDP growth rates above 5%pa for the country as a whole and 7-8%pa in the commercial heart of the economy in Gauteng Province around Johannesburg, transport demand on key import/export corridors was growing in double figures. Just as harsh lessons are being learned in

2. Locomotive on the Sishen Saldanha ore railway.



the country's electricity sector, with demand very close to exceeding installed generation capacity, government has realised that continued economic growth could be severely constrained if plans are not made for long-term transport infrastructure development. If, however, billions of public and private rands were to be applied to developing infrastructure, the SA Government wanted to ensure this takes place rationally and sustainably.

This is the context for the study reviewed here. In a nutshell, Government wanted to know "what is needed to bring about a sustainable increase in spending on transport infrastructure". Arup in Johannesburg was awarded the study in March 2008 and it was completed in August. The successful Arup tender had promised intelligence on relevant experiences in other countries via Arup's global practice, and duly forthcoming were reviews of the UK's rail privatisation experience and highways procurement and contracting procedures, details of Australian practice with infrastructure Public Private Partnerships (PPPs), and research on the corporatisation of the Port of Singapore.

The study was partly desk research and partly through two all-day workshops, one for roads and one for rail and ports. Past and present senior Government and private sector practitioners in infrastructure procurement, implementation, and management were brought together in Pretoria to glean lessons from the past and set best practice guidelines for the future. Arup's Australian specialist attended one event to add expertise on PPPs.

Below are captured the research findings in the report's four main sections: on statistics, on the history of procurement, on cost/benefit aspects, and on whether institutional form matters. Reviewed are:

- over 100 years of time-series comparisons of transport infrastructure investment with GDP growth data, appraising how different transport modes and GDP growth are interdependent
- the history of transport infrastructure procurement in SA and how this history and response to local and global trends has influenced the effectiveness of current approaches to procurement
- recent developments in cost/benefit appraisal methods and how their application (or non-application) influences the sustainability of transport infrastructure development
- transport infrastructure and systems, developments in other countries, and lessons potentially applicable to decisions that may need to be made with regard to some SA transport infrastructure agencies.

The final section draws together the most important recommendations made by Arup to SA's Department of Transport. Some findings of the research that may be more widely applicable are also reported.

Transport and economic development: do the statistics tell a story?

For at least 40 years economists throughout the world have studied the role of infrastructure in economic development. The critical issue has always been whether infrastructure investment brings about economic growth or economic growth leads to the capacity to invest in infrastructure. Theoretically, a broad consensus from all research is that transport infrastructure facilitates but does not create economic growth or development.

Consider a location with no resources at all, human or physical. Simply building a road or rail line to it does not conjure economic development from nothing. But where potentially valuable economic resources already exist, any major improvement in transport accessibility can result in the potential of such resources being realised.

Individual transport infrastructure projects may demonstrate this, but what of the long term? Do such impacts vary over time or with different types of transport infrastructure? These were among the questions to be answered.

Arup drew on some extraordinary statistical work at the University of the Witwatersrand in Johannesburg by Dr Peter Perkins, now a senior statistician with Statistics South Africa³⁻⁵. He prepared very long-term time series data sets of investment in transport, power generation, and telecommunications infrastructure in SA, sourced from early British colonial government official reports, the SA Reserve Bank, Statistics South Africa, Spoornet, The Council for Scientific and Industrial Research, Telkom, the National Traffic Information System, National Ports Authority, and other, international, sources. For SA's transport sector, rail data went back to the beginnings of the industry in 1875, ports almost to the turn of the 20th century, and paved roads to the 1920s. These were all placed alongside data for GDP growth. All the values were of course based to a common reference year for comparability.

Perkins then conducted statistical tests, first between all the infrastructure sets and GDP and then for each type of infrastructure, to see whether any statistically significant direction of causality existed. In other words does GDP growth lead infrastructure investment or is it more the other way round? The general answer was that over the very long term, infrastructure investment does lead, or force, GDP development, thus corroborating the more theoretical work that has arrived at a similar conclusion.

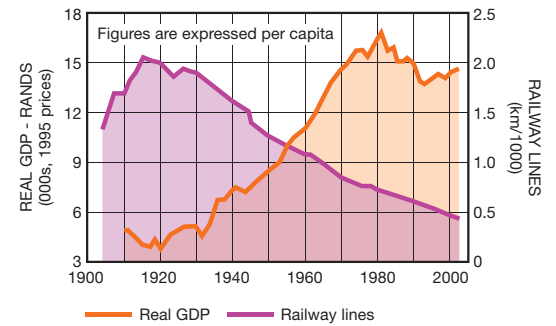
Comparison of the differing impacts of various transport modes, however, offers more interesting and perhaps controversial insights. Figs 3-5 illustrate the relationship over time between GDP growth and investment in rail and paved roads respectively in SA. All data is graphed in per capita terms as this offers a more realistic picture of wealth development over time.

Fig 3 shows that the rail network expanded significantly only until about 1930, with very little further line construction thereafter. The GDP decline from the 1980s reflects the introduction of economic sanctions from the late 1970s, with a rapid recovery from the early 1990s once political change took hold.

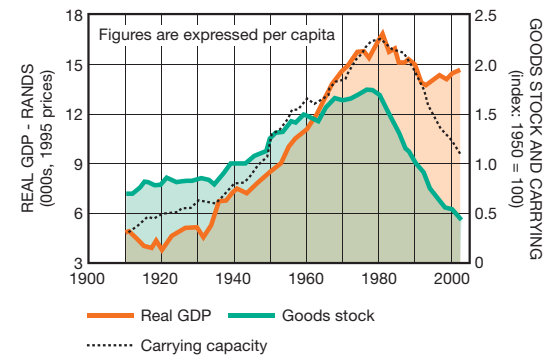
Investment in railway goods stock and carrying capacity grew in parallel with GDP up until 1980 and then fell, apparently in line with declining GDP. Despite the recovery in GDP, however, the decline in rail capacity continued dramatically (Fig 4). As will be noted in more detail below, a significant factor here was that rail transport in SA was institutionally protected from road transport competition from the 1930s through to the mid/late 1980s.

Fig 5 compares the development of SA's national and provincial paved road network with growth in real GDP over 60-70 years, and shows that:

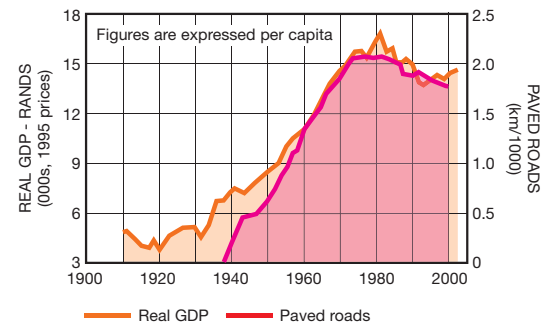
- The extent of paved roads per capita and GDP per capita align extremely closely throughout.
- Tailing-off of road construction during the sanctions period (mid-1970s to mid-1990s) precedes decline in GDP growth.
- Economic growth resumed after 1994 despite there being no further growth in the paved roads ratio.



3. Rail line route kms vs GDP, South Africa, 1900-2003⁴.



4. Rail goods stock and carrying capacity vs GDP, South Africa 1900-2003⁴.



5. Paved road development vs GDP development, South Africa: late 1930s-2003⁴.

The team carried out statistical correlation analysis on the time/series data to investigate any direction of causality between the individual transport modes' investment and GDP patterns. The evidence suggested that while the expansion of the paved road network in South Africa seems to have had a "forcing effect" on GDP growth, with rail and ports infrastructure the evidence suggested that causality was stronger in the direction of GDP growth to the infrastructure capacity creation. This may be because the "fixedness" of rail infrastructure means that it is generally more tied to particular freight generating sources for its business. Investment is undertaken largely to capture specific trades rather than to seek to generate business speculatively.

One policy implication from this is that major investments in new network capacity should be considered only if they are linked to a secured high volume trade, where the economic benefits derive primarily from that trade and not from any wider economic impacts.

In contrast to rail investment, statistics showed the development of paved roads in SA to exhibit a long-term “forcing effect” on GDP growth, the evidence across the whole period measured being that investment in paved roads is supportive of general growth in GDP.

The fact that GDP growth resumed and accelerated following the end of sanctions and start of the democratic era does not necessarily imply that the observed correlation no longer holds. It is more likely that capacity created in the years of high growth is being taken up, with congestion the inevitable outcome. In the light of the statistically suggested relationship between roads infrastructure and GDP, the rapidly worsening highway congestion of recent years is likely to become a significant constraint on further economic growth.

This evidence that road transport infrastructure investment generates long-term economic impacts is likely to be a consequence of the essentially open access nature of road transport technology and the broad distributional flexibility that is offered once its infrastructure is in place. The policy implications are significant even though they appear contrary to much contemporary concern about road building.

Clearly statistics do indeed matter. Perkins himself nevertheless cautions against relying solely on statistically-based conclusions in making policy, and advises that investment decisions on which infrastructure to invest in should be supplemented by appropriate cost/benefit analyses. But before examining that subject, a historical question needs to be answered.

6. Demonstrators form a human barrier against cutting through Twyford Down in Hampshire, England, in 1993. The M3 motorway extension project was the “last straw” for road objectors.



7. Beyer Peacock steam locomotive on Natal Government Railway, 1884.



Approaches to procurement: does the history matter?

Arup also investigated trends in how transport infrastructure has been procured, to see if any general guidelines could be discerned that could inform the development of a more sustainable South African approach.

At the global level can be discerned cycles of private, then public, then back to private sector procurement in both road and rail infrastructure development. The research tracked these cycles and found that an underlying explanation seemed to lie in changing perceptions of who benefits from infrastructure investment, the scale of the benefits, and the timescales over which they manifest themselves. The answers to these questions typically lead to answering who should pay, and how.

Almost all rail industries around the world started with private investment. Most moved on to public ownership and investment responsibility, though the past 20 years or so has seen greater emphasis on private investment again.

In the roads sector, the cycle appears to have been the reverse. Because of the open access technology, private investors couldn't easily protect investments in roads and so very early on the requirement for a programme of publicly developed roads was established in most western countries. In the UK especially, increasingly sophisticated programmes of publicly procured highways emerged, such as those of the Road Construction Units in many county councils.

With apparently no end to the extent of new roads that appeared justified by appraisal techniques based on travel time and safety improvements, doubts began to emerge from the late 1970s onwards. In the 1980s, value for money was questioned; in the 1990s, the balance between user benefits and wider environmental disbenefits (Fig 6). The first round of opposition led to increasing pressure for private sector testing and eventually private sector procurement of roads. The second trend led eventually to road construction being virtually halted.

But with the strong economic growth that persisted until late 2008, government commissions in both the UK and the USA appeared to be saying that the scale of growth in transport demand may again require levels of investment in infrastructure that exceed the commercial appetite of the private sector.

In South Africa, these cyclic trends are not so clearly discernible, partly because in the long apartheid era the economy became increasingly isolated from international involvement. Rail indeed commenced in the private sector, with companies developing short freight and commuter lines in Durban and Cape Town from 1875 (Figs 7, 8).



8. Botha's Hill station, Durban, which saw its first train in 1879.

The advantages of the new technology to support planned urban development led to take-overs of these early private businesses by the respective colonial administrations for further expansion. Inland, in the independent Transvaal Republic, the Zuid Afrikaanse Spoorweg Maatskapye (ZASM) privately developed a line from Pretoria and Johannesburg to the Mozambique port of Delagoa Bay, near present-day Maputo.

Following Britain's 1902 military victory in the Anglo-Boer War, these three railways first fell under military jurisdiction and then were amalgamated into the single South African Railways and Harbours Company in an Act of that name in 1913. Though owned ultimately by government, the SAR&H was a commercial entity, not a government department. It was mandated to be commercially viable but also to invest in an expanded network to open up the country for mining and agricultural development. The network thus expanded to more or less its current extent by the end of the 1920s, the only significant additions since being the Richards Bay coal line and the Sishen Saldanha ore line in the 1970s and 1980s (Figs 1, 2).

In the years before significant road construction began, the SAR&H's twin mandates to support national economic development and cover its costs were fairly well aligned, although additional government investment was provided wherever no clear business case existed for opening a line to an area government thought had economic potential.

From the 1920s and 1930s onwards, road and air transport respectively began to emerge as competitors to rail. The SAR&H appealed to government that its national developmental mandate was being impeded, and succeeded in requiring all road transport operators to be issued with licences that ensured they would not compete on a rail route. The Union Airways company that was beginning to divert the mail business from the railways was taken over directly by SAR&H, eventually becoming South African Airways. Thus protected, the rail sector continued to grow its business right through until the 1980s (Fig 4), when partial transport deregulation legislation was introduced.

One consequence of this history is that, despite the dramatic loss of business to the roads sector, rail's institutional heritage of being a custodian of national economic interest persists. This is a major factor preventing the SAR&H's successor company, Transnet, from embracing some of the private sector involvement options by which railways in other countries have sought to recover a sustainable future for themselves.

Roads procurement in SA has gone through a similar cycle to that experienced elsewhere. In the 1930s, national and provincial Roads Boards were constituted with responsibility for funding and procuring the construction of a rapidly expanding roads network. A similar pattern to the UK's RCUs was developed with sub-units operating within the larger provincial Boards.

At the time of the transition to democracy in the early 1990s, experiments were under way with private concessions to procure major road developments such as the Maputo Corridor concession. The National Roads Board led this initiative, operating increasingly commercially in its final years before the transition.

These experiences foreshadowed the establishment of a new agency structure at national level, one aim of which was to transfer the burden of national roads funding and maintenance from public to private sector. In the decade since its establishment, the South African National Roads Agency Ltd (SANRAL) has been able to progressively move away from grant funding by central government to self-funding via concessioned and direct toll projects. The current GB£1bn/ZAR15bn Gauteng Freeway Improvement Scheme is the latest stage in this evolution (Fig 10).

An important feature of this change to a more commercial status has been increasing reliance on detailed economic and social impact appraisal of schemes. SANRAL could demonstrate not only that many of its projects are intrinsically fundable but also that road investment brings substantial social and economic benefits.

Indeed, the high level of viability shown in some major schemes seems to indicate that it would be in the country's national interest if even more money than can be raised through commercial funding were invested in these schemes. In other words, the balance of public benefit against lifetime cost suggests that a sustainable increase in roads investment could be achieved by additional state funding, perhaps drawing directly on state borrowing or bond financing.

This conclusion emerging from SANRAL's practice is supported by detailed research at the University of Stellenbosch on infrastructure funding⁶. This work draws attention to an apparent anomaly: while most of the cost of SA infrastructure is met from current sources of revenue, the infrastructure is deliberately designed to add economic value through future generations. So, why are methods of procurement and funding of infrastructure not sought that reflect a better balance between cost and benefits over time?

9. Early 20th century South African national road - over Sir Lowry's Pass, Cape Town.





10. The Gauteng Freeway Improvement Scheme: adding additional central lanes while maintaining full bidirectional flow.

This implies that more long-term public sector borrowing may be warranted. Calitz and Fourie⁶ carefully add the caveat that this approach should be adopted within the context of normal public financing prudence, but they note that such prudence may be excessive when the estimated benefits of infrastructure projects far exceed the costs.

SANRAL's good experience with a more commercial approach to roads procurement indicates that the PPP route to infrastructure procurement should be followed more extensively, and the DoT explicitly asked Arup to assess the pros and cons of such models as part of a more sustainable transport infrastructure funding programme.

Arup in Australia accessed a very extensive review in that country comparing PPP-procured infrastructure projects with those conventionally procured. The team drew on this extensively in arriving at the following summary of the PPP role.

The principal difference between traditional and PPP projects is that the degree of responsibility/risk borne by the public sector is typically lower, most of the project planning being done by the private party. Except for fairly small projects, both methods rely on private contractors for construction and, where relevant, operation.

Successful PPP projects typically have an early consensus on their public objectives. Both parties are thus able to be realistic with themselves and their partners about project risks, in particular the likely scale of revenues and other benefits.

Where the private benefits can be captured effectively, as in a tolled river crossing, PPPs can also take much of the funding burden away from the public sector. But the mechanism can also work efficiently even when the public sector bears most of the costs, as with the Gautrain rapid rail link between Johannesburg, Pretoria and OR Tambo Airport⁷. This illustrates the further fact that PPPs have the greatest benefit during project preparation, and hence are useful for implementing specialist projects where new skills not usually present in public sector institutions are being introduced. They usually lead to more accurate estimates of project costs and timing simply because the private sector's aversion to risk-taking concentrates minds better.

While PPPs are designed to engage the private sector to assist in achieving public benefits cost-effectively, they cannot be regarded as a tool for establishing the nature or scale of public benefits. And while PPPs in transport infrastructure almost invariably demonstrate efficiency of procurement and cost control, leading to "on time

on budget" projects, they do not necessarily deliver national economic value for money. PPPs are thus best regarded as a special case procurement tool and not a substitute for the public sector's role.

So, does the history of procurement approaches teach us anything about how to achieve a more sustainable programme of infrastructure spending? Yes. Unsustainable approaches tend to occur when there is a misalignment between costs incurred and benefits produced. There can be misalignment of scale, when too much is spent for too little gain. This usually occurs after a new transport technology emerges and the previous one cannot offer the same benefits - substantially the reason why huge institutional realignment of the rail sector was needed over the past 20-30 years.

On the other hand, too little may be spent when the potential gains are far greater than the investments incurred. In SA this seems to be the case with the roads programme, where the procurement model only partially captures the scale of benefits estimated.

The key to sustainable transport infrastructure procurement would appear to be in designing a model that can capture the maximum proportion of benefits at minimum possible cost.

The answer probably lies in some combination of the PPP as a procurement tool and selection of projects that demonstrably yield national economic value. Because wherever procurement efficiency and economic value coincide, one has a win/win situation. So, to the next issue...

⁷ Arup is the Independent Certifier on the new Gautrain PPP high speed rail link being built between Johannesburg, Pretoria and OR Tambo International Airport - the largest such project in Africa.

Does cost/benefit analysis matter?

In the South African context, though probably not restricted to this country, one main reason for lack of sustainability in infrastructure development is that projects with poor economic prospects are often pursued for perceived social gain while projects with potentially greater economic benefits are set aside because of perceived disbenefits to targeted groups. Explanations for this include poor appraisal methods, institutional mandates that allow agencies to judge investment priorities by non-economic criteria, or simply unwillingness to accept appraisal results if they do not appear to support prevailing policy objectives.

Although decisions may ultimately have to be made on the basis of democratic mandates, decision-makers need to be aware of the benefits and costs of their actions. When this is not so, institutionally mandated decisions may be presented publicly as economically beneficial ones, leading to ongoing distortions in infrastructure investment priorities to the detriment of society as a whole.

One such distortion emerged when the UK Commission for Integrated Transport was asked to report on the findings of the initial batch of regional multi-modal transport studies, commissioned in the late 1990s to set out long-term transport investment priorities for each region. Government had given the studies a strong steer by seeking appraisal methodologies allowing a fairer comparison of rail and other public transport investments with road options. The CfIT report⁷ noted that while over 60% of all proposed investments were in rail and other public transport, benefit-to-cost ratios (BCRs) for rail solutions were typically very low and did not meet HM Treasury's benchmark BCR even with social benefits added. Most highway projects were found to score consistently much higher BCRs⁸.

Simultaneously the UK rail sector was struggling to emerge from its painful privatisation exercise. A House of Commons Committee in 2003 reviewed the value for rail, seeking answers from the Rail Regulator and also the Chief Executive of the then Strategic Rail Authority (SRA) to the question, "what are we getting in return for the much higher than expected cost of running the rail network?" Both individuals referred the chair to "the social benefits", though without offering evidence equating the value of these with the costs being incurred.

The conundrum of strong public support for railways but evidence that the social benefits fell far short of the costs led Government eventually to the most thorough re-examination of the case for transport infrastructure investment ever undertaken in Britain, the Eddington Transport Study¹.

11. The first French TGV service began operating in 1981.



As well as giving a valuable historical review of how transport infrastructure facilitated economic development in Britain, Eddington also sponsored several innovative research experiments designed partly to shed light on the above conundrum. Both areas of research - "agglomeration benefits" and "monetisation of environmental benefits" - were highly relevant to the whole system of cost/benefit analysis of transport projects.

Taking agglomeration benefits first, Eddington used the then current South and West Yorkshire multi-modal study to examine whether transport improvements add more value than just savings in travel time and costs for network users. For many years it was suspected that the benefits of improving access to urban economies were additional to savings in travel time. What about the ability to deal with more customers in one day than was possible from a remote location? What about being able to attract a wider range of skilled labour to the same location than before the transport improvement?

In France, studies of the inaugural TGV (*train à grande vitesse*) line from Paris to Lyon (Fig 11) had shown that previously Paris-only business sectors began to spring up in Lyon. The daily face-to-face contact characteristic of a capital city location now extended to the Lyon suburbs because travel was so reduced that the Parisian image could be maintained from a Lyonnais location.

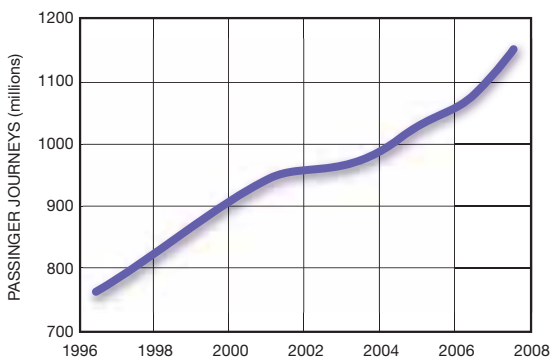
Unfortunately, no satisfactory way to objectively measure such phenomena had been achieved and so HM Treasury dismissed the anecdotal evidence as expressions of travel time and cost savings. Eddington explored this in detail and showed that urban efficiency gains or "agglomeration benefits" do indeed exist: they are additional and can contribute up to 50% extra value to conventionally calculated benefits of transport infrastructure projects.

The second major Eddington contribution to cost/benefit appraisal methodology concerned impacts on the environment. The SRA had already pioneered such a methodology in its 2003 "Sensitive lorry miles" report⁹ (to which Arup contributed research). This attempted to establish how much grant should be given to firms investing in rail facilities that resulted in trucks being removed from environmentally sensitive roads. Using a combination of impact measurement and stated preference techniques ("how much of your disposable income would you forego to have less noise/pollution, etc, passing your home?"), the report arrived at a range of values for environmental impacts saved per mile for the removal of trucks from different types of road.

The "Sensitive lorry miles" data suggested that rail's environmental impact was between two and four times less per mile than that of road vehicles, depending on the category of the road being relieved by transfer of road traffic to rail.

	The monetarised evaluations (pence/mile)		
	Congested motorways	Main urban roads	Main rural roads
Road environment cost	13.9	36.2	12.1
Rail environment cost	8.8	8.8	8.8
Rail environment cost saving	5.1	27.4	3.3
Congestion cost	79.0	121.9	45.8
Rail's environmental advantage as a % of congestion cost	6%	22%	7%

12. Road and rail environmental impacts⁹.



13. Passenger demand growth on the UK rail network, 1996-2007.

Eddington developed the appraisal methodologies further and arrived at rationally defensible values for a range of impacts, including global CO₂ emissions, local air pollution, noise pollution, and others.

The implication of the monetarised environmental valuations is that, while rail is indeed very much better than road, because of the dominance of congestion cost reduction in transport evaluations, rail's environmental advantage is typically not great enough to be the determinative factor in mode choice, except in dense urban contexts or in situations where rail will carry significant volumes of bulk freight (Fig 12).

Eddington then developed four appraisal stages starting with conventional costs and benefits only, and working up to inclusion of agglomeration and finally environmental. These were then applied to a package of urban and interurban transport projects including both road and rail. The overall conclusions were that benefits remain high for many of them, even after social and environmental costs and benefits have been fully accounted for. Although Eddington does not seek to engage directly in the road vs rail debate, the findings broadly confirm previous evidence that most road-based projects typically yield higher BCRs than most rail projects.

The key to effective rail projects appears to be to align them as closely as possible with urban growth so that the agglomeration benefits rather than the conventional travel time and cost benefits are the key to project viability.

The implications of these findings are highly significant for projects in the UK and South Africa. London's east/west Crossrail and the Gautrain Johannesburg/Pretoria rapid rail link have both faced sceptical responses from the respective treasuries, because their conventionally calculated economic benefit/cost ratios are low - between 2:1 and 3:1 - even allowing for social and employment creation benefits. Recognition that the Gautrain might accelerate already existing trends to urban concentration and facilitate further CBD growth was probably a factor in it getting the final go-ahead. And in London, studies of the potential agglomeration benefits associated with Crossrail have resulted in a substantially higher BCR.

In the main Eddington report this finding was couched in typically British understatement: "The benefits of transport infrastructure investments will tend to be higher where they occur in support of strongly growing urban centres and on links between points of access to an economy and those urban areas".

In its report to the South African DoT, Arup therefore recommended that transparent cost/benefit analysis methods be introduced to all transport sectors. This recommendation especially applied to Transnet, the state-owned rail freight and ports utility. At present Transnet is mandated to have a financially sound bottom line, which it is well able to achieve given its sole operator status in both sectors. But it does not apply broad-based national economic cost/benefit analysis to its major infrastructure investments, so there is no way of knowing whether these investments are really adding to national economic welfare or not.

Because South Africa's overall economic strategy is to achieve "accelerated and shared economic growth", cost/benefit analysis really does matter.

Does institutional form matter?

In the final area of investigation, the question essentially was whether public or private ownership matters as far as effective infrastructure construction and operation are concerned. To answer this, Arup sought assistance from colleagues in London and Singapore. The former contributed a discussion on how highway development and maintenance is managed in the UK, plus an excellent overview of the UK's rail privatisation experience, whilst from Singapore research assistance was provided in support of a case study of the corporatisation of Singapore Port.

The main lesson from reviewing highway procurement and management in the UK was that the key to sustainable investment programmes is flexibility in contract form. The question of public or private ownership or management appeared to be less important than seeking the most appropriate institutional mechanism for the job in hand. This entails, among other things, ensuring that implementing agencies have effective managerial as well as engineering skills. Many years of trial and error led to this point, the hard-earned lesson emerging that "horses for courses" rather than "one size fits all" is the key to a sustainable highway investment programme.

UK rail privatisation has become a paradigm for industry practitioners in other countries to either loathe or love. The comprehensive and balanced review from Arup in the UK offered very clear lessons, both positive and negative.

On the positive side it is evident that, for passenger operations, privatisation brought significant benefits to consumers. The competitive franchising model resulted in a multiplicity of operators competing not on the same tracks but within a clearly defined regulatory framework of targets and penalties. The system has been robust enough to survive several franchisee failures and being replaced or taken over by others. Passenger numbers are at their highest level in history and private investment in new rolling stock has mushroomed (Fig 13).

On the negative side, the privatisation of the rail infrastructure effectively failed, due to inadequate knowledge of the condition of the physical asset and hence massive underestimation of maintenance and renewal costs. The original privatised operator, Railtrack, focused more on share price management than technical aspects of the business, so that initially the share price rose as passenger numbers increased. While from a private business standpoint this may have been a rational approach to achieving a sound credit rating for future investment funding, the public saw neglect of a public asset for short-term private gain.

The Hatfield crash of October 17, 2000, in which four people died and dozens were injured, jolted Railtrack into awareness of its misjudgement of how extensive was the task of maintaining its infrastructure to modern safety standards. The cause was a cracked rail, and subsequent inspection of the network revealed numerous similar problems^{10, 11}.

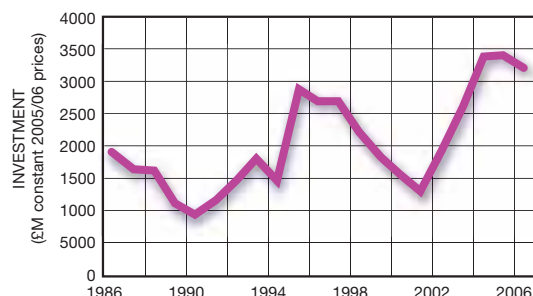
The identified costs of repairs and upgrades were way beyond the amount of investment permitted in terms of the economic regulatory regime that sought to link allowable investment to commercially earned revenue. The share price crashed and any hope of a privately funded recovery was lost.

Government took Railtrack into administration and, against the economic evidence, recapitalised it and set it on its way again as the new, not-for-profit, but still notionally private company, Network Rail. The regulatory regime had to accommodate itself to a new funding framework in which government was committed to a medium-term programme of capital expenditure with the objective of realising a viable infrastructure company (Fig 14).

What are the lessons in terms of sustainable investment in transport infrastructure? Perhaps the most important is that if a government regards as socially desirable a service that cannot be funded fully by the private sector, then it must take very seriously its responsibility for funding such a service. With over 20 private sector train operators on the network, it became clear that without publicly supported funding certainty, they could not sustain their side of the bargain.

Taking this responsibility a step further, a government wanting a passenger rail service must ensure that mechanisms are in place to ensure good technical management of the network as well as effective business management. Ultimately, running a national rail network costs more than can be justified in any commercial business framework.

14. Government capital investment in the UK rail network, 1986-2006, throughout the privatisation process and especially since the Hatfield crash.



As already noted, the British Government also discovered that the system as a whole was costing more than could be justified within even the broadest social cost/benefit framework. Though government has committed to funding the high cost of network renewals for the medium term, the long-term future of rail in Britain will depend on continued social consensus that the cost is worth the benefit. Some doubts must remain, in view of the 2007 Rail White Paper¹² which reveals that on top of annual funding subsidies, the British rail network also carries a £25bn debt sustainable only because it carries an unconditional Government guarantee. Without this guarantee, Network Rail would not be able to fund its infrastructure programme.

Key lessons for the sustainability of transport infrastructure investment in South Africa are that every possible effort must be made to understand the true costs of running a rail network. Given the country's limitations on capital funding, it would be advisable also to identify the most cost-effective elements of the network in terms of selected service criteria, and concentrate available investment on these routes. This is what Arup advised in SA's recent national passenger rail plan. All routes are ranked in terms of a range of service criteria, leading to a set of priority rail corridors where improvement efforts will be concentrated.

The case study of Singapore Port was requested specifically by the client to discern lessons for SA's ports sector. On the surface, the structure of the ports sectors in SA and Singapore are very similar. An infrastructure owning agency also acts as a sort of in-house regulator, and a service provider runs the ports themselves. There the similarity ends, because Singapore Port is one of the most efficient in the world (Fig 15), but SA's ports perform well below international benchmarks. Productivity is relatively low, given the technical sophistication of equipment available. Tariffs are regarded by the shipping industry as far too high.

The Port of Singapore Authority was a public agency until corporatisation in 1996/97 created a separate Port of Singapore Authority (PSA) and the Maritime and Port Authority of Singapore (MPA). PSA became a commercially mandated but 100% government-owned terminal operator, with MPA providing port services such as tugboat pilotage and other port safety activities. MPA is also the port planning agency and industry regulator.

The decision to create a separate, corporatised terminal operator was made despite its previous efficiency, reputation for quality services, profitability, and timely investment in new capacity. The main rationale for the new arrangement was to allow the PSA to operate more efficiently as a commercial organisation, freeing it from the hindrances of a government body and allowing it to be commercially focused and customer-oriented.

Thus liberated, it was better placed to develop new business opportunities and respond more effectively to future challenges, and to provide customised services for individual clients. Corporatisation created many commercial incentives, which apply to private firms, and increased the separation between PSA and other government linked companies (GLCs), and the Singapore Government. This separation also ensured a level playing field so that the GLCs do not have any competitive advantages or disadvantages relative to private organisations operating under similar market risks.

Ultimately the PSA's mandate is to secure and retain Singapore's status as the world's premier container terminal. To achieve this it has entered into successful alliances with shipping companies and terminal operators all around the world as part of a strategy to retain Singapore's hub port role in the region.

The key lesson for South Africa in terms of achieving sustainable investment in its ports infrastructure is that a protected commercial status is ultimately a hobbled commercial status. Singapore was willing to allow real commercial freedom to the PSA in a manner that forced it to face up to and respond to the real demands of the international shipping industry. For this to happen in SA, Transnet's port operating business will need to be released from its ties to all other elements of the wider Transnet business and allowed to act as a freely competing private business and with the freedom to choose how and with whom it will partner in both port and inland transport operations.



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Credits

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Economic consultant: Arup - John Davies, Nigel Halley, David Kinder, Andrew Marsay, Matshediso Seobi, Stefan Sanders, Gideon van der Westhuizen, Tan Yoong Heng
Illustrations: 1, 2, 7, 9 Transnet Freight Rail; 3-5, 12-14 Nigel Whale; 6 *The Hampshire Chronicle*; 8 Michael Jung/Dreamstime.com; 10 Keith Baker; 11 Jiri Hodecek/Dreamstime.com; 15 Nikontiger/Stockphotos.com.

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15. The case study of Singapore Port was requested specifically by the client to discern lessons for South Africa's ports sector.

Conclusions

Our research suggests that roads investment is more positively correlated with economic growth in South Africa than either rail or ports investment. However, a sustainable increase in transport infrastructure spending will require all investment decisions to be informed by broad-based cost-benefit analysis. Rail investment will yield significant economic value when focused on bulk commodity projects and on urban rail projects where there are high densities and volumes, and where pre-existing trends of urban economic growth can be discerned.

Private sector participation usually brings efficiency of procurement and cost control to transport infrastructure investments, but needs to be focused on projects that are sound in national economic value terms for a sustainable increase in spend to occur. For this to happen, it is essential to know the national benefit-to-cost profiles of investments in transport infrastructure, taking account of latest developments in cost/benefit appraisal, as well as their intrinsic financial viability.

Finally, private ownership of infrastructure is not a prerequisite for a sustainable increase in infrastructure investment to occur, but this goal is more likely to be achieved in the public sector when public agencies are mandated to align their infrastructure investment decisions with demonstrated national economic value.