

THE VALUE OF TRANSPORT RESEARCH – A DFID PERSPECTIVE

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ABSTRACT

Despite the benefits from investments in transport research, acquisition of funding for research projects in developing countries is difficult to obtain. There may be a number of reasons for this, including a lack of awareness of the potential benefits of research and a poor appreciation of the link between transport and the Millennium Development Goals for poverty reduction by funding agencies and collaborating governments alike. Another factor is constraint due to the research capacity of local institutions in many less developed countries. There is a need for research to find innovative solutions to meet the demands for improved access and mobility by the rural and urban poor. The need for close collaboration with local practitioners is an essential factor in identifying local problems and devising appropriate solutions. Information on the benefits of transport research in relation to the global investment in transport is scarce. Examples are available of the qualitative and quantifiable benefits from some past DFID-funded research projects in the sector. DFID support for current transport research is evident in the programs in Asia (SEACAP) and Africa (AFCAP). There is a need for a long-term commitment to road infrastructure and transport research for the benefits of this investment in research to be realised.

1. INTRODUCTION

In the period up to 2020, investment in the transport sector in Asia alone is expected to be of the order of \$2 - \$3 trillion⁽¹⁾, which probably equates to a crude global estimate of the order of 4 – 5 times greater than this figure. It is now generally accepted that there is clearly a close link between transport and development, although no targets were set for transport in the Millennium Development Goals (MDG's). However, it is becoming increasingly clear that transport is a key factor in achieving poverty reduction goals for developing countries. In the simplest terms, good transport investments facilitate social and economic activities and growth, while poor investments inhibit these gains, as well as draining significant resources from other important sectors such as health and education.

Access and mobility of the rural and urban poor are important enabling factors for poverty reduction and improvements in livelihoods. It is also becoming increasingly clear that a paradigm change in approach to transport problems will be required if the transport needs of both the urban and rural poor are to be met by 2020, particularly in the least developed countries (LDC's).

Good roads are essential for the provision of reliable transport services. In many developing countries, maintaining roads in a condition that facilitates the provision of reliable transport services to the rural poor is becoming increasingly difficult. Insufficient financing for the maintenance of rural roads combined with scarce or dwindling gravel resources in many countries means that maintenance targets are seldom achieved. Innovative solutions are required to improve the delivery and sustainability of rural road infrastructure but these must be shown to be technically appropriate

and cost effective. It has been suggested that each of the factors shown in Figure 1 need to be met for low-volume sealed roads to be sustainable.

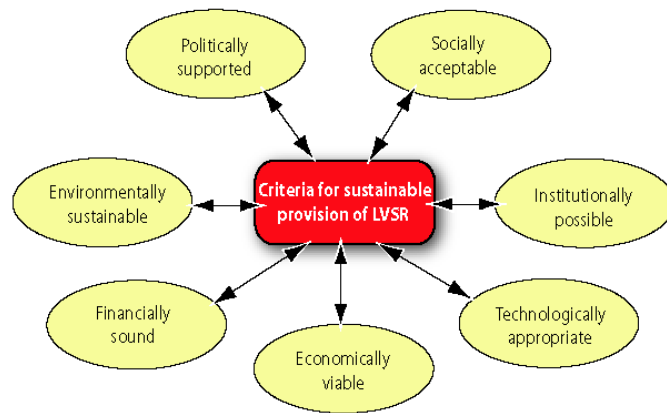


Fig 1: Framework for road sustainability

Source: SADC Guideline for low-volume sealed roads

Sustainable development is the goal of most international development agencies and it is accepted by the UK Department for International Development (DFID) that transport is essential for sustainable development and has a direct impact on most of DFID's aims. The World Bank is also committed to improving the sustainability of the sector through increased efficiency and making the supply of transport services more responsive to the needs of users⁽²⁾. Knowledge derived from research is an essential ingredient for sustainable development in that it provides the information necessary for decision making.

Research is the mechanism for the advancement of knowledge and for social and economic progress worldwide. It is the proven method for developing and testing new and innovative ideas. The results of successful research, combined with demonstration projects, enable practitioners to adopt and apply new and innovative approaches with confidence. Unfortunately, the transition from successful research/demonstration to the implementation and mainstreaming of new technology is often extremely difficult and it seems to be particularly difficult in road engineering. In the UK, it has been reported that "although the UK has a good track record in the intellectual aspects of Research and Development, it tends to be less equipped to apply and exploit the results and that somehow, the country's undoubted technical ability often fails to be carried through to application"⁽³⁾. Therefore, it seems that the process of transference of knowledge into practice might well be a universal problem.

Research is seen by many as a luxury but without it, few of the advances in scientific and engineering knowledge would have been possible. Visual evidence of the contribution of research to technological development can be found in almost every facet of our lives and this includes roads and transport. Researchers in the sector, in collaboration with local practitioners, are constantly undertaking research and demonstration projects to develop new techniques, improve the use of local resources and raise awareness by practitioners of alternative approaches in the provision of roads and transport services.

Despite the undoubted benefits, the acquisition of funding for transport and transport-related research in developing countries is difficult. This problem is compounded by the constrained research capacity at most academic institutions in developing countries. The main focus of many of these institutions is training. For their knowledge base, they rely heavily upon research carried out by institutions and programs from more developed countries. This can also be problematic if this knowledge base is not carefully adapted for the specific environment of the developing country, as often happens.

It is perhaps timely to review the case for funding and the available evidence on the cost-effectiveness of investment in transport research.

Much of the investment in transport research has been into improving the cost-effective delivery and sustainability of access roads for the rural poor in emerging and developing countries. It is recognised that research in road infrastructure is just one component of investment in transport research and some examples of the benefits from interventions in the broader transport sector are included in this paper.

2. INFORMATION ON THE “VALUE OF RESEARCH”

There is relatively little evidence available that provides a broad quantitative overview of the cost effectiveness of transport research. Individual projects are occasionally subjected to economic evaluation but there is little evidence of the economic case for global investment in transport research. Studies that have been conducted have been by research institutions themselves as part of the justification for investment in their research activities, although these studies also appear to be in relatively short supply for the transport sector in general.

More evidence is available on the benefits from innovative and demonstration projects based on the results of research. However, only rarely are the benefits related to the investment costs of the research itself, on which these initiatives were based.

This paper includes a review of the results of a major study carried out by the Transport Research Laboratory (TRL) in the United Kingdom on the benefits from transport research⁽⁴⁾ together with evidence from the Australian Road Research Board (ARRB)⁽⁵⁾ and selected case studies from these and other institutions on the benefits, both observed and projected, for various implementation initiatives. Other examples are included in which the impacts of research are evident but they have not been quantified in economic terms.

3. RESEARCH NEEDS IN THE TRANSPORT SECTOR

The transport problems in developing countries require local solutions that are inherently different from those in more developed countries. The prevailing climate is often different and climatic factors have a considerable influence on road design and performance. The mix of traffic on both urban and rural roads is different from developed countries and also often differs between developing countries. The modes of transport are also different. Motorcycles, pedal cycles and various forms of non-motorised transport compete with cars, trucks and pedestrians for the use of the available road space. Moreover, road authority institutional cultures vary widely among developing and developed countries.

Pedestrians comprise a large proportion of road users in many developing countries, often with little or no provision for their safety. Only recently have NMT's been included in traffic counts. Pedestrian movements are still rarely included in these counts or in the forecasting of future traffic, but even on rural roads, congestion caused by large numbers of pedestrians is already evident near markets, schools and other public places.

There seems little purpose in designing durable road structures with a projected life of 15 to 20 years to facilitate sustainable access only for congestion, due to increased use of NMT and pedestrian traffic, to restrict this access and imperil the safety of these poorest of road users.

The safety of all road users in developing countries is of increasing concern. Over 3,000 deaths occur from road accidents are reported every day worldwide with 85% of these in developing countries.⁽⁶⁾ Under-reporting is also a problem in these countries. Over 30,000 serious non-fatal injuries are reported per day but the actual figure is estimated to be of the order of 150, 000 per day. This is not only an enormous human tragedy but it comes with a severe economic cost. Many developing countries are losing as much as 3% of GDP due to road accidents. This cost to society negates investment in development. Interestingly, it has been reported that the costs of road traffic accidents in 1997 in the emerging and developing countries was approximately \$65 billion, which was equivalent to the total 'official' bilateral and multilateral aid for the same year. This figure has probably increased to around \$100 billion in current prices.

Road traffic accident rates in the developed world are decreasing, mainly through the introduction of road safety legislation, awareness and training based on research. Unfortunately, accident rates in the developing world continue to rise with the poorest road users, such as cyclists, user of NMT's and pedestrians being particularly vulnerable. Another worrying statistic is that pedestrians form between 13% and 20% of road casualties in the USA and Western Europe but this figure rises to between 50% and 60% for developing countries.⁽⁷⁾

The mobility of the urban poor is also of concern. A significant movement of the rural population to urban centres is underway in many developing countries as the rural poor seek access to economic opportunities in the hope of improving their livelihoods. In some countries where most people once dwelled in the rural areas, the urban population now exceeds 60% of the total population. It is estimated that in Asia, by 2020, 4 billion people will be living in 2,500 cities with populations exceeding 100,000. The effect of urban population growth on traffic congestion is already apparent in many towns and cities in Asia and elsewhere. The problem of moving people in these cities is already apparent and it is one that will exacerbate in the future. Research will also be required to devise solutions to meet the mobility needs of the urban poor.

The problems mentioned above require local solutions.

Thus, research effort is needed in most of the areas related to transport. Collaborative research is effective, only if it fully involves local practitioners. This involvement is vital in identifying local problems associated with the provision of access and transport services; and in helping devise sustainable solutions to meet the need for safe and sustainable access and greater mobility for people living in urban and rural areas of the developing world.

4. FUNDING FOR RESEARCH

UK government research commissioned in 1995 indicated that for every £1 million spent on research, society in the UK benefited by over £20 million annually. Despite this evidence, it is often difficult to acquire funding from international donor agencies for research into transport problems in developing countries. It is difficult to estimate the amount spent globally on transport research. Of one thing we can be certain and that is that it is a tiny fraction indeed of the amount needed?????. The reluctance to fund research is surprising considering the significant historical benefits that have accrued from research in the sector.

DFID supports research projects as an important part of its development programme for improving rural livelihoods. It continues to recognise the important role of transport in the development process and 20% of its budget is devoted to transport. The actual level of support for research in the transport sector has varied from time to time according to government policy on aid and, in particular, on aid in the transport sector.

For many years, DFID funded an Engineering Knowledge and Research Programme (EngKaR) which resulted in many advances in knowledge in the sector. The transport component of this research programme was designed specifically to address problems in roads and transport in developing countries. Much of this research has been conducted by TRL. Application of DFID-funded research at the TRL was facilitated by Overseas Road Notes that are seen as definitive documents for developing countries on transport policy. The EngKaR programme has been discontinued but current DFID-funded transport research is being incorporated into programmes such as the South East Asia Community Access Programme (SEACAP) and a similar programme (AFCAP) in Africa.

DFID continues to fund transport research in developing countries by providing both bi-lateral and multilateral support with international partners. Its current support for transport research is around £4 million annually.

5. EXAMPLES OF THE BENEFITS OF PREVIOUS DFID-FUNDED RESEARCH

Much of the DFID-funded pioneering research on public transport, urban transport, road safety and road infrastructure in the 1960's and 1970's was carried out in the newly independent ex-colonies of the UK. Current research activities are more global, reflecting the need for donor support rather than any historical link with the UK. Infrastructure research by TRL on behalf of DFID in Malaysia and Indonesia led to the advancement of knowledge of the behaviour of asphalt pavements.

TRL research also did much to alert the countries of the developing world and the bilateral and multilateral aid agencies to the growing problem of road deaths and injuries throughout Asia as well as in Africa and Latin America. The magnitude, nature and cost of the problem were defined and a wide range of appropriate remedial measures developed, including the accident analysis package, MAAP, the development of road safety education materials, the publication of 'Towards safer roads in developing countries' which provided guidance on the introduction of low cost engineering measures, a highway code for African truck drivers, guidelines on the safety of public transport systems and advice on the management and financing of road safety at the national level.

More recent work in India and Bangladesh examined how low income families are particularly disadvantaged when the head of the household (in particular) is fatally or seriously injured in a road

accident. Such families, it was shown, find it more difficult to survive as an entity, to avoid getting into serious debt, to remain in permanent employment and to continue the education of children within the family. Ways in which such families could be assisted in the future were put forward.

Research on urban public transport operations, particularly in Asian cities provided valuable insight into factors affecting the demand for and supply of road-based public transport in some of the largest cities in the world. The research programme examined ways in which the operation and financing of major bus companies could be improved, the role of 'paratransit' systems (i.e. vehicles other than the conventional bus), the safe and efficient use of 'with and without' contra flow bus lanes and the operation of busway transit systems whereby complete roads are given over to the exclusive use of public transport vehicles. Studies also examined the particular problems of low income areas of these cities and identified how their residents needs for low cost public transport can best be met.

One detailed study also examined the role of metro systems in major cities throughout Asia, Africa and Latin America and identified the conditions (such as city size, growth, affluence, demand along major corridors etc) under which it may be appropriate for Third World cities to justify the construction of metro systems.

DFID has also funded extensive research in public transport, road safety and infrastructure in Africa. Included in these was a TRL project in Botswana in the 1980's to derive specifications for the use of the locally available (sub-standard) materials for road construction projects in the Kalahari region. The results indicated that the provision of sealed shoulders on rural roads provided a drier road environment and enabled these local materials that were previously considered to be unsuitable to be used for the construction of the road pavement and surfacing with savings conservatively estimated locally to be in excess of \$20 million on the main road network alone.

This research also led to a regional project in southern Africa in the mid 1990's the results of which showed that the road environment, rather than traffic was the most important factor influencing the performance of low-volume sealed roads. It also produced clear evidence of the unsuitability of applying imported specifications for road design and construction and the need for revised local specifications that enable local materials to be exploited.⁽⁸⁾

These research projects together with other research funded by NORAD and SIDA led to a Guideline document⁽⁹⁾ highlighting the need for a paradigm change in low-volume roads provision in southern Africa. The document was commissioned by the Southern Africa Development Community (SADC) and was compiled with the assistance of local practitioners.

Other significant outputs from the research were revised design standards for rural roads and locally derived specifications that enabled greater use to be made of local materials for road construction. These factors enable gravel roads to be upgraded to sealed road standard at much lower costs. The evaluation of Sida-funded projects in Zimbabwe using the Highways Design and Maintenance Model (HDM) produced some of the first evidence that in whole-life cost terms, gravel roads could be economically upgraded at much lower threshold levels of traffic than was previously thought possible. This finding has also been confirmed by recent studies in South East Asia.⁽¹⁰⁾

In many African countries transport services in rural areas are often severely disrupted in the wet season as gravel roads deteriorate rapidly. Transport operators sometimes suspend services when roads become rough through inadequate maintenance. Sealed roads also need to be maintained but they also facilitate all-year, all-weather access to transport.

These projects also demonstrated the value of accessing local knowledge and the benefits that collaboration in research can yield by providing local solutions to problems in the transport sector.

5. CURRENT DFID-FUNDED TRANSPORT RESEARCH

SEACAP

DFID is funding the South East Asia Community Access programme (SEACAP) with support from local governments, the World Bank and the Asian Development Bank (ADB). It is a poverty-targeted transport initiative within the gTKP framework. SEACAP is aimed at improving the sustainable access of people in rural communities to health, education, employment and trade opportunities with projects currently in Cambodia, Laos PDR and Vietnam.

SEACAP provides funding for applied research, communicating the research outcomes to stakeholders and supporting the mainstreaming of the solutions. The programme identifies and supports the uptake of low-cost, proven solutions for rural access. It focuses on the needs of both rural women and men and aims to maximise the use of local resources, including labour, materials, enterprise and ingenuity.

The programme started in 2004 and has expanded to include more than 30 projects. It is probably too early to quantify the benefits of the research in economic terms. However, projects based on SEACAP research are already having beneficial impacts.

Access roads in remote areas of Vietnam were in a very poor condition denying rural communities access to education, healthcare and opportunities for economic growth. Revised specifications have enabled greater use to be made of local road-building materials, thus reducing costs and increasing the provision of roads that provide sustainable access⁽¹¹⁾.

The research on gravel roads in Vietnam has yielded valuable information on rates of deterioration and has raised serious questions about the cost and capability of authorities to maintain some gravel roads.⁽¹²⁾ The evidence from this study also supports evidence from Africa that it may be more cost-effective in terms of whole-life costs, to construct a sealed road even for relatively low levels of traffic, if access is to be sustainable.

As a result of the research, the standards and specifications for low-volume rural roads have been reviewed in Laos, are being reviewed in Vietnam and are planned to be reviewed in Cambodia.

Evidence is emerging of the impact of SEACAP's research, dissemination and mainstreaming achievements. In Cambodia, agriculture is the predominant activity of rural people. The poorest spend 450% more time travelling 3 times farther than people with better access.⁽¹³⁾ The impacts of improved access roads include an increase of loads by between 2 and 5 times, agricultural surplus comprise 61% of loads, 80% of market traffic is between local villages, 55% of vendors sell goods at lower prices and a 600% increase in the volume of trade. These benefits are quickly reversed if the

infrastructure deteriorates. Unfortunately, preservation of the road asset remains a problem that needs to be addressed by better transference of knowledge into practice – the SEACAP objectives.

Trials have been constructed to demonstrate a variety of construction methods and alternative surfacing techniques using local materials.⁽¹⁴⁾ Technology transfer, training and education are also important components of SEACAP. The training programme has received plaudits from the collaborating government departments in the region. Training the trainers is also seen as an important way of transferring knowledge from central to provincial and district level. Overall benefit ratios for interventions in the transport sector in Vietnam are estimated to be in the range of 5% to 50%.

SIDA and SEACAP are supporting modules in education establishments to raise awareness of the benefits of research and of alternative approaches to rural roads and transport provision by technicians and engineers during their training phase.

AFCAP

DFID has recently initiated a similar programme to SEACAP in Africa. AFCAP will provide advice and undertake research to facilitate the delivery of safe and sustainable access for poor communities in Africa. It is based around a portfolio of research, demonstration, advisory and training projects and will be linked to the sub-Saharan Africa Transport Policy programme (SSATP) and support the work of the African Union and the New Partnership for African Development (NEPAD).

The programme aims to ‘close the loop’ between research and application which has often proved elusive. The outputs of the programme are expected to feed directly into regional and national governments’ rural transport policies and strategies for poverty reduction. The programme has started with projects in Ethiopia and Mozambique.

The expected outputs of AFCAP have the potential to significantly reduce the estimated \$12 billion annual costs of the operation and maintenance of roads in Africa.

6. DISSEMINATION OF KNOWLEDGE

Research is an important component of these programmes but so too is dissemination and implementation of existing knowledge. The benefits of research can be realised only if the results of the research are known and are implemented.

gTKP

DFID is also supporting the Global Transport Knowledge Partnership (gTKP) to facilitate the sharing of available knowledge. It is an innovative partnership working through existing initiatives established by its partners to make effective use of available knowledge and increase the capacity of less developed countries to access and apply knowledge and good practice. gTKP is a global organisation providing opportunities for networking between practitioners and the building of partnerships through its website.

Good road infrastructure is essential for developing countries to compete in world trade. Change is needed now to have an impact by 2020. gTKP aims to contribute by facilitating knowledge sharing of new initiatives and research outcomes in the transport sector. Evidence of good practice is made

available to policy makers through the Technology, Infrastructure and Planning Resource Centre (TI-UP).

gTKP 's activities are overseen by a steering group comprised of international experts with day-to-day activities managed by the Core Management Group. gTKP offers advice and support in seven theme areas

- Environment and Climate Change
- Finance and Economics
- Governance
- Road Safety
- Rural Transport
- Social Development
- Urban Transport

Each theme is headed by a champion and gTKP services are free.

TRS

DFID is also cooperating with the World Bank on the project for Transport Research Support for inclusive growth (TRS). The aim of this programme is to facilitate interventions in the transport sector supported by the World Bank and other development partners to contribute to sustainable growth and the needs of the poor in developing countries. The programme will use the experiences from previous collaboration in the Transport and Rural Infrastructure Services Learning and Sharing Partnership (TRISP) to focus on key emerging research issues and the application of lessons learned.

7. EVALUATION OF RESEARCH

Research is a voyage into the unknown. The results from previous research sometimes provide guidance that can facilitate the framework for new research but if the expected outcomes are already known, then it is not research. One definition of the differences between consulting and research is that in consulting 'the needs are defined and the solutions known' and in research 'the issues are defined but the outcomes are unknown'.

The outcomes of the majority of research projects tend to be beneficial. Occasionally, the benefits from research are negative in terms of conventional evaluation in that the results may simply influence future research as a step forward in knowledge, rather than having immediate impact. Sometimes the results do not confirm the hypothesis for undertaking the research but such information is also valuable in that it can provide useful lessons for future work.

Research is sometimes also a process of quantifying what we already know qualitatively or in testing and adapting previous experience to current conditions and the local environment.

The Romans constructed roads which lasted for hundreds of years. Unbound macadam can be considered as the modern equivalent of this type of construction and it is still used on some roads. Many towns in Europe still have streets constructed from stone cobbles. Specifications have been

developed for the composition and construction of modern roads constructed in this way but their origins are historical. These roads are generally unsuited to carry the heaviest of traffic but they have undoubtedly proved to be fit for purpose and sustainable; a goal which we are striving to attain for many of our roads today.

We also tend to think of urban restraint measures for transport as a modern phenomenon but pedestrian movements only were allowed (i.e. no hand carts or bullock carts) during the hours of darkness in Pompeii as long ago as AD26 as a noise prevention measure.

The benefits of research aimed at influencing policy are difficult to evaluate in monetary terms as are research projects that yield social or environmental benefits. Many of the benefits from pro-poor transport initiatives yield benefits that are predominantly social, such as facilitating visits to health centres, opening up employment opportunities, providing improved access to education etc. It is often difficult to quantify these benefits in monetary terms, even if there is alternative evidence that the results of the research, when implemented, have a positive impact. The importance of identifying these benefits is now well recognised as is the need to quantify them in monetary terms wherever possible. A number of papers published recently give guidance on the evaluation of social benefits directly or by proxy or by assigning weights to these benefits to enable them to be included in economic appraisal and evaluation rather than an add-on as has often been the previous practice.

Collaborative research with government agencies and the private sector in developing countries presents opportunities for technology transfer, training and institutional strengthening. These benefits of research are also not easily quantifiable in economic terms but they are recognised as an important developmental component of collaborative research.

As a result of these constraints, studies to evaluate the benefits of transport research have often been confined to projects that yield benefits that can be quantified in monetary terms using conventional economic indicators.

8. ECONOMIC EVALUATION

The benefits from research begin with the implementation of the results. These can begin to accrue quite quickly, if implementation follows immediately after the completion of the research. More usually, there is a delay between the time that the outputs of the research become available and implementation, and there are a number of reasons for this. For example, changes in legislation may be needed to enforce the wearing of seat belts. In engineering, revised standards and specifications may need to be documented to cater for significant changes in practice. Deregulation may be required to encourage or allow competition in the provision of new transport services. In these circumstances, the initial benefits from research may be delayed but benefits may then continue to accrue over many years.

Cost Benefit Analysis (CBA) is the normal method used for economic evaluation of projects and the results are usually quoted as the Benefit/Cost ratio (B/C), Net Present Value (NPV) or Internal Rate of Return (IRR). The NPV can be regarded as profit from the research. The ratio of benefits to cost (NPV/RPV) provides evidence of the profit in relation to the cost of the research. The IRR is the discount rate that reduces the NPV to zero. This measure is sometimes favoured by aid agencies

because it does not require disclosure of a country's discount rate. The '1st year rate of return' is a measure which is sometimes used for timing the start of projects.

In order to compare the costs and time dependent benefits, costs that are incurred over the research period and the benefits that subsequently occur over a given time period are discounted (or compounded) to a fixed point in time usually referred to as the base year. The rate at which costs and benefits are discounted over time is referred to as the discount rate. This rate has a considerable influence on the value of benefits that accrue over the analysis period with long-term benefits being valued less than those that occur in the short-term. In general, the higher the discount rate then the lower will be the total benefits over time, discounted to the base year.

9. EVALUATION OF RESEARCH PROJECTS

In a study carried out by the California Department of Transportation, it was claimed that 8 projects costing a total of \$6 million achieved annual benefits of \$35 million with a range of B/C ratios of between 2:1 and 44:1.

One of the most comprehensive published studies on the value of research is contained in a document published by the TRL on a project commissioned by the U.K. Department of Transport.

The methodology adopted in the TRL study was broadly the same as that developed by the California Department of Transportation, which included the following basic principles.

- A base case which assumes use of existing knowledge (as opposed to a "do-nothing" case).
- All costs and benefits should be listed with timings
- A discount rate should be applied to future benefits and costs
- Nett Present Value should be the criterion for assessing value.
- Sensitivity analysis should be included.
- Not all research yields positive benefits.

Projects that succeed must cover the costs of those that fail, that yield low benefits or for which the benefits cannot be calculated in monetary terms. TRL were conducting between 400 and 500 projects at the time of the study. Most of these projects were expected to succeed and many were expected to produce high future benefits, such as the impact of drink-driving legislation.

The projects included for economic appraisal were selected from those that were expected to succeed in terms of producing positive benefits in monetary terms and give good value for money.

The 12 projects studied were selected from 3 main areas of research having the following aims:

- to reduce road construction and maintenance costs
- to save accidents
- to cut traffic congestion

A standard discount rate of 8% was used in the study although the sensitivity analysis included the effect of a range of discount rates on the results. The NPV was used as the main measure of the return on the research. The effect on NPV of using three different base years was examined for each

project; the start year of the research, the base year of 1992 and the deployment year of the results. On average, altering the base year from the base year of 1992 to the start of the research reduces the NPV on average by a factor of 4. Altering the reference year to the start of deployment of the results decreases the NPV by just 19 percent on average.

Table 1 Summary of Measures of Return on research – central estimates

Purpose of Research	Cost of research £m	Average Benefit over 20 yrs £m	NPV from 1992 base £m	NPV/PV of research Ratio	IRR %
Reducing road construction and maintenance costs					
(a) Soil nailing	0.48	3.3	25	43	51
(b) Reinforced embankments on soft soils	0.75	2.6	26	28	60
(c) Off-site recycling of bituminous materials	1.21	15.0	114	75	56
(d) Strengthening masonry arch bridges	0.1	0.2	1.7	14	45
Saving accidents					
(a) Effect of macrotexture on accidents	2.6	284	1783	447	49
(b) Seat Belt wearing	8.59	112	3241	73	33
(c) Accidents at roundabouts	0.62	14	142	106	50
(d) Urban safety management	5.35	62	526	28	44
(e) Front under run guards on HGV's	0.66	20	107	91	31
Cutting congestion					
(a) Roadworks on motorways	0.57	11	109	165	_(a)
(b) SCOOT urban traffic control	3.92	54	942	112	73
(c) MOVA self-optimising signal control	2.23	32	248	69	43
Average for 12 projects	2.26	51	605	104	49

Source: TRL Project Report 86

(a) Implementation of the research on “road works on motorways” began within one year of the start of the research, which is unusual. The IRR is very sensitive to early returns and gave a value in excess of 1400% for this project.

The benefits were estimated for a twenty year period from the time that they started to accrue. This does not imply that benefits would not continue to accrue after this period but they would be reduced in the economic analysis through discounting. Assuming the benefits were the same every year, they could be expected to increase by an additional 13 per cent on average, if the analysis period was extended to 30 years.

Predicting benefits is uncertain but the study was conducted approximately halfway through the 20 year analysis period. Thus for most projects, it was possible to assess the impact of the research for the first 10 years with some certainty about the achieved benefits; and possibly with less uncertainty than is usually the case, in predicting future benefits for future years. For each project, estimates were made of the NPV, NPV/RPV (RPV - the present value of the research) and IRR for three scenarios, namely ‘low success’, central estimate and high success.

With 1992 as the base year, the total central estimate of the NPV of all the projects was £7,300 million with a range from £3,500 million for the low success scenario to £11,800 million for the high success scenario.

The results showed that all twelve projects in the study would pay for themselves within less than 6 months. **The annual benefits for the 12 projects over 20 years was 15 times the annual costs of all TRL projects (over 400) being undertaken in the base year.**

Whilst the study demonstrated very clearly the large benefits that can accrue from research, it also showed that even projects that produce high returns may take over 10 years to do so.

10. EXAMPLES OF THE ECONOMIC BENEFITS OF PROJECTS

Most of the available data on implementation benefits in the transport sector appear to be from engineering projects, presumably because the benefits can be expressed more easily in economic terms.

A recent review of the benefits of research was included in a paper entitled ‘Why invest in research? –A Review of past research outcomes’ presented at the 22nd Australian Road Research Board conference in 2006. The benefits from research investments in the roads sub-sector were reviewed and some examples are given in Table 2, which also includes some TRL projects.

Table 2: Returns on investment on implementation projects

Project	Benefit/cost Ratio
Louisiana Pavement Research Facility	5.3
California heavy Vehicle Simulator Programme	3.7 – 8.3
Australian Accelerated Pavement Testing Programme (ARRB)	3.8 – 4.9
Asphalt servicing for roads in tropical environments (TRL)	8.0
Transport Research Board Projects (USA)	2 – 44
Utah Department of transportation research	9.0
Selected Research projects in Texas	77 – 3200
Kansas Transport Research Programme in total	15
Canadian research into heavy vehicle weights and dimensions	1 000

The C/B ratios for most transport research programmes appears, on average, to range between about 1.5 and 20 with the literature also reporting some individual projects that give very large benefits. When these occur, they are often as a consequence of earlier less successful research with the projects with large benefits covering the costs of projects with low or negative benefits.

Research that results in measures being introduced to reduce road accidents tends to yield high benefits. However, the key to achieving these and other benefits from research in the transport sector is the application of evidence-based knowledge, which is often not easy in developing countries where funding is scarce and other important sectors such as water, sanitation and health are also competing for funds.

11. FUTURE DFID SUPPORT FOR TRANSPORT RESEARCH

While DFID’s current and planned transport portfolio are designed to get existing knowledge into widespread use in Africa and Asia, further challenges include:

- The role of infrastructure in promoting more sustainable and equitable growth and linkages with other sectoral research including agriculture.

- Defining good practice for investment and management of rural transport.
- Transport policy and climate change. The challenge of transport activities and infrastructure that contribute less to climate change whilst maintaining equitable access for poor people.
- Transport, congestion and health and the role of successful cities with good policies in transport.
- Road safety; influencing change through evidence-based techniques.
- Developing research appreciation and capacity in developing countries.

The need for a paradigm change in the provision of rural roads and transport services is being stated more frequently. Such change can be effected through the implementation of existing evidence-based knowledge derived from research together with projects demonstrating the benefits of good practice and the applied research necessary to fill the prevailing gaps in knowledge.

Road infrastructure research tends to be long-term. Roads are expensive and should be designed and built not only to serve their intended function, but also to be sustainable as were the roads that the Romans built. The concept of the design-life of a road relates to the period over which the benefits justify the investment. It does not mean that the road should fail at the end of this period. Benefits to society from infrastructure improvements also take a while to filter through. Some of the major advances in road technology, transport provision and road safety have been as a result of lengthy research projects. It is important that funding agencies recognise that to reap the benefits from research they might well need to be prepared to “stay the distance”.

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