Poster Presentation: A Plus in Quality of Life

7b: Mapping Quantifiable Benefits for Cycling Initiatives

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Abstract

This presentation is proposed under the theme 'Quality of Life', in particular the question 'Can the increase in quality of life be quantified and qualified?' It is proposed as a poster presentation, and will examine how recently developed mapping methods can be used to provide a quantifiable benefit for cycling initiatives, and can also be used to assess conditions in the urban realm generally. In particular it will look at:

Noise mapping – The United Kingdom (UK) Government commissioned maps which showed levels of road traffic noise levels in urban areas as part of a national ambient noise strategy. These can be developed to evaluate the benefits of cycling by providing forecasts of ambient noise levels that would result from achieving modal shift to cycling.

Pollution levels – Plots of pollution levels have existed for much longer than the noise maps but they can be used in combination to provide an overall picture of quantified levels in noise and air pollution.

Road standards – Some UK local authorities have started to use colour-coding for the streets in its cycling map in order to indicate the level of 'difficulty' each particular road presented for cycling. With refinement, such maps can be used to indicate the quality of the urban realm with respect to, for example, heavy traffic, and can be combined with the noise and pollution indicators outlined above to give an overall assessment of the quality of life.

The Future – Colin Buchanan has developed an economic model which evaluates pedestrian and walking initiatives by demonstrating the economic benefits of such schemes. This model can be further developed to assess cycling initiatives and can be combined with the quantification methods above to give a much broader and in-depth analysis for cycling schemes.

1. Introduction

This paper attempts to give an answer to the question: **'Can the increase in quality of life be quantified and qualified?'**

It attempts to show examples of how an increase in the quality of life can indeed be quantified and qualified, and how the results could be used to justify future investment in cycling infrastructure and monitoring the return on investment, based upon a matrix of the various aspects of quality of life.

To answer this, some recent developments in mapping will be looked at to see how such data can be used to present a 'multi-faceted' picture of the potential qualitative effects arising from the promotion of cycling, and how in addition an economic appraisal model developed for walking schemes can be adapted for cycling schemes.

Quality of life in terms of transport and the promotion of cycling can include:

- Health improvement (reduced accidents/ severity and general health)
- Reduced travel (distance, time, and cost of travel)
- Reduction in living cost, and more leisure time
- Reduced pollution, noise, and congestion
- Increased accessibility to green sites and open space
- Reduced dependence on the car (and associated costs, i.e. insurance, maintenance, etc) and road maintenance costs
- Improvement and development of local areas, stimulating community activity

The mapping examples in this paper will explicitly demonstrate noise, pollution, and 'road quality'.

For the local and national authorities in those European countries that have comprehensive cycle programmes in place, the rationale for this topic may seem unnecessary, perhaps even somewhat strange. But there are several countries around the world, including the UK from where examples in this paper are drawn, that have a political and social culture such that the advantages accruing from the promotion of sustainable modes like cycling need to be clearly demonstrated.

This is no bad thing, as the time is now right to show how cycling can make real contributions to a nation's health and economy as well as offering transport solutions.

Two recent high profile reports were published in the UK. One was **The Eddington Transport Study**, published December 2006, in which it was stated that:

> typically, smaller projects offer the highest returns, since they can be targeted at specific bottlenecks on the transport system at relatively low cost… Furthermore, such projects often have lower noise and landscape impacts, so their environmental impact can be considerably less than a new piece of infrastructure. Improving the attractiveness of walking and cycling, e.g. by creating or upgrading routes, can provide strong returns with wider [benefits].

The second report was the wider implications of the **Stern Review on the Economics of Climate Change**, published October 2006. The scope of that report goes far wider than this discussion, but the report does note that "deep emissions cuts will also be required in the transport sector".

These two reports are indicative of the general political climate in which justification of expenditure on cycling in terms of the quantifiable benefits is more likely to find support.

2. Noise mapping

The UK Government commissioned maps which showed levels of road traffic noise levels in urban areas as part of a national ambient noise strategy. These can be developed to evaluate the benefits of cycling by providing forecasts of ambient noise levels that would result from achieving modal shift to cycling.

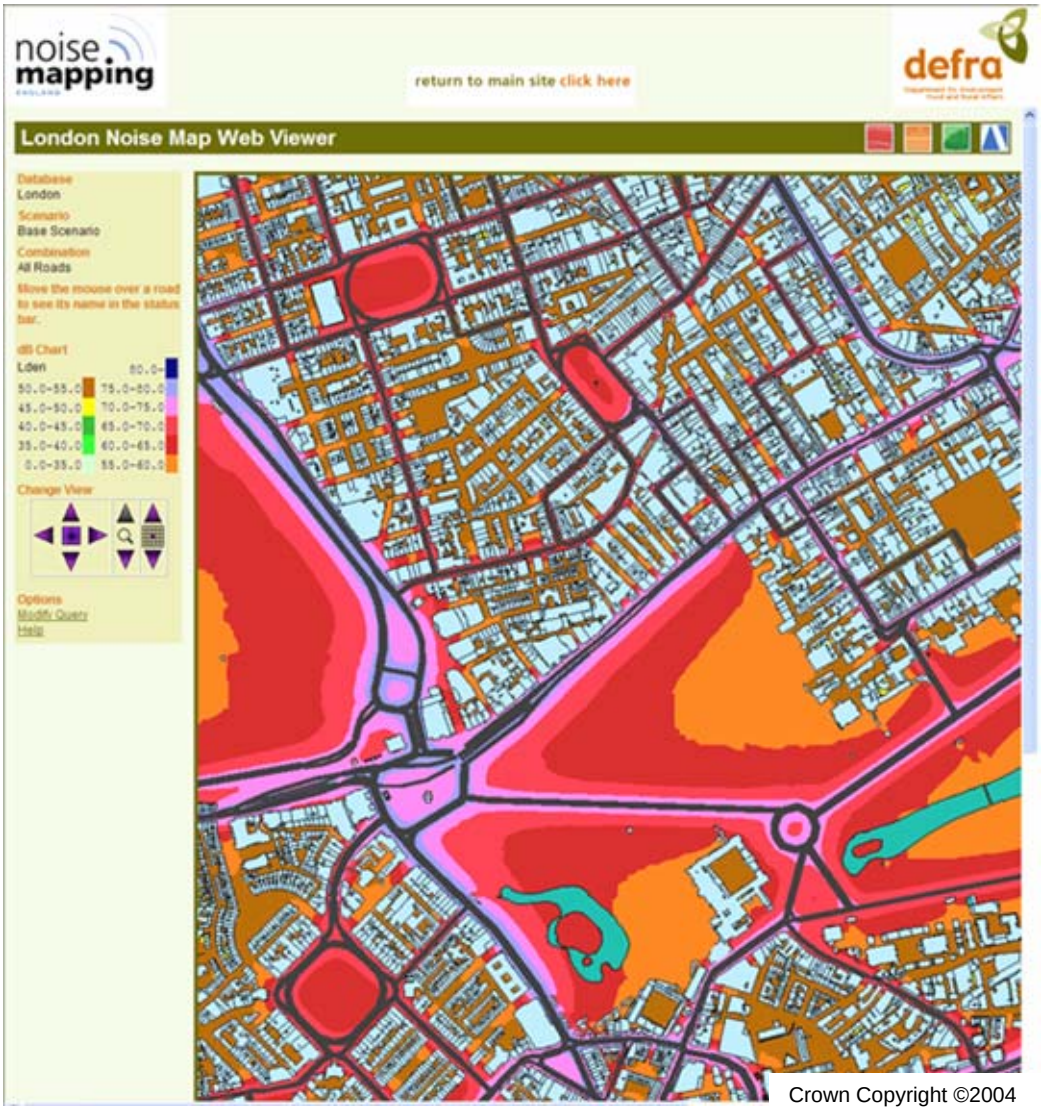

Figure 1: A plot of noise levels from the UK Department for Environment, Food & Rural Affairs

The map above displays levels of noise by using colour-coding to correspond to increasing decibel levels. The deep purple colour is the noisiest and is aligned along the busy main roads in central London. The lighter blue colour indicates much quieter areas.

The fact that noise is quantifiable and able to be displayed in a graphical format such as above presents an opportunity to support the promotion of cycling. For one thing, excessive noise has been linked to public health issues[1] (also mentioned in the two documents quoted below). The health benefits of cycling are more commonly expressed in terms of physical exercise and to a lesser extent mental well-being. The potential for the reduction in traffic noise that a modal shift to cycling offers could make an indirect but significant

[1] Loud noises 'bad for the heart': BBC News, 24 November 2005, http://news.bbc.co.uk/1/hi/health/4460694.stm and Traffic noise 'harms' child health: BBC News, 28 May 2002, http://news.bbc.co.uk/1/hi/health/2012610.stm

contribution to health through noise reduction not just for cyclists but for society as a whole, whether or not they cycle.

In a recent survey in London, road traffic noise was found to be the biggest single cause for concern amongst residents. The UK government found that:

Although road traffic noise is only one type of noise that affects people, it is a concern for more Londoners than any other individual source of noise. In the London Household survey, undertaken by the Greater London Authority in 2002, 13% of Londoners surveyed said that road traffic noise was a serious problem, compared with 4% who considered that noisy neighbours were a serious problem. It is widely recognised that, at the same time, there is a need to protect existing areas of tranquillity from erosion. (Report: "The London Road Traffic Noise Map", DEFRA, September 2004)

In order to address such issues, in 2002 the UK government started to develop an Ambient Noise Strategy in England, due for completion by 2007. The Noise Mapping Project shown above was an outcome of this strategy, which would be used to determine noise 'hotspots' and "provide information to assess the relationship between noise and other policy areas"[2].

It this 'relationship' with other policy areas that presents an opportunity for the further promotion of cycling as a national priority. The benefits that can accrue from noise reduction include real health benefits. This can be a justification in itself, but it can also be demonstrated that public expenditure on the promotion of cycling offers much better value for money in the promotion of public health than remedial measures offered through a conventional health service based on expensive treatment. Noise mapping offers a tool whereby the relationship of health benefits and noise reduction through modal shift to cycling can be expressed in a quantifiable way.

The health issues arising from noise has also been addressed at a European level. Directive 2002/ 49/ EC of the European Parliament and of the Council of 25 June 2002 relates to the assessment and management of environmental noise:

> It is part of Community policy to achieve a high level of health and environmental protection, and one of the objectives to be pursued is protection against noise. In the Green Paper on Future Noise Policy, the Commission addressed noise in the environment as one of the main environmental problems in Europe.

Two things have to be borne in mind when using the quantification of noise as a basis for justifying cycling promotion policies. Firstly, the policy has to achieve modal shift from private motorised vehicles to bicycle usage. An increase in cycling per se with no reduction in motor vehicle usage is unlikely to reduce ambient noise levels (depending on the existing traffic levels), as the source of noise generation is still present.

Secondly, the degree to which motor traffic levels would have to be reduced in order to produce a reduction in traffic noise sufficient to have a significant health benefit would have to be established. This is fairly well understood and there has been a lot of research on link between traffic volume and noise. Also, any noise reduction strategy will probably have to prioritise those roads in which a significant outcome may be more realistically achievable within a certain time frame. Streets that genuinely prioritised pedestrians and cyclists, or even pedestrian/ cyclist-only streets, would clearly deliver benefits.

In any case, targets set by the European directive above mean that "Member States shall ensure that no later than 18 July 2008 the competent authorities have drawn up action plans designed to manage… noise issues and effects, including noise reduction if necessary for: (a) places near the major roads which have more than six million vehicle passages a year… (b) agglomerations with more than 250 000 inhabitants. Such plans shall also aim to protect quiet areas against an increase in noise."

[2] DEFRA Noise Mapping: http://www.noisemapping.org/

3. Pollution levels

Plots of pollution levels have existed for much longer than the noise maps but they can be used in combination to provide an overall picture of quantified levels in noise and air pollution.

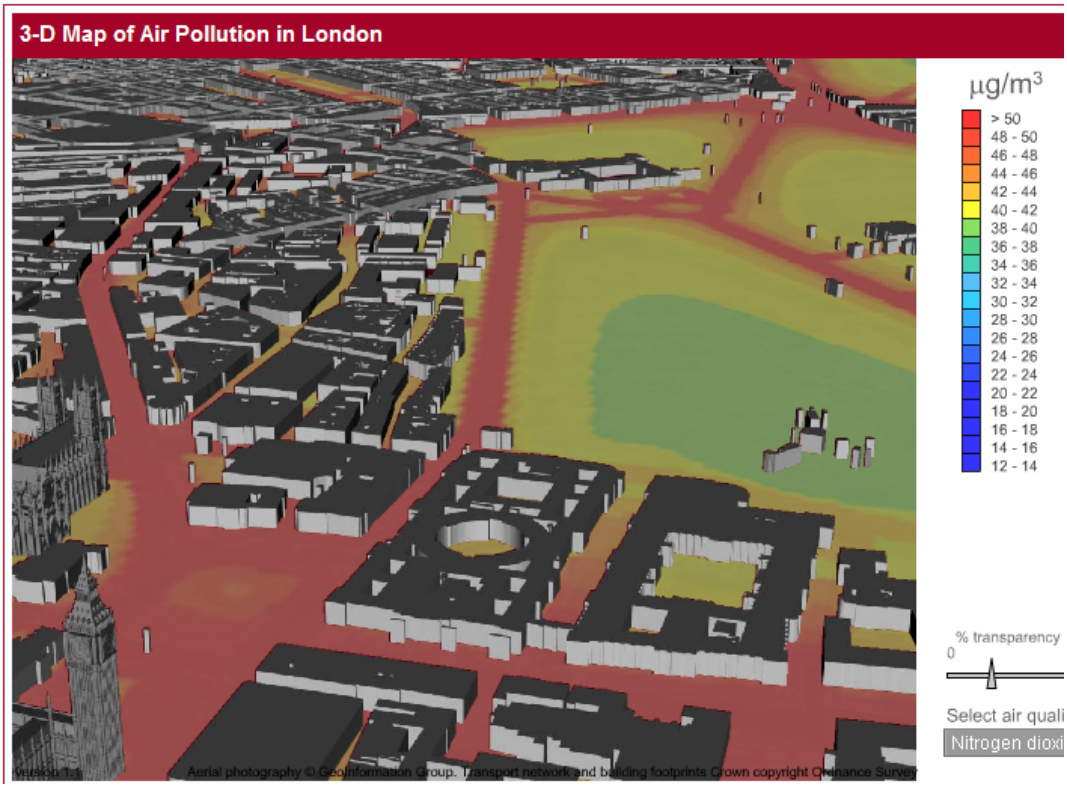

Figure 2: A 3-D map of vehicle pollution levels developed by King's College London for the London Air Quality Network project.[3]

The link between pollution and health and the monitoring of pollution levels has been understood and undertaken for many years. More recent developments in mapping techniques such as the three-dimensional model shown above in Figure 2, are able to show results in a more graphical form.

As with noise-mapping, pollution-mapping means that the outcomes of any reduction in the source of pollution are more readily demonstrated. A strategy that seeks to promote cycling coupled with a modal shift from motorised vehicles can potentially be justified in terms of the health benefits accruing from reduced pollution levels.

The health costs attributable to pollution are more also readily available. A European Commission study in 2005 for example found that the adverse health effects to people in the European Union were costing the economy more than 80bn euros (£55bn) a year.[4] The cost savings that would accrue in the promotion of a modal shift to cycling can be more clearly demonstrated and therefore justified.

However, as with noise, the benefits that could accrue from a reduction in pollution levels through the promotion of cycling would have to rely on a modal shift from motorised vehicles to bicycles. An increase in cyclists per se would not reduce pollution levels. Also, the degree of modal shift required to produce a significant health benefit would have to be investigated to ascertain the benefits of the outcomes relative to the cost of implementation.

[3] The London Air Quality Network: http://www.londonair.org.uk/
[4] 'Air pollution causes early deaths', BBC News, 21 February 2005, http://news.bbc.co.uk/1/hi/health/4283295.stm

4. Road standards

Some UK local authorities have started to use colour-coding for the streets in its cycling map in order to indicate the level of 'difficulty' each particular road presented for cycling. With refinement, such maps can be used to indicate the quality of the urban realm with respect to, for example, heavy traffic, and can be combined with the noise and pollution indicators outlined above to give an overall assessment of the quality of life.

Figure 3: The Cheltenham Cycle Map[5]

In June 2004, a new style of map was launched that was produced jointly by Cheltenham Cycle Campaign and Cheltenham Borough Council in England. What was new about this map was that it attempted to grade roads within the town of Cheltenham in terms of how 'easy' or 'difficult' each road was to cycle on, in attempt to give guidance to cyclists as to the best route according to their confidence and road skills.

This innovation is a fresh approach to cycle mapping. The traditional cycle map has been a standard road map with an overlay of 'cycle routes', which were meant to be advisory routes cyclists should take that usually avoided busier roads. This new approach is an improvement because it does not attempt to try and guess where people will cycle (which could be anywhere of course), but instead gives cyclists information for all roads and lets them decide on the best route.

Subjectivity is always possible in grading roads in this way, but this can be avoided by using a 'quantifiable' scale. Such a scale exists in the form of the UK's recently launched National Standards in cycle training, and this standard can be used in 'graded' cycle mapping. For example, there are three levels of skill that can be attained through the training: Levels 1, 2 and 3[6]. This can be correlated with the scale above to give an indication of how well trained or experienced a cyclist should be to cycle a particular road.

An interesting development in the use of such standards has been adopted in the London Boroughs of Ealing and Lambeth where cycle promoters are piloting the use of National Standards cycle training in order

[5] Courtesy of Cheltenham Cycle Campaign: http://www.cyclecheltenham.org.uk
[6] Level 1: basic control skills (starting, stopping, emergency stopping, gears, looking behind and signalling)
Level 2: on-road riding using quiet roads
Level 3: riding on busy roads including multi-lane filtering techniques and busy roundabouts

to assess whether road conditions, including existing cycle facilities, are actually any good or deliver any benefit. This can be further developed into, or used as part of, an audit procedure for cycle provision.

Indeed, a procedure could be developed to assess whether proposed facilities would be suitable either for a particular location or whether they are suitable at all. The kind of 'skill map' above could indicate whether a facility is worth implementing with respect to predicted benefit. For example, the map could give a guide as to the best place to install a given type of facility (or the best type of facility for a given place), taking into account existing or predicted cycle flows.

Thus, a quantifiable method that was developed for advising cyclists is being used to assess the 'quality' of general cycle provision on the highway. And a road that was 'easy' to cycle on indirectly indicates that the road is qualitatively different to one that is more 'difficult', in that it may well be a nicer road (little traffic, low noise and pollution, etc.)

5. The Future

Colin Buchanan has developed an economic model which evaluates pedestrian and walking initiatives by demonstrating the economic benefits of such schemes. This model can be further developed to assess cycling initiatives and can be combined with the quantification methods above to give a much broader and in-depth analysis for cycling schemes.

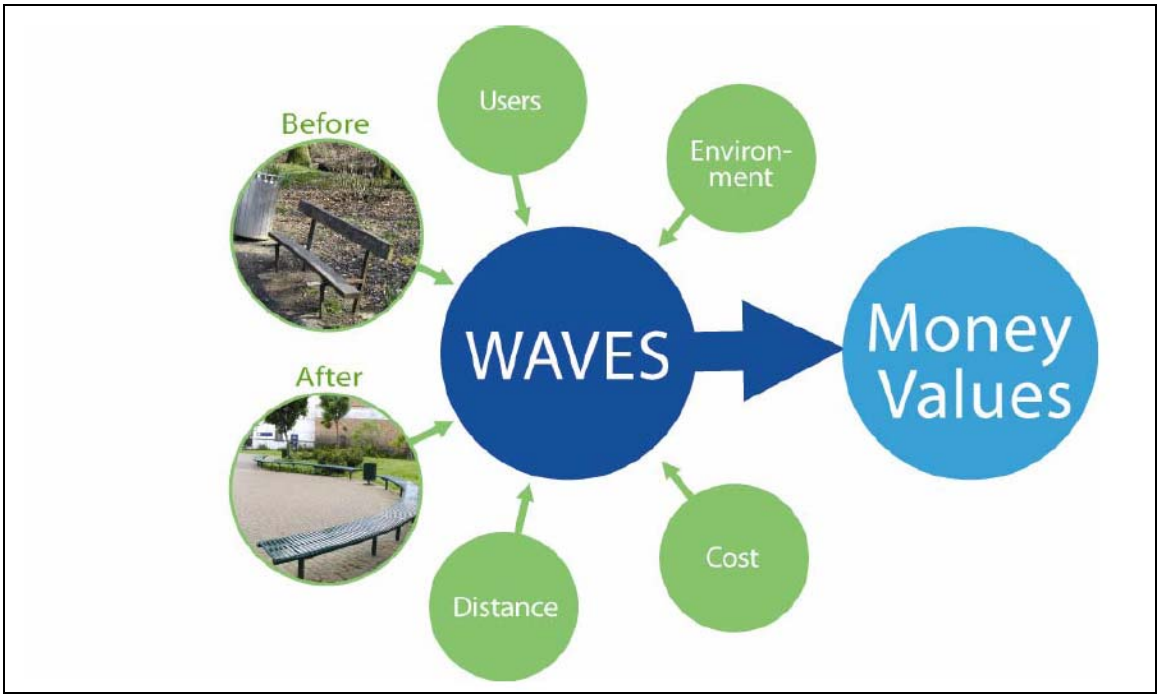

Figure 4: Colin Buchanan 'WAVES' Model

Colin Buchanan has recently worked with the UK Department for Transport and Transport for London in developing quantitative guidelines for walking schemes. The framework offered a comprehensive approach to evaluation including quantitative assessment of quality, physical fitness and security benefits. The result was a robust cost-benefit analysis of walking schemes.

In addition, Colin Buchanan carried out a monitoring assessment of walking conditions along key 'Strategic Walks' in order to assess performance against a series of key indicators. User counts and surveys were conducted along each route and attitudes towards walking improvements were examined.

This analytical framework can also be adapted for cycling schemes. One reason why rail, bus and general highway infrastructure projects have received so much more funding in the UK than cycling schemes is that

there are established methods of evaluation to measure their economic impacts. These appraisals allow these modes to quantitatively demonstrate benefits and value for money. However, these methods of evaluation have never really been applied to cycling schemes.

The most common justification of cycling schemes is the benefit to cyclists in terms of improved safety, and this is often counterbalanced with time savings and/ or directness of route. Evaluating safety involves measuring the cost of collisions and is an important element in demonstrating the need for safer routes.

However, assessing time savings and safety alone does not capture the wide ranging benefits that cycling projects offer. There are a wide range of other benefits that need to be quantified and assessed in order to demonstrate value for money in the same way as can be determined for more 'capital intensive' modes. These benefits are shown in Figure 5:

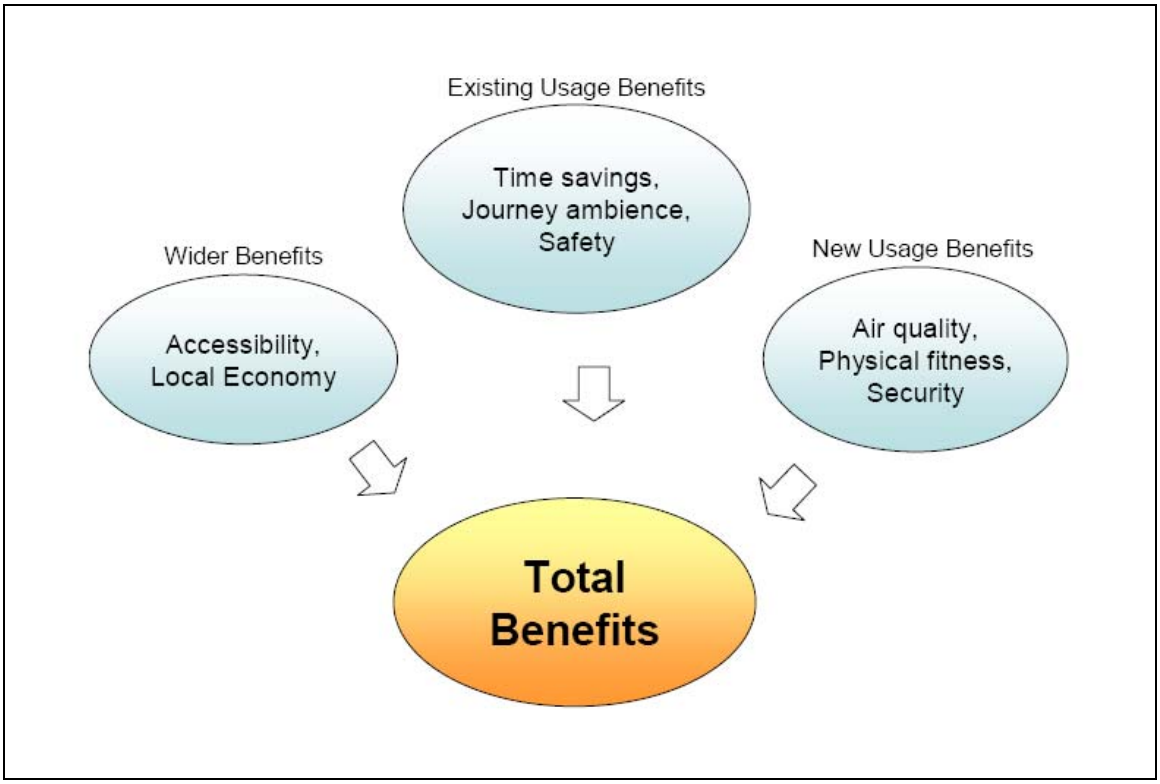

Figure 5: Potential benefits of Investment in the cycling environment

The framework developed by Colin Buchanan, coupled with the quantification methods highlighted above, will go a long way towards raising the profile of cycling as a serious proposition in terms of expenditure on transport, especially in those countries that do not have a tradition of 'serious' public expenditure on cycling.

6. Summary and possible ways forward

Three types of quantification and mapping have been highlighted above. A clue to how such mapping can be used in parallel as a comprehensive toolkit in assessing the impact of cycling can be discerned from the press release in May 2005 concerning the Air Pollution Research in London that developed the online 3-D map showing pollution levels (Figure 2). The statement read “This navigable ‘Virtual London' will allow pedestrians and cyclists to choose routes that avoid the most polluted roads and help builders and planners devise ways to prevent new constructions or traffic flow schemes causing increases in pollution levels.”

The three quantifiable mapping methods outlined above can contribute to an overall understanding of how the promotion of cycling, whether through highway infrastructure, marketing, or other forms of promotion, can make a quantifiable difference to the quality of life.

In the same manner that the cycle mapping was used to assess the quality of provision (Figure 3), all three mapping techniques combined can begin to show a multi-faceted picture of the quality of the environment. Not only this, but it could potentially demonstrate how the promotion of cycling, given the provisos mentioned (modal shift, etc.), could contribute to the overall quality of life.

Further, the quantification methods developed by Colin Buchanan can quantify ‘quality of life’ issues in terms of monetary benefits, which are especially important for justifying government programmes and initiatives to promote cycling. Indeed, such an appraisal method can be adapted so that resources are targeted for maximum benefit.

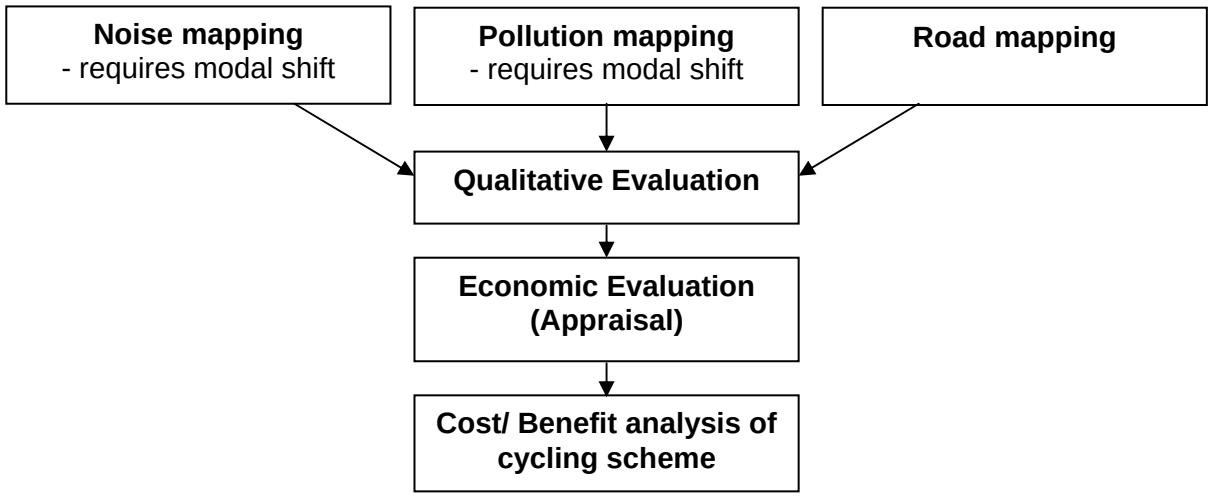

Figure 6: Using mapping techniques and economic evaluation to produce an economic appraisal of cycling.

Possible Framework

A possible framework for the justification of cycling schemes will need to consider:

- Where the benefits come from
- Who gains from the benefits

To give a possible example by way of illustration, a new highway cycling scheme may have an effect on cycling trips in several different ways. These possibilities will give rise to different benefits as indicated below:

	BENEFIT BY SOURCE				
Possible effects	Time Savings	Improved safety	Environment (Noise/ Pollution reduction)	Improved Health	Contributes to Public Policy
	L E A S T B E N E F I T				
Re-routed cycle journeys	Possible	Yes	No	No	No
New cycle journeys	No	Possible	No	Yes	Yes
Modal shift cycle journeys	Yes	Possible	Yes	Yes	Yes
	M O S T B E N E F I T				

Figure 7: Table of Benefits by Source

Re-routed cycle journeys: These are cycle journeys that would otherwise have been made but are now made along the new cycle route, which could be because it is quicker, but equally (if not more) likely because it is perceived to be safer. The benefits are general benefits to society, rather than the individual. Thus, a cycle journey that would have been made anyway accrues no further benefit in terms of pollution, health, or a government policy (e.g. no increase in the number of cyclists).

New cycle journeys: These are cycle trips that were not formerly being made, but are now cycle journeys which could either be new trips or possibly shifted from other non-road modes. There may not necessarily be a time-saving to these trips, but there could be effects on pollution and health, and of course government targets.

Modal Shift cycle journeys: These are trips that were being by other modes, e.g. car, train, metro, bus. There is likely to be an improvement in journey times other road-based modes and an improvement in pollution, health, and government targets generally.

Thus, this example shows that the maximum benefit is to be gained from those schemes which bring about a modal shift to cycling, rather than say attracting cyclists that were already using parallel routes. The appraisal method highlighted above (Figures 4 and 5) can then assess the possible benefits and target those schemes that will bring about the most benefit.

Currently, at least in the United Kingdom, cycling schemes are not assessed in terms of their possible benefits in the manner above. Solutions and consequent spending is primarily determined on the basis of the suitability and condition of the highway with respect to cycling design standards, which typically follows an alignment that was previously determined to be suitable for cycling mostly in terms of perceived safety.

The potential problem with this is that resources may be channelled where benefits are not maximised. With regard to the table above, a new facility can be installed which may increase cycling along that facility by large amounts, say a 50 per cent increase. But this increase does not tell us where those journeys came from, i.e. whether they were existing journeys, new journeys, or journeys formally made by car. If the 50 percent increase were re-routed journeys, the most benefit that could be achieved might be safety, but this could be the only benefit.

If however modal shift was achieved, this would have the greatest benefit across all areas and would offer the greatest ‘return’ on investment. An economic appraisal would be able to prioritise spending on those measures that could achieve this.

Conclusion

The framework outlined above as a possible example attempts to prioritise the allocation of resources for maximum benefit, and furthermore can be used to demonstrate how improving the quality of life can have both qualitative and quantifiable benefits.

Thus, the increase in the quality of life can be quantified and qualified, and can be used to justify spending on cycling programmes because the potential savings from health spending for example can also be demonstrated.

Further possibilities for investigation of Quality of Life issues:

- **Safety on the road**

  One of the indirect benefits of the promotion of cycling is that when there are a greater number of cyclists on the road, this results in a safer environment for vulnerable road users, both pedestrians and cyclists. This is highlighted in Transport for London's report **A Business Case and Evaluation of the Impacts of Cycling in London** (January 2004) but it is acknowledged that 'significant' increases in cycling levels are required to achieve this.

- **Absenteeism**

  Economies lose a significant amount of money through illness-related absenteeism. It has been shown that moderate amounts of physical activity on a regular basis can offset such absenteeism as a cost saving to employers who do not have to pay sick leave. Cycling to work can offer opportunities for physical activity as part of a daily routine.

- **Productivity**

  Various findings have linked health, physical activity, mental alertness, and productivity.

- **Mental well-being**

  Although a somewhat broader concept than either of the above, it is nevertheless influenced by them. Also, it has been recognised amongst health professionals that physical and mental well-being are interlinked, and thus physical activity contributes to mental well-being. There have also been several pilot projects in the UK that have promoted cycling with mental health patients specifically for this reason.

Acknowledgements

I am grateful for the valuable contributions to this paper from:

Paul Buchanan – Economist, Colin Buchanan

Walter Viti – Associate, Colin Buchanan

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