Whole life value of footways and cycle tracks

by V Atkinson, L Baldachin and S Bird

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Executive summary

This report is part of the Contract 3/302_061, *Footway and Cycle track Management Research*. Information about this work can be found on the Footway and Cycle track Management Group (FCMG) website at http://www.footways.org/index.htm. The objective of this research was to produce guidance on the whole life value of footways and cycle tracks indicating the relative whole life cost and advantages and disadvantages of various construction types and maintenance treatments. The costs of accidents are also considered and other issues which may influence the value are discussed.

Currently, it is foreseen that the end point of this work will be the revision of the Whole Life Costing section in Application Guide AG26 (Version 2)(TRL, 2003). The output of this investigation will also contribute to the production of practical guidance on the application of risk management techniques to the management of footways and cycle tracks.

It is expected that authorities will use whole life cost and whole life value to inform policy decisions, to enable the best network solutions to be found and to help in deciding the most appropriate construction or maintenance for a particular length of footway or cycle track.

A literature review of whole life costing of footways and cycle tracks was undertaken through searching the Internet, the TRL library database and technical publications. The review showed that, while whole life costing of footways is generally considered of importance, there is little and contradictory guidance on which materials and methods result in whole life cost benefits.

The concept of whole life costing, its principles and a method of producing qualitative whole life costs are presented. Other aspects which affect the choice of footway materials and the wider costs, such as claims, accidents, regeneration schemes and sustainability have also been discussed. It was found that aesthetics can play a large role in choice of footway material in urban settings. Aesthetically pleasing footways can encourage business and regeneration of an area, creating more revenue than a cheaper surfacing.

Information on construction and maintenance costs was obtained from a number of local authorities and showed that there were large regional variations in costs. Average costs and typical maintenance regimes were used to model the whole life cost (WLC) for different types of footway. It was found that in rural areas where maintenance is infrequent the WLC is dominated by construction costs and therefore flexible footways are the least expensive. In urban locations where there is a greater degree of vehicle overrun and disruption by utilities, maintenance is more frequent and the WLC of flexible surfacing and slabs are similar. However slabs are thought more likely to cause trips, increasing accident costs.

Recommendations are that local authorities should keep records of the cost of footway construction, maintenance and associated costs such as claims. These could then be input into a regional database allowing the WLCs to be modelled for each region. Guidance on how local authorities can use their own costs and maintenance regimes to calculate the WLCs for different types of footways is given.

Abstract

While whole life costing is considered important, a literature review of the whole life costing of footways and cycle tracks found that there is little and contradictory guidance on which materials and methods result in whole life cost benefits. This report provides guidance on the whole life evaluation of footways and cycle tracks. The concept of whole life costing, its principles and a method of producing qualitative whole life costs are presented. Other aspects which affect the choice of footway materials and the wider costs, such as claims, accidents, regeneration schemes and sustainability are discussed. Whole life value is also considered; this aims to achieve the optimum balance between whole life costs on the one hand, and the aspirations, needs, and requirements of stakeholders on the other. Aesthetics can play a large role in choice of footway material in urban settings because aesthetically pleasing footways can encourage business and regeneration of an area. Information on construction and maintenance costs was obtained from a number of local authorities and showed that there were large regional variations in costs. Average costs and typical maintenance regimes were used to model the whole life cost of asphalt and flagged footways. It was found that in rural areas where maintenance is infrequent the whole life cost is dominated by construction costs and therefore flexible footways are the least expensive. In urban locations where there is a greater degree of vehicle overrun and disruption by utilities, maintenance is more frequent and the whole life costs of flexible surfacing and slabs are similar. However slabs are thought more likely to cause trips, increasing accident costs.

1 Introduction

Recent government initiatives towards sustainable transportation and increased public expectations have both led to a drive towards making facilities for pedestrians and cyclists more attractive, safer and accessible. Management of footways and cycle tracks must provide benefits in terms of a high level of service, cost effective maintenance and improved quality of workmanship. Research is therefore needed to identify how the management of footways and cycle tracks fits into the developing asset and risk management contexts.

There are currently around 350,000 km of footways in the United Kingdom. Decisions made in the prioritisation and selection of schemes for these footways and for cycle tracks will be based on a range of factors, one of which will be cost. To complement any models developed, practitioners would value guidance based on whole life costs and the wider issues that need to be taken into account. These might include local resident's views, aesthetics, heritage areas, susceptibility to over-run, and ease of reinstatement after utility works and ease of re-cycling.

The work reported here was carried out as part of the Contract 3/302_061, *Footway and Cycle track Management Research*. The objective was to produce guidance on the whole life evaluation of footways and cycle tracks indicating the relative whole life costs and advantages and disadvantages of various construction types and maintenance treatments. Whole life value is also discussed; this is the process which aims to achieve the optimum balance between WLC on the one hand, and the aspirations, needs, and requirements of stakeholders on the other.

It is expected that authorities will use whole life cost and whole life value to inform policy decisions, to enable the best network solutions to be found and to help in deciding the most appropriate construction or maintenance for a particular length of footway or cycle track.

A literature review of the whole life costing of footways and cycle tracks was undertaken through searching the Internet, the TRL library database and technical publications. This is presented in Section 2 of this report.

The basic principles of whole life costing and whole life value are set out in Section 3.

Costs of various types of construction and maintenance and typical maintenance regimes were obtained from Local Authorities. These have been summarised in Section 4. The costs obtained from Local Authorities have been used to calculate examples of whole life costs of footways of different constructions and scenarios, and these are presented in Section 5.

Section 6 discusses briefly how whole life value might be taken into account. Conclusions are given in Section 7 and Section 8 provides some recommendations in carrying this work forward.

2 Literature review

2.1 Whole life costing

Many articles reference whole life costing and allude to it being a useful tool and advantageous in the decision-making processes associated with footway and cycle track maintenance and construction. (Smith, 2003; Dixon, 2003; Allen and Ballantyne, 2003; Bushell, 2001; Cornwall County Council, 2002 and Tameside County Council, 2002).

Pearson states that "The best choice of construction will be that whose cost, when added to predicted maintenance costs over the structure's lifetime, represents the lowest total expenditure and the best use of resources" (Atkinson, 1997). This promotes both effective asset management and sustainability.

Pearson explores the economics of flexible and flag construction. He sets out the factors to take into account in a whole life cost investigation and compares the costs over a 50 year life cycle between footways constructed from asphalt surfacing (often referred to as flexible or bituminous), normal flags and small element flags. However, he recognises that the maintenance regime and the initial quality of installation can affect the whole life cost (Pearson, 1990). Pearson states that if less than 0.3% of flags need to be replaced per annum, a flagged footway would have a smaller whole life cost than a normal flexible surfacing. If the number is more than this, flexible footways would have the lower whole life cost.

Different authorities vary in their opinions on the best materials to use, in whole life cost terms. Some are of the opinion that flexible surfacing is more durable and cheaper in the long term (Bath and Northeast Somerset Council, 2004; Eastbourne Borough Council and Totton, 2003). Others state that other materials are more suitable, such as concrete block or tegula paving (Bushell, and Totton, 2001; Baker, Howard, and Harris, 2002; Surveyor Magazine, 2003a).

Bushell (2001) states that twenty years ago, flexible surfacings provided a simple and cheap means of paving footpaths. However, public perception of flexible materials as a footway or cycle track surface is not favourable, with a MORI poll of 1000 people showing an 80% preference for the look of block paving compared to 5% for flexible surfacing. The introduction of machine laying has decreased the relative costs of block paving compared to flexible surfacings. Ease of reinstatement is also cited as an advantage of block paving with the results aesthetically more pleasing than the appearance of a frequently reinstated flexible surface. Bushell claims that concrete block paving has a significantly lower whole life cost than other surfacings.

The above opinion is not held by all. In contrast Eastbourne Council claims that flexible footways cost approximately a quarter of the costs of like-for-like reinstatement compared to slabbed or block footways (Eastbourne Borough Council, 2003). Part of the high costs of modular footways may be because the paving elements removed become the contractor's property to dispose of accordingly.

Hertfordshire County Council adopts a whole life cost approach towards carriageways, footways and cycle tracks, using the principles of asset management. Hertfordshire Highways is an alliance between Hertfordshire County Council, Mouchel Parkman and Amey Lafarge. Their assessment of the lifecycle of the roads was based on deterioration information (Smith, 2003). Work is scheduled to enable planned activity to coincide in a specific area. The team reduces its overheads and makes best use of its resources because it maintains a steady workload throughout the year. Integration of routine cyclical work into other activities improves efficiency. Hertfordshire Highways has increased its buying power by 15% by adopting a whole life cost approach, using principles of comprehensive asset management. Maintenance is pre-planned rather than waiting for defects and rushing from one emergency repair to another. If a defect occurs in the footway and the plan details that the footway is due for renewal in 3 months time, a temporary repair designed to last until the major works begins will be undertaken. By understanding the footways and the timing of their deterioration, maintenance can be planned to maximise value for money and prolong the life of the network. This translates into less disruption for the public as the repairs and maintenance are done at the best time and are designed to last.

There are various tools available for whole life costing of highways, where much is known about the deterioration in relation to the level of traffic using the highway. However, there is little that is specific to footways and cycle tracks, where the deterioration is not necessarily traffic or age dependent. This demonstrates a need for a functional tool aimed at determining relative whole life costs of footways and cycle tracks. To inform this, local authorities were asked what their typical maintenance regimes were, using the need for maintenance with time as a proxy for a deterioration curve. This is reported in section 4.

2.2 Funding issues

The actual material costs involved in the installation of a footway or cycle track is a leading concern to authorities. As a direct result of this, decisions on footway maintenance are often taken on a short-term basis rather than on a whole-life cost basis, and cheaper materials may be favoured over more expensive, more durable, products (Living Streets, 2003b).

Many authorities recognise the benefits of whole life costing but lack the immediate funding. In a review of Tameside County Council highway maintenance policies it was stated that “Although temporary remedial/maintenance works may be cheaper in the short term, they are usually more expensive in the long term. Now that the Council is able to promote higher levels of investment into the highway network, the Engineering Service is able to undertake much more pre-planned structural maintenance work which is much more cost effective than the short-term patch and prop expedient that Highways Authorities have had to deliver in past years, with massive under investment. This will inevitably result in optimising Whole Life Costs.” (Tameside County Council, 2002).

Tameside, Herefordshire & Cornwall County Councils and Eastbourne Borough Council have highlighted the issue of funding difficulties in policy documentation (Tameside County Council, 2002, Herefordshire County Council, 2001, Cornwall County Council, 2002 and Eastbourne Borough Council, 2003) and call for increased investment into footways and cycle tracks on an independent basis. Without increased investment many authorities will not have the funding to implement whole life costing strategies.

2.3 The indirect costs of poorly maintained footways

Living Streets (a nationwide campaign of The Pedestrians Association) conducted a survey of 1,134 older and disabled people in London. For these more vulnerable pedestrians, a good walking environment is critical. A great number of older people have problems with balance. Many visually impaired people cannot detect unevenness or sometimes their white canes catch in cracked paving. People over 60 have fewer cars per capita than the general population. The proportion having access to a car falls from 83% at the age of 60 to 47% at the age of 70 and only 24% by the age of 80. The majority of London’s senior citizens meet their needs on foot and for them the footways are their mode of transport. Although car ownership differs in other parts of the country, the increased reliance on a good walking environment is likely to be true for disabled and older people across the UK. The survey in London showed that the poor condition of footways affected seven out of every ten respondents’ ability to move along the streets, with two out of every ten describing the poor condition of pavements as the most serious problem facing them upon leaving home.

From the available literature it is difficult to get an accurate picture of the level of liability claims resulting from defects in footways or cycle tracks. Anecdotal evidence suggests that in many councils, liability claims form a high percentage of their maintenance budget, though there is some evidence to suggest that claims are becoming more driven by the ‘compensation culture’ than by footway condition. A report by the Government (DTI 1990 Home and Leisure Accident Research. TSO) suggested that pavement falls bring ten times as many people into accident and emergency departments as are injured in road traffic crashes. The ratio is possibly even higher at times of ice or snow. In many places, only the road surface is gritted leaving pedestrians to slip and slide on the footway, or to walk in the road.

Poorly maintained footpaths create constant difficulty for any pedestrian and trip hazards cause large costs to the NHS and the national economy (The House of Commons Transport Committee, 2003a). It is approximated that the national average number of 'trip hazards' for every 100 metres of footway is currently at 4.1 (The House of Commons Transport Committee, 2003b). This is an unacceptable hazard to the general public and it should be possible to deliver safety improvements through effective maintenance policy, systems and procedures. Whole life costing would be an effective procedure to fit such a framework into.

Some councils actually use injury claims data as an indication of maintenance requirements. At Caerphilly County Borough Council the level of claims and costs has a major influence on expenditure and staff resources (Cornwall County Council, 2002 and Noble, 2001). Caerphilly's risk management strategy relies on an integrated system of data collection and management. Pro-actively trying to stop defects arising in carriageways and footways is a key element of their strategy. As part of this process they are looking at claims 'clusters' and trying to relate them to the frequency of inspections and the level of use. A result of analysing claim locations is the review of inspection frequencies on 'lower' categories of roads, footpaths and car parks, where it seems most personal injury claims take place. The strategy for dealing with these 'hotspots' comprises increased inspections, lowered safety defect thresholds and improved response times for repairs.

Some authorities believe the emphasis of footway and cycle track construction and maintenance should be on a safe surface with no hazards to pedestrians, and catering for vulnerable users, albeit at the expense of aesthetic and environmental considerations (Eastbourne Borough Council, 2003 and Herefordshire County Council, 2001).

2.4 Benefits of improving the pedestrian environment

Community Street Audits have highlighted the need for increased prioritisation of footway maintenance. Local authorities tend to decide their spending priorities for highway maintenance by reference to the road and if the footway is improved too, this is a by-product. The condition of a footway, and its level of use, is not taken into account when decisions are made about spending priorities. Living Streets would like to see local authorities prioritise footway improvements on the basis of condition of footway and usage.

The London walking plan (TfL, 2004) identified that there was no set methodology in place to objectively assess pedestrian environments relative to aims for integrated walking. An aim of the plan was to encourage councils to encourage their public to walk. It stated that local authorities must have appropriate systems and tools to allow informed decision making. A key principle was that the pedestrian environment should effectively facilitate all pedestrian activities.

The Pedestrian Environment Review System (PERS), used by the London Borough of Bromley (Allen and Ballantyne, 2003) allows complex pedestrian environments to be analysed within a framework that promotes quantitative and qualitative factors to be considered simultaneously. The need for maintenance is assessed by looking at various categories of significance, such as capacity, legibility, safety and quality, along a pedestrian route. Each element within these categories is given appropriate weighting to emphasise its importance within the pedestrian environment.

A council's decision to regenerate pedestrian routes is often prompted by the result of a survey, giving the public direct influence on the timing and material used for the reconstruction of footways and cycle tracks. For example, in the London Borough of Camden, a scheme to resurface the footways was triggered by the results of a MORI survey highlighting the residents' desire for an improved street environment (Totton, 2003). Totton states that "the state of the footway can act as an indicator of the seriousness with which a council considers walking as part of its transport strategy".

In Scotland a study carried out for the Scottish Office identified better maintenance of footways as pedestrians' top priority for improving facilities. This resulted in improvements in the standards of footway design and quality audits, identifying locations where facilities need improvement to ensure network continuity, and good quality urban design that can be maintained at a reasonable cost (Scott and Basford, 2001).

Warwickshire County Council states that decisions on the use of materials in footway and cycle track maintenance or reconstruction will be subject to consultation with local residents (Warwickshire County Council, 2004).

For some regeneration project proposals it may be possible to obtain assistance with funding, such as EU Objective 5B funding support and Millennium Commission funding (Baker, 2002).

Regeneration schemes are a key contributor to public realm enhancements, often situated in an urban centre with the aim of promoting the local economy (Howard 2002, Baker 2002 and Surveyor Magazine 2003b). Though the schemes may use surfacing materials which are both expensive to purchase and to lay, the economic benefits to the area may well make regeneration schemes financially worthwhile as a whole. Other benefits include pedestrian and cyclist safety (Totton, 2001 and Howard, 2002), reduction of vehicle impact (Baker, 2002) and environmental restrictions (Totton, 2003 & 2001, Harrison, 2002 and Baker 2002) from historical influences and existing surroundings.

Aesthetics is a key issue influencing the decision process on material selection. The aesthetic look of footways and cycle tracks is thought to affect such things as investment appeal (Surveyor Magazine, 2003b and Harrison 2002) as well as the public's perception of their local authority (Totton, 2003) and their psychological welfare (Totton, 2003 and Highways Magazine, 2000)

2.5 Material selection

Materials chosen for aesthetic reasons may not be the best materials in whole life cost terms. For example, natural stone paving is seen to improve the image of an area (Harrison, 2002), but is a very expensive material. In some cases an overriding factor in material selection is the area in which the footway is situated, such as a conservation area; e.g. Whitehaven in Cumbria (Baker, 2002).

New materials are constantly coming onto the market and the performance of these materials will not be well established, thus the maintenance frequency and the whole life costs of footways using these materials will be difficult to establish. One example is a flexible surfacing containing glass, called Glasphalt, which can be used both as a base and as a binder course (Walter, 2002).

The maintenance required to keep streets aesthetically pleasing may include regular street cleansing, sometimes with pressurised water, restricting the material selection to those which can withstand such pressures (Totton, 2003). Specification of materials which can withstand vandalism may also be an issue in some areas (Highways Magazine, 2000).

2.6 Sustainability

There are several levels of government policy that can affect how footways and cycle tracks are designed. The most far reaching policies are those emanating from central government, such as Planning Policy Guidance 25 (PPG25, 2003) on development and flood risk, and the National Walking Strategy.

PPG25 requires planners and developers to design for drainage in a sustainable and innovative way. Currently, the material being developed for the use of Sustainable Urban Drainage Systems (SUDS) is a range of permeable paving systems allowing water to drain through footway surfacing (Harris, 2002) which could become a required material for surfacing in certain flood risk areas.

With sustainability also on the agenda, recycling and other aspects may well be required to become a more prominent feature in Councils' future strategies too (Reid, 2001 and Totton, 2003). This may take the form of the inclusion of recycled materials, as well as use of different methods of material application such as cold-application techniques which save energy. All these specifications will add cost in some places and detract in others which could be ascertained by way of a whole life cost assessment including sustainability factors.

2.7 Summary of literature review

The literature review showed that while it is accepted that whole life costing is important in the decision process for footway construction, there was little hard information to provide guidance. Opinions on which materials are advantageous in whole life cost terms vary from one authority to another.

Claims are a major issue for many authorities. The cost of claims has been examined and is reported by Bird and Sowerby (2005). A tentative relationship between claims, footway construction and footway maintenance has been deduced, and the risk management model shows how this might affect the overall costs over the lifetime of the footway.

Regeneration of an area generally involves using surfacings chosen for their aesthetics rather than economy or performance. However, improving an area encourages businesses to come into it and encourages pedestrians to use it. Thus there are advantages in wider economic terms.

Costs of materials and labour will vary according to location. Properties of new materials may not be fully understood. Highway Authorities may not have full records of maintenance carried out in the past, and knowledge of the maintenance regime is critical to any calculation of whole life costs. Thus a method of whole life costing may be agreed upon, but individual authorities may have to perform their own calculations to come up with the best solution for them.

The following discussion of whole life costing and whole life value should enable local authorities to carry out their own calculations to get the best solution for their particular circumstances.

3 Principles of whole life costing

Most people will be aware that the real cost of owning an asset involves more than the initial purchase price. For example, the cost of owning a house includes more than the purchase price of the property; the other costs to be considered include running costs such as lighting and heating bills, the costs associated with maintaining and refurbishing the building, as well as the payment of local taxes. As this example clearly shows, the cost of owning an asset is not all incurred at the point of acquisition, but continues throughout its whole life.

3.1 Definitions of whole life costing

Whole life costing (WLC) is a technique that is used to establish the total costs of ownership over the anticipated service life of an asset. It has been defined as:

> "The systematic consideration of all relevant costs and revenues associated with the acquisition and ownership of an asset" (Construction Research and Innovation Strategy Panel, CRISP)

However, it is also important to think in terms of meeting identified needs rather than simply acquiring particular assets. WLC is not simply concerned with the question "what is the cost of this item or service?" but is aimed at answering the question "what is the cost of achieving this objective in this particular way?" Thus a WLC approach requires the client to define what they want from the asset they are asking the delivery team to provide. This means that it is necessary to establish performance specifications for the asset rather than simply provide a prescriptive specification. This is reflected by BS ISO 15686-1, which defines WLC as:

> "[an] economic assessment considering all agreed and projected significant and relevant cost flows over a period of analysis expressed in monetary value. The projected costs are those needed to achieve defined levels of performance, including reliability, safety and availability." (BS ISO 15686-1)

For major town centre footways, there may be several construction options that would meet the requirements. The aim of a WLC assessment is to make investment decisions with a full understanding of the cost consequences of the different options available. In a traditional, capital focused, project it is likely that the option with the lowest initial capital cost would be selected. However, WLC assessment can be used to select the option that meets the specified requirements for the minimum total cost over the life of the asset.

WLC can be used at any stage in the life of an asset (new build or maintenance and refurbishment) and can be used by all of the organisations within the supply chain.

3.2 Principles of whole life costing

The principle of whole life costing is to calculate all the costs associated with a project for its designated service life, so that comparisons can be made between options. Where there are a number of construction options that meet the requirements of the client, it has traditionally been the option with the lowest initial costs (i.e. design and construction costs) that is selected. More recently, it has been recognised that such an approach does not provide the full picture with regard to costs because it does not take account of longer term issues such as the maintenance costs associated with each option over the service life of the asset. The situation is further complicated as the maintenance requirements (and therefore costs) for a given option are unlikely to be the same in each year of the asset's life. Also the changing value of money over time needs to be accounted for.

Maintenance costs for a stretch of footway might be £1,000 in the first year after construction. However they will not stay at that level for each year throughout its life. Reasons for this include:

a) Inflation (i.e. the general increase in the price of the same goods and services over time, without a corresponding increase in value)

b) Marked changes in the unit costs of raw materials due to shortages or over-supply (a good example is provided by recent increases in energy prices which are well in excess of inflation)
c) Change in the condition of the asset (which necessitates different maintenance treatments at different times throughout its life)
d) Changes to maintenance techniques (e.g. due to innovation or new materials).

In summary, the ownership of infrastructure requires the expenditure of different amounts of money at various times through the service life of the asset, and the real value of the money spent depends on the magnitude of the cost and the time at which the expenditure takes place. If decision makers are to select the construction option that truly provides the lowest cost over the whole life of an asset, it is necessary to use a system of financial evaluation that allows for all of the likely costs associated with a particular construction option and the time at which these costs are incurred. This is the objective of a WLC assessment.

3.3 Discount rates and present value

Because WLC considers different levels of expenditure at different times throughout the life of an asset, it is necessary to make adjustments to account for changes in the value of money over time. There are various ways of explaining the time value of money but, in essence, it is more advantageous to pay costs later rather than earlier, because cash which does not have to be spent immediately can be invested and thereby increase in value by attracting interest. However, it also has to be remembered that whilst money that is invested will increase in value over time, the 'purchasing power' of that money will be offset to some extent by the effects of inflation.

In order to take account of these time dependent influences on the value of money, a notional interest rate, known as the discount rate, is used. This can be thought of as the *real* rate of increase in the value of money over time, i.e. the rate over and above the general inflation rate of the economy.

The discount rate, r, is calculated using the following equation (Dale, 1993):

$$r = \left[\left(\frac{1 + \text{interest rate}}{1 + \text{inflation rate}} \right) - 1 \right]$$

If, for example, the interest received on an investment is 7% per annum, while the rate of inflation is 3% per annum, then

$$r = \left[\left(\frac{1 + 0.07}{1 + 0.03} \right) - 1 \right] = 3.883\%$$

For transport infrastructure procurement, HM Treasury specifies that a discount rate of 3.5 per cent should be assumed for the first 30 years of any WLC assessment, reducing to 3.0 percent thereafter (HM Treasury, 2003).

The discount rate is used to determine the change in the value of money over time. To take a simple example, suppose that a maintenance treatment for a pavement costs £100,000 at current prices and a highway authority wants to know how much money should be invested today to repeat the maintenance treatment in 10 year's time, given interest and inflation rates of 7% and 3% respectively.

At a 3% inflation rate, if the cost of treatment is £100,000 now, then in 10 years time the cost would be £134,392.

This is calculated from the equation:

$$F = P \times (1 + i)^n$$

Where

F is the future amount

P is the present amount (in this case £100,000)

i is the inflation rate per period (expressed as a decimal value, in this case 0.03 pa), and

n is the year for which the future amount is being calculated (in this case *n* = 10)

Therefore

$$F = £100{,}000 \times (1 + 0.03)^{10} = £134{,}392$$

Having calculated the future cost, the next step is to work out how much money would need to be invested today to meet a cost of £134,392 in 10 years time. The present value of a future amount of money can be calculated from:

$$PV = \frac{F}{(1 + j)^n}$$

Where

PV is the present value (i.e. the amount of money to be invested at the present time)

F is the future amount of money required (in this case £134,392)

j is the interest rate per period (expressed as a decimal value), and

n is the number of years for which the money is invested

If it is assumed that an investment can earn interest at 7% per annum, then the amount of money that would need to be invested today to meet the future cost of £134.39 in 10 year's time is:

$$PV = \frac{£134{,}392}{(1 + 0.07)^{10}} = £68{,}321$$

However, the use of a discount rate simplifies the calculation considerably. The present value (PV) of a future amount of money (e.g. a future maintenance cost) can be calculated by using the formula:

$$PV = \frac{X}{(1 + r)^n}$$

Where:

PV is the present value (i.e. the amount of money to be invested at the present time)

X is the cost (at current prices)

r is the discount rate (expressed as a decimal value), and

n is the year in which the cost will be incurred (in this case it occurs in Year 10 so *n* = 10)

With an interest rate is 7% per annum and an inflation rate of 3% per annum the resulting discount rate is 3.883 % (as shown above) and therefore the present value of the maintenance cost is:

$$PV = \frac{£100{,}000}{(1 + 0.03883)^{10}} = £68{,}321$$

This means that if a maintenance treatment (which costs £100,000 at current prices) is to be undertaken in 10 year's time, it would be necessary to invest a sum of £68,321 at the present time in order to meet this future maintenance cost.

The method of adjusting future year's costs to their present value is called discounting and it forms the basis of the WLC approach. Because the discounting method allows a future cost, no matter how big it is or when it is incurred, to be converted into a present value, it can be used as the basis for a fair comparison between construction options that require different levels of expenditure at different times.

3.4 Undertaking a whole life cost assessment

To carry out a WLC assessment it is first necessary to estimate the costs associated with a particular construction option in each year of the chosen analysis period. It is important to note that these estimates are based on the present day prices of undertaking a maintenance treatment. There is no need to make allowances for inflation when estimating future costs because this will be taken into account by the discounting procedure. Thus if a particular maintenance treatment costs £10k at current prices then that is the figure used as the cost estimate for that treatment in future years. However, it is necessary to make allowances for any likely changes in the unit costs of goods or services that are over and above inflationary increases. For example, if it is anticipated that raw materials or energy costs are likely to increase sharply in future years (due to shortages or increased demand) then this should be reflected in the cost estimates.

Once the costs have been estimated over the period of analysis, the next step is to calculate the discounted costs for each year (i.e. convert them to their present values). The discounted costs are then summed to give the net present cost of the asset. This may be defined as the funds which would need to be set aside today to meet all the eventual costs, both initial design and construction and future maintenance, after allowing for the accumulation of interest on that part of the funds intended for future commitments.

Net present cost (NPC) is calculated by the following formula:

$$\mathbf{NPC} = \sum_{t=0}^{t=N} \mathbf{C_t / (1+r)^t}$$

$$= C_0 + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \ldots \frac{C_N}{(1+r)^N}$$

Where

C_0	=	Capital cost
C_t	=	Maintenance costs in year t
r	=	Discount rate
N	=	Length of study period, in years

The NPC is not a fixed sum for any given asset; it depends on the time period chosen for the analysis and the discount rate selected, as well as the estimated costs. In general, for a shorter time period, the estimated costs are likely to be more accurate, for longer time periods even a small positive discount rate reduces future costs to negligible levels.

3.5 Sensitivity analysis

Although the mathematical principle underlying WLC assessment is sound, the level of uncertainty associated with the accuracy of predictions regarding the magnitude and timing of future cost elements can have a major impact on the relevance of any results. Therefore it is important to undertake sensitivity analyses in which a range of values are used for a particular variable and the sensitivity of the solution to changes in specific variables can be assessed.

3.6 Whole life value

The WLC approach considers only the economic aspects associated with the ownership of an asset. Whole life value (WLV), on the other hand, encompasses the economic, social, and environmental aspects associated with the procurement, operation and subsequent disposal of an asset. WLV is a technique that aims to obtain the optimum balance of stakeholders' aspirations, needs and requirements, and whole life costs (DTI, 2005).

Returning to the analogy of house ownership, a prospective buyer might well calculate the whole life costs associated with a number of different houses, but the final decision on which one to buy is unlikely to be based purely on financial criteria. The decision will be a balance between cost and several other factors such as the location of the house, its character and build quality, the size and functionality of its rooms and so on. When prospective buyers are weighing up the pros and cons of one house against the other, they will ultimately make the investment decision on the basis of WLV.

The WLV of an asset represents the optimum balance between stakeholders' value drivers and the whole life costs of the asset. The value drivers will differ from one stakeholder to another and therefore it is important to identify the various drivers and prioritise them to suit the particular requirements of the project. In practice it is rare for the various value drivers to be accorded the same level of importance within the decision making process. It should also be remembered that there is likely to be some conflicting interests between the various stakeholders and so there may be constraints on what can be achieved.

Thus the challenge in achieving WLV lies in defining measures of value which are appropriate to the project being considered, and which address the value drivers of the various stakeholders.

In order to obtain the optimum whole life value and reap the benefits of quality and value for money, quantitative whole life costing needs to be carried out and a system developed for assessing the value of those issues that cannot be given a quantitative cost.

4 Data for WLC of footways

In order to evaluate the whole life cost of a footway or cycle track, as discussed above it is necessary to know the cost of the initial construction, the ongoing costs of repairs and the cost of reconstruction when the footway or cycle track reaches the end of its life. Many local authorities equate reconstruction to renewal of the bound layers as the foundation is rarely reconstructed. Material and labour costs are required.

Other costs which could be considered are the costs of cleaning throughout the life of the asset and the costs of claims/accidents which may vary according to the type of surface on the footway or cycle track.

Road pavement deterioration is caused by traffic and there are established deterioration relationships which inform the frequency of maintenance operations such as resurfacing. In footways and cycle tracks, deterioration is less predictable and will depend on the initial construction, the elements, the number of utility excavations, the misuse the footway suffers (e.g. vehicle overrun) etc.

Local authorities were approached in order to obtain information on construction and maintenance costs, and maintenance regimes. In order to obtain data, a questionnaire was designed and sent to 51 Local Authorities in the UK. The original questionnaire can be seen in Appendix A. Replies were received from 19 authorities.

Most authorities had unit prices available for new construction and maintenance, including materials and labour. Engineers were asked to estimate typical maintenance regimes for footways and cycle tracks with different types of surfacing; these regimes would necessarily take into account all the contributory factors to deterioration.

4.1 Cost information

Of the 19 Local Authorities which replied to the questionnaire; 14 provided sufficient information to calculate approximate unit costs of footway construction according to Application Guide AG26 (Version 2) (TRL, 2003). These are summarised in Table 4.1.

It should be appreciated that cost information was given in a variety of forms, ranging from an authority's **e**stimate of an all-in cost to a fully priced schedules of rates. There are wide regional variations in component costs. Where possible, rates were calculated that exclude traffic management, preliminaries and overheads. Thus, except where noted, the costs given in Table 4.1 are considered to be a sufficiently realistic representation of current costs in order to be able to make general comparisons of whole life costs. However, it would be necessary for an authority to make comparisons using their own cost data in order to draw conclusions that are valid locally.

Table 4.1 Summary of footway cost information

Description[1]	**Number of results**	**Average Cost (£ per sq m)**
New and re-construction (pedestrian only)		
Asphalt surface	21	23
Concrete surface	2	31
Block surface (new)	8	42
Flag surface (new)	10	33
Re-lay flags (assumes no breakage)	2	17
Re-lay blocks (assumes no breakage)	1	20
New and re-construction (light vehicle over-run)		
Asphalt surface	9	31
Concrete surface	1	59
Block surface (new)	1	24* (55)
Flag surface (new)	1	47
New and re-construction (heavy vehicle over-run)		
Asphalt surface	2	42
Concrete surface	1	74
Block surface (new)		
Flag surface (new)	1	50
Patching (small areas)		
Asphalt surface	8	24
Concrete surface	1	54* (40)
Block surface (new)	2	48
Flag surface (new)	2	30* (40)
Re-lay flags or blocks	7	43
Kerbs (provide and lay)	6	17 (£/m)

[1] Construction thickness according to AG26

* These results are based on relatively few data and appear inconsistent with other costs. Therefore the alternative costs in brackets, assessed using judgement, have been used in the subsequent analysis.

4.2 Maintenance regimes

In general local authorities agreed with the maintenance regime suggested in the questionnaire in Appendix A. Detailed observations on maintenance regimes are presented in Appendix B. These can be summarised as:

- A footway has a life expectancy of 25 to 40 years.
- During the first five years of its life less than 1% of an asphalt surfaced footway is patched.
- For future 5 year periods, patching will be between 1% and 5% over the 5 year period.
- An asphalt surfaced footway will generally be resurfaced after 20 to 25 years.
- Slurry seal is often used to stop deterioration of asphalt footways.
- A policy of replacing flags with flexible surfacing is common.
- Most damage is done by vehicle overrun and utilities.
- Limited budgets often prevent preferred maintenance regimes.

4.3 Summary of data requirements to enable WLC calculation

Local authorities can apply the WLC formulae to their own network, enabling them to take into account regional variations of costs and their own maintenance regimes. For this they will need the following information:

- Construction thickness
- Cost of materials
- Cost of labour for various scenarios.

This will enable the unit costs of new construction and patching etc. to be calculated for footways of varying construction. Many local authorities already have standard rates for construction and patching or relaying modular paving.

They will also need to know or estimate:

- Service life (to major reconstruction)
- Typical maintenance costs per year of the footway's life
- Typical annual maintenance regimes for different footway categories and surface types.

This will enable them to estimate in which years maintenance is carried out so that the discount rate can be applied to obtain the present value of the maintenance operations.

A more sophisticated WLC analysis might also include:

- Costs of cleaning for each surface type and category
- Costs of claims for each surface type and category.

Other direct costs can also be included, if known. Authorities will need to;

- Set an accounting period, e.g. 40 years
- Use an appropriate discount rate, for example the current Treasury rate, 3.5%.

It should be noted that accuracy will decrease with longer accounting periods.

5 WLC comparisons

The information on costs and maintenance regimes have been used to calculate the whole life costs of footways constructed with different surfacing materials and a number of scenarios.

5.1 WLC comparison between 'pedestrian only' footways surfaced with asphalt and with flags

The basic whole life costs have been calculated for two footways constructed for 'pedestrian use' only, as defined in AG26. The construction thicknesses assumed are given in Table 5.1.

Table 5.1 Construction thicknesses

Surfacing material	Asphalt	Flags
Surface thickness	20mm surface course 50mm binder course	50mm (or greater) flags 25mm bedding sand
Sub-base thickness	100mm	150mm

New construction costs are taken from Table 4.1 and are:

Asphalt surfacing £23/m^2

Flag surfacing £33/m^2

The maintenance regime assumed is shown in Table 5.2, with patching or replacing flags as necessary every 5 years and surface dressing the asphalt footway after 25 years.

Table 5.2 Footway parameters

Parameter	Unit	Value
Footway category		2
Pedestrian traffic	No. per day	2,000
Surface type		Flexible
Interval before resurfacing: asphalt flags	years	 25 40
Maintenance inspection interval	years	5
Maintenance defect threshold	mm	13
Safety inspection interval	days	90
Safety defect threshold	mm	20
Safety defect response time	days	28

As previously stated, the net present cost is calculated from the formula

$$\mathbf{NPC} = \sum_{t=0}^{t=N} \mathbf{C_t / (1+r)^t}$$

Thus if the present cost of resurfacing a footway surfaced in asphalt is £10/m^2 (estimated cost), the net present cost of the resurfacing in 25 years time, using a discount rate of 3.5%, is:

$$10/(1.035)^{25} = 4.23\ (£/m^2)$$

The average cost of patching an asphalt footway is £24/m^2. Thus the cost of patching 1% of the footway is £24/m^2 x 1/100 =£0.24/m^2. The net present cost of patching 1% in year 10 is:

$$0.24/(1.035)^{10} = 0.17\ (£/m^2)$$

For simplification the worked examples below include only new construction, maintenance and reconstruction which will vary according to the surface type. No costs have been included for kerbs, crossovers etc.

Tables 5.3 and 5.4 show the timing of new construction and maintenance, an assumed maintenance regime, the unit costs and the discounted costs for each item, for footways surfaced with asphalt and flags, respectively. It is assumed that both footways will need reconstruction after 40 years, giving a residual value of zero.

Table 5.3 Whole Life Cost calculation for asphalt footway

Year	Description of expenditure	Amount being treated	Unit Cost (£/m^2)	Cost (£/m^2)	Discounted Cost (£/m^2)
0	New construction	100%	23.00	23.00	23.00
5	0.2% surface patch / 5yr	0.2%	24.00	0.05	0.04
10	1% surface patch / 5yr	1%	24.00	0.24	0.17
15	1% surface patch / 5yr	1%	24.00	0.24	0.14
20	1% surface patch / 5yr	1%	24.00	0.24	0.12
25	Surface dressing	100%	10.00	10.00	4.23
30	0.2% surface patch / 5yr	0.2%	24.00	0.05	0.02
35	1% surface patch / 5yr	1%	24.00	0.24	0.07
40	Residual value			0.00	0.00
	Total cost			**34.06**	**27.79**

Table 5.4 Whole Life Cost calculation for flag footway

Year	Description of expenditure	Amount being treated	Unit Cost (£/m^2)	Cost (£/m^2)	Discounted Cost (£/m^2)
0	New construction	100%	33.0	33.0	33.0
5	0.4% surface patch / yr	0.4%	45.0	0.18	0.15
10	2% surface patch / yr	2%	45.0	0.90	0.64
15	2% surface patch / yr	2%	45.0	0.90	0.54
20	2% surface patch / yr	2%	45.0	0.90	0.45
25	2% surface patch / yr	2%	45.0	0.90	0.38
30	2% surface patch / yr	2%	45.0	0.90	0.32
35	2% surface patch / yr	2%	45.0	0.90	0.27
40	Residual value			0.00	0.00
	Total cost			**38.58**	**35.75**

The cost of the asphalt footway (£34.06/m^2) is 88% that of the flagged footway (£38.58/m^2). Looking at the discounted costs increases this difference. The whole life costs (the sum of the discounted costs) of the asphalt footway are (£27.79/m^2), only 77% of those of the flagged footway (£35.75/m^2).

5.2 Other direct costs

The cost of cleaning footways may vary according to the surface type. High suction cleaners can suck up bedding and grouting sand from modular surfaces. On such surfaces it may be necessary to use a less automated method of cleaning. This is likely to increase the difference in whole life costs between modular and asphalt surfaced footways.

The cost of claims is of great importance to local authorities. If it can be shown that claims are more prevalent on certain footway types, this can also be taken into account in the whole life costs. If the average yearly cost of claims on each footway type is known, the discounted costs can be calculated and added to the whole life cost calculations.

5.3 Indirect costs: WLC calculations including estimated costs of accidents

Maintenance is carried out to preserve the structure of the footway and to maintain the surface in a suitable condition for pedestrians and other users. Nevertheless defects will still occur in even a well-maintained footway and these may result in trips and accidents. The poorer the maintenance regime, the higher the number of accidents is likely to be if all other factors, such as the volume of pedestrians using the footway, are equal.

5.3.1 Costs of accidents

TRL is currently carrying out research into the costs of accidents on footways. These costs can be a direct cost to the highway authority, in the case of claims. They can also be an indirect cost, if a fall results in hospital and medical expenses and loss of earnings or productivity.

Accident costs have been estimated by:

- Examining claims data from 3 local authorities, including descriptions of injuries
- Looking at the Home Accident Surveillance System and the Leisure Accident Surveillance System data bases (ROSPA, 2005) compiled from interviewing A&E patients
- Combining the above with costs derived by Hopkins and Simpson (1996) for home accidents.

The average cost of a casualty following a footway fall was found to be £5,606 (2005 prices).

5.3.2 Risk of accidents

A risk assessment model for footways is being developed to estimate the risk of accidents (pedestrian falls resulting from trips on defects) on an authority's network. The measure of risk is the number of walking related injury accidents predicted on the network. A software tool containing this model is under development.

The model is based on the assumptions that it is possible to derive the probability that a person walking over a given defect will have an accident, and that the numbers of defects on the network will be a dynamic balance between the rate at which they appear and the rate at which they are repaired.

The number of accidents on a particular footway will depend upon:

- The number of defects present: N_{defect}
- The probability of those defects resulting in an accident: $P_{accident}$

The number of defects of various heights likely to be present was derived from analysis of survey data combined with typical maintenance and inspection regimes. This gave information on the time period during which pedestrians were likely to be exposed to defects, before those defects are repaired.

The probability of defects resulting in an accident was derived from analysis of local authority claims data and pedestrian flow information.

The number of accidents on a section of the network per year ($N_{accident}$) is taken to be:

$$N_{accident} = \sum F \times L \times t \times N_{defect}(h) \times P_{accident}(h)$$

Where:

F = pedestrian flow on the section of the footway network (people per day)

L = length of section of the footway network (km)

t = time of pedestrian exposure to defect (days)

$N_{defect}(h)$ = number of defects, of height h, developing on the network per km per year

$P_{accident}(h)$ = probability that one person will fall and injure themselves whilst walking past a defect of height h.

The sum of this product for each height (h) of defect is calculated over the range of defect heights for which information is available.

The predicted cost of accidents may be obtained by multiplying the number of accidents by the average cost of a walking accident.

Thus:

$$\text{Cost (£)} = 5{,}606 \times N_{accident}$$

The risk model allows an estimation of the cost of accidents to be included in the WLC calculations, if required. The total number of accidents on the network is the sum of that on different sections, e.g. all categories and construction types.

5.3.3 Whole life cost for asphalt footway including estimate for risk of accidents

Table 5.5 shows the whole life cost as shown in Table 5.3, for a 'pedestrian only' footway, asphalt surfacing. However, the estimated annual cost of accidents has also been included.

Including an estimate for the cost of accidents, the total whole life cost over the 40 years of the footway's life is £43.6/m^2**.**

It can be seen that in this example the cost of the accidents caused by trips, over the life of the footway, is approximately half as much again as the whole life costs of the construction and maintenance.

The approach described above could be used to describe different maintenance regimes. However an important consideration is that a poorer maintenance regime may lead to a higher number of trips and a subsequent higher cost of accidents. Where pedestrian flows are greater (e.g. for footway categories 1 and 1a) the cost of accidents will increase in significance. In a WLC analysis carried out in a pavement management system, for example, Do-nothing and Do-something options would be considered in each year. Thus it may be shown towards the end of the life of the footway that maintenance treatments are justified on the basis of savings in the costs of accidents. Also, a more complete analysis would take into account savings in reactive repairs of safety defects, as safety defects may not arise if maintenance was carried out earlier.

Table 5.5. 'Pedestrian only' asphalt surfaced footway, good maintenance regime, including estimated cost of accidents

Year	Description of expenditure	Amount being treated	Unit Cost (£/m²)	Cost (£/m²)	Discounted cost (£/m²)	Cost of accidents from risk model (£/m²)	Discounted cost of accidents (£/m²)
0	New construction (pedestrian only)	100%	23.00	23.00	23.00	0.57	0.57
1						0.61	0.59
2						0.64	0.60
3						0.68	0.61
4						0.72	0.62
5	0.2% surface patch / 5yr	0.2%	24.00	0.05	0.04	0.61	0.51
6						0.65	0.53
7						0.68	0.54
8						0.72	0.55
9						0.76	0.55
10	1% surface patch / 5yr	1%	24.00	0.24	0.17	0.65	0.46
11						0.69	0.47
12						0.72	0.48
13						0.76	0.49
14						0.80	0.49
15	1% surface patch / 5yr	1%	24.00	0.24	0.14	0.69	0.41
16						0.73	0.42
17						0.76	0.43
18						0.80	0.43
19						0.84	0.43
20	1% surface patch / 5yr	1%	24.00	0.24	0.12	0.73	0.37
21						0.77	0.37
22						0.80	0.38
23						0.84	0.38
24						0.88	0.38
25	Surface dressing	100%	10.00	10.00	4.23	0.57	0.24
26						0.61	0.25
27						0.64	0.25
28						0.68	0.26
29						0.72	0.26
30	0.2% surface patch / 5yr	0.2%	24.00	0.05	0.02	0.61	0.22
31						0.65	0.22
32						0.68	0.23
33						0.72	0.23
34						0.76	0.23
35	1% surface patch / 5yr	1%	24.00	0.24	0.07	0.65	0.20
36						0.69	0.20
37						0.72	0.20
38						0.76	0.21
39						0.80	0.21
40	Residual value	100%	0.00	0.00	0.00	0.69	0.17
	Total cost			34.1	27.8	29.0	15.7
						Total WLC	43.5

5.3.4 Flagged footway – pedestrian only construction

The whole life cost for a 'pedestrian only' flagged footway is shown in Table 5.4. When the estimated cost of accidents is added from the risk model, these costs increase significantly. The risk model indicates that the number of trips on a flagged footway is considerably higher (perhaps two or three times as high) than the number of trips on an asphalt footway, thus the cost of accidents will be even higher on flagged footways. A comparison of estimated whole life costs is shown in Table 5.6.

Table 5.6. Comparison of asphalt and flagged footway costs

Footway surface	WLC (£/m^2)	WLC including estimated costs for accidents(£/m^2)
Asphalt	27.8	43.6
Flags	35.8	82.4

For the flagged footway, the whole life cost of accidents is estimated to be £46.6/m^2 bringing the total whole life cost to £82.4/m^2. This compares with a whole life cost of £43.6/m^2 for a similar asphalt footway. Thus taking into account the estimated risk of trips and the costs of the resulting accidents significantly increase the whole life costs of flagged footways compared to asphalt footways.

There is a whole life value benefit to not having accidents and a direct whole life cost benefit to the highway authority if the claims can be reduced. Thus highway authorities may benefit from considering these costs.

5.3.5 Limitations

It should be borne in mind that the work on risk analysis is incomplete and the data have been used only to illustrate what might happen if the costs of accidents were taken into account. It illustrates that it may be worth considering indirect costs as well as the direct costs of construction, inspection and maintenance. The costs used in the example calculations are averages and estimates and may give misleading results if applied inappropriately.

There will be large regional variations in costs of material and labour. It is suggested that authorities compile their own data if calculating whole life costs.

5.4 Cycle tracks

A similar approach as that taken with footways can also be applied to the calculation of WLC for cycle tracks. At the time of writing, there was little data available on the costs of constructing and maintaining cycle tracks so they could not be included in the modelling. However costs are likely to be similar to those for footways.

Cyclists usually prefer smooth, flexible surfaces. Cycle tracks may require additional maintenance operations included in the calculations such as hedge and tree cutting, removing glass, unblocking gullies and clearing debris and spillages etc. This can be included in the WLC if typical timing and cost information is available.

Accident data were not available for cycle tracks.

6 Whole life value considerations

The location of the footway will influence the surface material used. In rural areas it has been found that asphalt footways have the lowest WLC. The cost of construction is the dominating factor as maintenance is usually infrequent. In urban areas footways are more heavily used and are also more likely to be subjected to vehicle overrun and utility reinstatements. Maintenance is more frequent so slabs are similar in WLC to flexible footways. However, slabs are more prone to cause trips, so the accident costs may be higher.

In addition to WLC, other factors also influence the choice of material. The aesthetics are especially important in urban settings and aesthetically pleasing footways can be used to encourage business and regeneration. Public opinion, ease of maintenance and cleaning and environmental issues can also influence the material choice. The whole life value of the footways would take these factors into account.

To get best whole life value, those factors which cannot be costed directly need to be given a weighting which enables dissimilar parameters to be compared. In a historical town centre a footway which fits in with the environment may be more important than the cost – it may be considered that the footway is an integral part of the town centre environment and a pleasant environment will bring in tourists, increase spending in town centre shops etc. If aesthetics are given a high weighting then the footway materials may be chosen for their aesthetic appeal rather than purely for their cost. Careful consideration is required of all relevant factors, if whole life value is to be compared. This is beyond the scope of this report.

7 Conclusions

- Whole life costing is recognised as an important tool for making decisions on footway construction and maintenance.
- Opinions vary as to which surfacing materials are best in WLC terms.
- An asset management system which integrates footway maintenance with associated roads maintenance may significantly reduce overall costs.
- Whole life costing can only be fully implemented if sufficient funding is available at the time of initial construction.
- Claims are a significant cost and ideally should be taken into account in calculating whole life costs
- In different situations wider benefits (such as area regeneration and sustainability) may have significant overall economic implications.
- Public opinion is important to many authorities and may override cost considerations.
- Whole life cost information of new materials is unlikely to be available.
- Whole life cost calculations are hugely influenced by construction costs, as future costs are discounted to net present value.
- Costs of construction and maintenance are significantly different in different authorities.
- Further information is required on cycle tracks in order to calculate WLCs.

8 Recommendations

In order to advance the knowledge on footway and cycle track construction and maintenance costs it would be useful if local authorities could keep records of costs, maintenance and accidents. This information could be collated into a regional database and a model constructed for each region.

Footway materials are often chosen for reasons other than cost, but comparisons of the WLC of different materials using data from their region could aid in local authority decisions. A whole life cost model would ideally take into account the cost to an authority of claims.

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10 References

Allen D and Ballantyne C (2003). *The Walk of Life.* Surveyor Magazine, 10 October 2003.

Atkinson K (1997). *Highway Maintenance Handbook*. Thomas Telford, London.

Baker B (2002). *Town Jewels.* Surveyor Magazine, 14 February 2002.

Bath and Northeast Somerset Council (2004). *Transportation Web Pages: Techniques for Kerb and Footway Maintenance and Cycleways.* Bath and Northeast Somerset Council.

Bird S (2003). *Making Tracks.* Surveyor Magazine, 24 April 2003.

Bird S and Sowerby C (2005). *Development of a Risk Analysis Model for Footways and Cycle Tracks, TRL Unpublished Report, July 2005*

BS ISO 15686-1 (2000) *Buildings and constructed assets. Service life planning. General principles*. British Standards Institution.

Bushell M (2001). *Easy on the Eye.* Surveyor Magazine, 14 June 2001.

Cornwall County Council (2002). *Cornwall Local Transport Plan Annual Progress Report 2002.* Cornwall County Council.

CRISP – *About whole life cost*s. Construction Research and Innovation Strategy Panel: www.wlcf.org.uk/AboutWholeLifeCosts.htm

Dale S J (1993). *Introduction to lifecycle costing*. Life cycle costing for construction, edited by J W Bull. Chapman & Hall.

Department of Trade and Industry (2005). *Achieving whole life value in infrastructure and buildings.* 2005. Her Majesty's Stationary Office, London.

Department for Transport (2004). *National Road Maintenance Condition Survey: 2003*. Her Majesty's Stationary Office, London.

Devon County Council (2003). *Devon County Council Local Transport Plan Annual Progress Report 2003.* Devon County Council.

Dixon D (2003). *One for the Road.* Surveyor Magazine, 20 November 2003.

Eastbourne Borough Council (2003). *Highways Frequently Asked Questions Web Pages.* Eastbourne Borough Council.

Harris J (2002). *Walking on Water.* Surveyor Magazine, 21 February 2002.

Harrison P (2002). *A Stone's Step.* Surveyor Magazine, 14 February 2002.

Herefordshire County Council (2001). *Herefordshire County Council Local Transport Plan.* Herefordshire County Council.

HM Treasury (2003). *The Green Book***.** http://greenbook.treasury.gov.uk/index.htm

Holyoak J (2001). *Walk Through Experience.* Surveyor Magazine, 11 October 2001.

Howard J (2002). *Walking Back.* Surveyor Magazine, 14 February 2002.

Living Streets. Info@livingstreets.org.uk

Noble J (2002). *Taking Stock.* Surveyor Magazine, 28 March 2002.

Noble J (2001). *Playing Safe.* Surveyor Magazine, 22 March 2001.

Northern Ireland Road Service (2006). *What we do*, http://www.roadsni.gov.uk/about/remit.htm

Office of the Deputy Prime Minister (2001). *PPG25: Development and Flood Risk.* Her Majesty's Stationary Office, London.

Pearson D (1990). *Flags Beat Blacktop in Whole Life Costing of Footway Construction.* Highways Magazine, Volume 58, May 1990.

PPG25 (2003). *Development and flood risk* Planning policy guidance 25. http://www.planningportal.gov.uk/england/professionals/en/1021020428593.html

Reid M (2001). *Get Better Soon.* Surveyor Magazine, 6 September 2001.

Scott P and Basford L (2001). *Best Foot Forward.* Surveyor Magazine, 14 June 2001.

Smith R (2003). *Herts in the Right Place.* Surveyor Magazine, 27 November 2003.

Surveyor (2003a). *Surface Tension.* Surveyor Magazine, 23 October 2003.

Surveyor (2003b). *Fully Grounded.* Surveyor Magazine, 27 February 2003.

Surveyor (2002). *Papering the Cracks.* Surveyor Magazine, 28 March 2002.

Surveyor (2000). *Pedestrian Progress.* Highways Magazine, July 2000.

Tameside County Council (2002). *Post Scrutiny – Executive Response in Respect of the Council's Highway Maintenance Policies.* Tameside County Council.

The House of Commons Transport Committee (2003a). *Local Roads and Pathways: Fifth Report of Session 2002-03, Volume I, HC407-I.* The Stationary Office Limited, London.

The House of Commons Transport Committee (2003b). *Local Roads and Pathways: Fifth Report of Session 2002-03, Written Evidence, HC407-II.* The Stationary Office Limited, London.

Totton B (2003). *From the Ground Up.* Surveyor Magazine, 13 February 2003.

Totton B (2001). *Welcome Home.* Surveyor Magazine, 8 November 2001.

TfL (2004). *Walking plan for London*

Treasury (2003). *The Green Book, http://greenbook.treasury.gov.uk/index.htm.*

TRL Limited (2003). *Application Guide AG26 (Version 2): Footway and Cycle Route Design,* Construction and Maintenance Guide. TRL, Crowthorne.

Walter M (2002). *Glass-paved Streets.* Surveyor Magazine, 28 March 2002.

Warwickshire County Council (2004). *Highway Maintenance Policy – A Public Guide.* Warwickshire County Council.

Appendix A. Questionnaire

Request for Information on the Whole Life Costs of footways and cycle tracks

We have put together the table below, as a method of comparing the whole life costs of footways surfaced with flexible surfacing and with block paving. We have some confidence in the costs, but are very uncertain of the maintenance regimes.

WLC comparison between flexible footways and pavers

Description of expenditure	Cost £/m^2	Year	Net Present Cost £/m^2
Flexible			
New construction	21.0	0	21.00
5% surface patch	0.2	5	0.17
10% surface patch	0.4	10	0.28
5% surface patch	0.2	15	0.12
Surface dressing	2.0	20	1.01
5% surface patch	0.2	25	0.08
10% surface patch	0.4	30	0.14
5% surface patch	0.4	35	0.12
Reconstruct (flexible)	10.0	40	2.53
TOTAL (Whole Life Cost)			**25.4**
Pavers			
New construction	29.0	0	29.00
Lift and relay 5%	1.0	5	0.84
Lift and relay 5%	1.0	10	0.71
Lift and relay 5%	1.0	15	0.60
Lift and relay 5%	1.0	20	0.50
Lift and relay 5%	1.0	25	0.42
Lift and relay 5%	1.0	30	0.36
Lift and relay 5%	1.0	35	0.30
Lift and relay 5%	1.0	40	0.25
TOTAL (Whole Life Cost)			**33.0**

Ideally we would like to be able to complete tables like those above for other forms of constructions – footways surfaced with paving slabs, stone setts, small pavers etc. and also to have information on the cost of kerbs and other associated works. We would also like to consider footways in the various footway categories – from busy town centre to rural footways.

Any information that you can provide would be very useful – and would naturally be kept confidential. If you could possibly help by providing us with the following we would be very grateful.

1. Unit costs of construction for flexible, flagged, small modular footways (including labour).
2. Unit costs of maintenance, including removing old surfacing
3. Time to reconstruction (i.e. total replacement of surfacing)
4. Normal maintenance regime – including planned and safety maintenance.

Appendix B. Observations on maintenance regimes

B.1 Authority 1

Our experience is that vehicle overrun and utilities are major causes of footway deterioration and greatly influence maintenance programmes. It is therefore difficult to prepare appropriate maintenance regimes and they can only be typical guidelines. Your 'guesswork' is reasonable.

Over the past 2 years our patching and minor repairs to footways has averaged 0.52% of total footway area. It would be difficult to subdivide this work into the different categories of footway types. Though we have benefited from increased structural maintenance funding over the past 2 years the level is still well below that required for good practice and a substantial maintenance backlog still exists. Works are undertaken on a priority basis. Your suggestion of 5% surface patch over 5 years (1% per year) is therefore considered to be reasonable.

We consider that surface dressing is not an appropriate treatment on flexible footways and should be changed or omitted. A change to 10% patch is suggested. The life of 40 years is reasonable and indeed reflects our current renewal programme. In the past 2 years our programme of reconstruction/resurfacing of footways has represented 2.2% of the total footway area (45 years).

B.2 Authority 2

From our records I have calculated that flexible footways 0-5 years after adoption are treated with patches of less than 1% of their area throughout that 5 years. Similarly 5 - 10 years old are patched less that 1% of their area.

I would have to spend a considerable time studying footways between 10 and 25 years so I have not in case this information is of no use to you, but I can let you know that footways between 25 and 30 years old can be patched with around 3% of their area over that 5 years.

We tend to surface dress at around 30 years and I would then expect the patching to revert to <1% for the next 5 years.

Our maintenance regime is to inspect a minimum of every 6 months and address defects of >20mm.

We would like to reconstruct at around 40 - 50 years but budgets do not allow this. We tend to carry on patching or even re-slurry when patching can no longer be carried out. At present we are able to reconstruct less than 0.25% of our footways annually.

B.3 Authority 3

Time to reconstruction varies dependent on a number of factors, construction type, weather, usage, utility excavations, etc.

All footways are inspected on a regular basis (See Code of Practice for Maintenance Management) and temporary action taken as safety dictates. Longer term more major resurfacing etc. schemes are undertaken on the basis of condition, i.e. worst first authority wide taking into account safety and usage as budget allows. A rating system is used.

Most of our cycle ways are fairly new.

We have used slurry dressing but this is not liked by the public.

Sequence of work is patch and mend then full reconstruction

We do ‘worst first’, preferring schemes where we are able to do a package of lighting, raising kerbs and carriageway together.

Some footways last 20 years, some 10 years.

Mainly use HRA, as it is better in colder conditions.

Use modular construction in conservation areas, but is 20% more expensive, and there are tripping hazards.

B.4 Authority 4

Have used slurry seal at £2 per sq m, but overlay at a cost of £35 to £40 per sq m gives a 25 year life

Paving slabs are susceptible to lorry overrun.

Must now consider costs for disposal.

B.5 Authority 5

Slurry seal is used to arrest deterioration, and reconstruction where deterioration has progressed too far.

B.6 Authority 6

Do not have the funds for planned maintenance.

B.7 Authority 7

Whole Life

Estimating the life of footway in this authority is again difficult and would depend on a number of factors below

- Substrate – a clay substrate can cause a number of premature failures especially after extreme or seasonal weather.
- Utility works – certainly in urban areas, despite the utilities best efforts, once a hole is made in a footway structure this will accelerate the footway deterioration. Poor reinstatements only make maters worst. Once the footway takes on the appearance of a patch work quilt it can generate complaints, even if it does not have any serious structural defects.
- Overrun – particularly in urban and residential areas were there is a lack of parking.
- Roots and overgrowth – a common problem in rural or independent footways. Trees in town/urban area can be a particular problem

If any footway is not subject to the above then there is a good chance it will have a long and relatively trouble free life.

Maintenance regime

Safety and detailed inspections are very much in line with the current Code of Practice and other authorities. Concerns have been expressed that the majority of safety inspections are driven and it would be impossible pick up all footway defects. Due to the size of the footway network in this authority walked safety inspections would not be possible with current resources.

Footway reconstruction is prioritised on an ‘as needed’ basis. Factors taken into account would include the level of defects present and the importance of the section to the network.

Where possible, flags or block paving will be replaced by macadam, but this depends on planners etc.

B.8 Authority 8

Our maintenance regime is based on our inspection regime which is in accordance with the Welsh Assembly's Trunk Road Maintenance Manual. Primary walking routes are inspected monthly, with Category 1 defects addressed within 24 hours and Category 2 defects included in relevant planned programmes of works.

Flexible footways require very little attention in the first 5 years, and probably only say 1% of their area within 5 – 10 years. Unfortunately no accurate records are available for years 10 onwards. We would expect to apply slurry seal (or similar) within 15 - 20 years in urban areas and surface dressing in rural areas, and expect to consider reconstruction at around 25 – 30 years.

B.9 Authority 9

When resurfacing footways, medium-texture bitumen macadam is generally used for the surface course (the authority's policy to replace slabbed footways with macadam construction on schemes outside the city centre continues).

If resurfacing is carried out before structural failure occurs, the new surface course would normally be expected to last 10 to 12 years; a reconstruction should give 25 to 30 years life.

The most cost-effective policy would be to resurface every ten years. The relatively short period of disruption to traffic (both vehicular and pedestrian) when resurfacing is much more palatable to our customers than weeks or even months of aggravation when a major scheme becomes necessary. This policy would cost approximately £50m for footways and £105m for carriageways (at current prices) over 10 years. It should also be pointed out at this stage that this approach should vastly reduce the burden on patching budgets (£1.2m last year) and third-party claims.

B.10 Authority 10

It is now our policy with recently adopted paths to carry out preventative maintenance i.e. surface dressing after 5 years

Patching is normally carried out after 7 - 10 years

Present funding restrictions are putting added pressure on footpath maintenance in general.

B.11 Authority 11

Our footways budget is fairly small in comparison to our overall roads budget.

The extent and low traffic volumes on our footways mean that we do not have a major replacement commitment.

In the absence of utility interference, we would be expecting at least 25 – 30 years from any new or replaced sections

We therefore have very little information on year on year repair costs, other than the flexible patching and slurry seal rates.

I would be inclined to agree generally with the example you forwarded last month, 1 - 2% maximum post treatment values during first 20 years.

The dispersed nature of some of out main towns and scarcity of local quarries leads to fairly expensive unit rates.