

ESTIMATING THE HEALTH BENEFITS OF CYCLING

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Abstract

This paper examines the health and economic benefits from the construction of a new segregated cycle way in Ireland. The health economic benefits were estimated using the World Health Organisation's (WHO) Health Economic Assessment Tool (HEAT). This tool can be used to calculate the health economic benefits from an intervention (construction of a new cycling facility). The data used for this tool was retrieved from the survey that was undertaken in the study area in 2012 and 2013. In total there were 845 responses to this survey. The results of the paper show that the construction of the proposed cycle way would yield significant health and economic benefits if constructed.

INTRODUCTION AND BACKGROUND

Internationally many countries and cities are reporting increases in cycling. Cycling has many benefits, which have been well documented including reducing emissions and congestion, and the health benefits from cycling. This paper seeks to examine the impacts of the health benefits of new cycling infrastructure using a case study of a cycle way, which is being planned in Ireland.

To quantify the economic benefits of the new cycling infrastructure being proposed the WHO HEAT tool was used. The HEAT tool was developed by the WHO in 2011 (1). This tool was specifically developed to measure the health benefits of cycling and to place an economic value on these benefits (1). The purpose of this tool is to create an economic assessment of cycling infrastructure and policies. This tool can be used to examine both existing infrastructure and policies, and analyse the potential benefits of proposed infrastructure and policies.

In many cases, the financial benefits derived from increased cycling from a new policy or new piece of cycling infrastructure may not have direct tangible financial benefits. The calculation of the return on a potential investment from increased health can be a very difficult issue to assess, however HEAT provides a methodology to measure these economic impacts. Increasing the health of a population as a whole usually leads to several marked improvements in many areas. For instance, if the working population is healthier, then there are less sick days taken annually and therefore the population becomes more productive (1). Another aspect is a reduced mortality rate. By reducing the mortality rate, more people are living (longer) and working longer. This healthier population also results in a decrease in the cost of running the health services, as there will be less demand from a healthier population (1). The HEAT tool factors these benefits into the financial analysis of an investment in infrastructure or policy.

It is well documented at both government and academic levels that cycling has a very positive impact on both personal and public health. Many of these studies conclude that any form of increase in the cycling mode share for commuting and for other purposes would result in a corresponding improvement in the health of an individual who cycles. This also results in an increase of the health of a country as a whole where there is a reduction in mortality rate of the population who cycle. From the World Health Organisation (1), it is known that physical inactivity in the world is one of the leading causes of ill health. The

promotion of active travel behaviour is a “Win-Win” approach as it not only increases everyday activity of individuals, it also has a positive impact on the environment.

Cavill et al (2) found that physical activity was a fundamental way of improving mental and physical health of individuals; however there are many where daily physical activity is not present with very negative consequences on their health. The authors also demonstrate how increased physical activity leads to a reduction in the cardiovascular Disease, Stroke, Cancer, and Type II Diabetes. Increased activity also leads to a reduction in anxiety and depression. Rojas-Rueda et al (3) and de Hartog et al (4) both found that the gains in health from increased activity from a higher level of cycling far outweigh the potential negatives from the increased risk from a traffic accident and the increased exposure to pollution.

Anderson et al (5) documented 13,375 women and 17,265 men over a 14 and a half-year period. Over this period 2,881 women and 5,668 men died. This research found that those who cycle to and from their places of work and education had 40% reduction in their mortality rate. This reduction in mortality rate was the same for both men and women, with no statistically significant difference between the genders. Mindell et al (6) looked at how various different transport modes affect human health in an urban environment. It was found that the benefits of transport (access to work, leisure, education, social contacts) were most experienced by the healthy and the affluent. The harmful effects (air pollution, community severance, injuries) of transport are mostly experienced by the poor, young and old in society. It surmised that a modal shift away from cars in favour of walking and cycling would reduce the harmful aspects of transport and improve the health of individuals in society and would also improve the environment and society.

Hendrikson et al (7) investigated the levels of absenteeism amongst cyclists and non-cyclists. It was discovered that those that cycled to and from their places of work had one day less of absenteeism than those that did not cycle. The authors believe that this reduction is due mainly to the better health of those that cycle and results in a financial gain for an employer. Unwin (8) found that there was a very large potential for improvement in the health of the Britain just from increased levels of cycling. It was found in a study of male civil servants that regular cyclists (those who cycled for at least an hour every week) had less than half the coronary attack rates than non-cyclists. It is known from the Nichols et al (9) that Heart Disease in Britain cost the country £9 Billion. Therefore, it can be deduced that there could be a potentially large reduction in the cost to the British economy from any marked uptake in cycling.

The results presented in this paper examine the potential health economic benefits from the construction of a new cycle way in Ireland. Currently in the field of economic analysis of investment in cycling infrastructure the industry is seeking to demonstrate to policymakers and the general public of the benefits of cycling. The findings of the paper add to the research on estimating the benefits of investment of cycling infrastructure and to show how including health benefits can demonstrate the positive economic benefits of investing in cycling infrastructure.

RESEARCH METHODOLOGY

This section of the paper details the steps used to conduct the HEAT analysis. Specific information regarding cycling in the area needs to be gathered before the HEAT analysis can commence. The basic process and formulas upon which HEAT is as follows:

Step 1. Volume of Cycling Per Person:

- This step requires information on duration, distance, and frequency of cycling trips.

Step 2. Protective Benefit:

- This step looks to calculate the present reduction in mortality rate from those cycling. The reduction in mortality rate as a result of cycling is calculated using Equation 7.1.
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$$\text{Reduction in Mortality} = 1 - (\text{Relative Risk})^{\frac{\text{Volume of Cycling}}{\text{Reference Volume of Cycling}}} \quad \text{Eq (7.1)}$$

Step 3. Population that Stands to Benefit:

- This step repeats Step 1 and Step 2, except adjusted for the predicted levels of the population that stands to benefit from an intervention.

Step 4. General Parameters:

- This step requires information on the intervention such as the buildup period, the present mortality rate in the country, and over what time frame the benefits are to be measured.

Step 5. Estimate of Economic Savings:

- This step combines the results of the previous steps and outputs the estimated benefits from an intervention. These benefits include:
 - i. A benefit cost ratio based on the input costs of the intervention
 - ii. Reduction in mortality rate
 - iii. The value of a reduction in mortality rate
 - iv. Total value of all benefits from the intervention

The HEAT tool uses estimates of the relative risk of death from any cause among regular cyclists, compared to people who do not cycle regularly. It is based on relative risk data from studies from around the world. The relative risks are applied to the amount of cycling entered by the analyst and a log-linear relationship is assumed between cycling and mortality. In order to prevent inflated values and to keep the analysis accurate, the risk reduction is capped at approximately 50%. The tool uses the mortality rate to calculate the number of people who would normally be expected to die in any given year in the study population. Succeeding this, the reduction in expected deaths in the study population that cycle is calculated from the adjusted relative risk. The tool produces an estimate of economic savings from this calculated reduction in deaths.

Cycle way examined

The HEAT analysis conducted in this study was applied to the area surrounding the proposed cycle route. The cycle route that is planned is along a disused towpath of a canal. The cycle route will be fully separated from any vehicular traffic. The proposed route is approximately 60km long and varies greatly in condition. Some sections of the route are presently used as local roads whereas other sections are overgrown and have become flooded by the canal.

A map indicating outlining the study area can be seen in Figure 1. The specific course of the cycle route is displayed in blue. A buffer zone of 5km was placed around the preferred route. The edges of this zone are displayed in red. This zone encompasses most of the major settlements in the area. The population densities of each electoral district in the area can also be seen. Each green dot represents two people. As expected, the population density increases with proximity to Dublin City. It can be observed how there are many settlements along the preferred route that have high densities relative to the surrounding countryside. The road infrastructure is shown in yellow on the map.

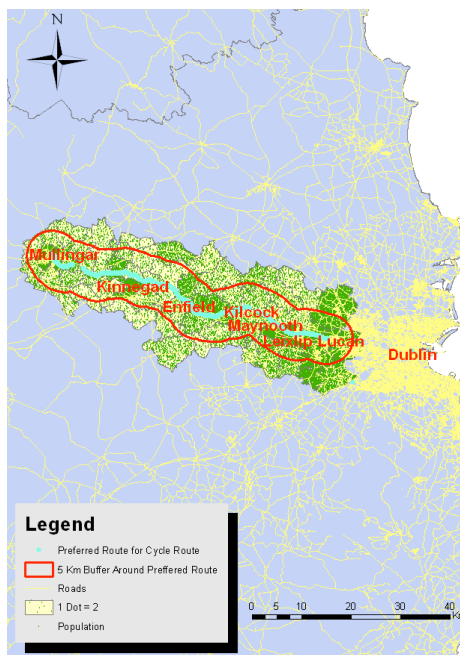


FIGURE 1 Indicative Map of Preferred Route with Buffer Zone, Population Density, and Roads

Applying HEAT

This section looks at the process that was used to determine the health economic benefits of an intervention. The information required, how it was attained and the analysis performed on the information is outlined. As seen in the steps outlined previously before the HEAT analysis could be performed, specific information regarding cycling in the study area needed to be gathered. A survey was distributed in December of 2012 amongst the National University of Ireland, Maynooth, Intel Ireland and Hewlett Packard offices in Leixlip and to the local Business Association. These institutions and groups were located within 1km of a proposed high quality cycle route. Extensive analysis was also conducted into the 2011 census statistics of the electoral districts located within the buffer zone of 5km.

The design and layout of the HEAT tool was studied and the logic behind the process was mapped. For the present day evaluation of cycling benefits, information was required on the number of trips per day, per person, and the number of days on average a person cycles. The average distance of these trips, and the number of people undertaking these trips also needed to be identified. From this, a baseline was established, from which, the benefits of an intervention (new cycling infrastructure) could be determined. Following from the establishment of a baseline, information on the potential and predicted usage from an intervention is necessary. The information required is the same as the pre-intervention data, except that this data is what is predicted and therefore determines the potential benefits.

In Figure 2, the questions used to extract the necessary information can be seen. The questions posed were in relation to the regularity of present day cycling of the cycling, and commute distance and time. The respondents were presented with "What if" questions in relation to the creation of a high quality cycling facility along the proposed cycle route.

Section 1 - General Questions

* Do you presently cycle to and from NUIM?

- Yes
 No

How far from NUIM do you live?

- Less than 3km
 Between 3km and 5km
 Between 6km and 10km
 Between 11km and 20km
 Over 20km
 Work from home

Other (please specify)

What is your travel time to NUIM?

- Less than 5 minutes
 Between 6 minutes and 10 minutes
 Between 11 minutes and 20 minutes
 Between 21 minutes and 40 minutes
 Over 40 minutes
 Work from home

Other (please specify)

If a High Quality Cycling Facility Existed in your Area

Segregated from Traffic, High Quality Cycling Facility:



* If a high quality Greenway/cycle path like the one pictured above was constructed along the Royal Canal Towpath with direct access to NUIM, would you use this facility?
(The facility would be fully seperated from vehicular traffic)

	Yes	No
To access NUIM?	<input type="radio"/>	<input type="radio"/>
For recreational/shopping purposes?	<input type="radio"/>	<input type="radio"/>

* And how often would you use the facility for commuting to and from your place of work or education?

- Almost every day
 1-2 times a week
 1-2 times a month
 1-2 times a year
 Never

FIGURE 2 Screenshot of Questions Pertaining to the HEAT Analysis

Data Gathered

There were in total 845 valid responses to the survey. In Table 1, a selection of the responses from the survey undertaken in 2012 and 2013 can be viewed. It can be seen that 27% of the respondents cycled to and from their place of work and education. Presently at a national level in Ireland, the percentage of people cycling to and from their place of work and education is 2.2 % (10). In Dublin, the percentage of people commuting to and from their place of education and work is 5%. Therefore, it can be seen how there is a bias in the sample of people surveyed. However, the section containing the means of travel of those who do not cycle to and from work provides a reasonably good representation of the country with the percentages matching approximately with the national figures. The numbers and

percentages of those that said they would use a cycle route constructed along the Royal Canal towpath are shown in Table 1. It can be seen that 56% said that they would use the cycle route to commute from their place of work/education and 29% said they wouldn't.

TABLE 1 Selection of Information Gathered from the Survey

Information from Survey	Numbers	Percentage
People who cycle to and from their place of work/education	229	27
People who do not cycle to and from their place of work/education	616	73
Total	845	100
People who do not cycle to and from their place of work/education, what were their means of travel		
Motor Vehicle (Driver)	214	35
Motor Vehicle (Passenger)	29	5
Walk	128	21
Bus	77	12
Train	63	10
Missing (Excluding Cyclists)	105	17
Total	616	100
If a high quality cycling facility was constructed along the Royal Canal Towpath, would you use the facility to commute to and from your place of work/education		
Yes	472	56
No	199	24
Missing	174	21
Total	845	100

The personal information of the respondents and the demographic information from the census data from the study area and the national census statistics can be viewed in Table 2. The census statistics were gathered from the POWSCAR dataset which is produced by the Central Statistics Office in Ireland (10). The census statistics from the study area in Table 2 compares favorably to the national census statistics in terms of providing a representation of the country. It can then be seen that many of the categories from the survey are comparable to the census statistics from the local study area and the national census statistics.

TABLE 2 Data from the survey, Census Statistics from the Study Area, and the National Census Statistics

Demographics from Survey			Census Statistics From Study Area			Census Statistics for the Entire Country		
Gender	Number	%	Gender	Number	%	Gender	Number	%
Male	304	36	Male	73,616	52	Male	144,6963	52
Female	327	39	Female	68,161	48	Female	133,6973	48
Missing	214	25	Missing	0	0	Missing	0	0
Total	845	100	Total	141,777	100	Total	278,3936	100
Education								
Primary, Secondary	253	30	Primary, Secondary	43,372	31	Primary, Secondary	822,363	30
Third Level	374	44	Third Level	8,581	6	Third Level	190,929	7
Missing	218	26	Missing	89,824	63	Missing	1,770,644	63
Total	845	100	Total	141,777	100	Total	2,783,936	100
Age								
15-24	214	25	15-24	6,524	5	15-24	126,592	5
25-34	256	30	25-34	28,523	20	25-34	518,514	19
35-44	111	13	35-44	26,596	18	35-44	475,689	17
45-54	122	15	45-54	17,918	13	45-54	383,247	14
55-64	93	11	55-64	8,986	6	55-64	222,100	8
65+	35	4	65+	1,276	1	65+	44,502	2
Missing	15	2	Missing	51,954	37	Missing	101,3292	35
Total	845	100	Total	141,777	100	Total	2,783,936	100
Marital Status								
Single	430	51	Single	31,880	22	Single	680,216	25
Married	193	23	Married	57,943	41	Married	1,090,428	39
Missing	222	26	Missing	51,954	37	Missing	1,013,292	36
Total	845	100	Total	141,777	100	Total	2,783,936	100
Means of Travel – Commute								
Drive	312	37	Drive	66,163	47	Drive	1,255,699	46
Drive (Passenger)	32	4	Drive (Passenger)	23,297	17	Drive (Passenger)	508,338	18
Walk	129	15	Walk	21,481	15	Walk	414,938	15
Cycle	228	27	Cycle	2,443	2	Cycle	61,177	2
Bus	77	9	Bus	15,841	11	Bus	288,562	10
Rail	64	8	Rail	5,181	4	Rail	70,976	3
Other	0	0	Other	4,065	4	Other	104,853	3
Missing	3	0	Missing	3,206	3	Missing	79,393	3
Total	845	100	Total	141,777	100	Total	2,783,936	100

HEAT EVALUTION

The HEAT analysis undertaken in this study looks solely at commute trips. As the census statistics do not gather information on non-utility related trips, it would be inaccurate to

formulate HEAT estimation for non-utility trips. Therefore, this section looks solely at work and education related trips. As commuting trips represent typically only 25% of trips in Ireland, the benefits estimated in this section are likely to underestimate the true economic benefits of introducing the new cycling facility (11).

Presently, it can be seen from Table 3 that the population of the area surrounding the preferred cycle route is 141,777 people. Of those, there are 2,443 people who cycle for commuting to and from their place of work and education. This represents a work/education travel modal share of 1.72%, compared to the national average of 2.2%. When the results from the survey are compared to the census statistics, it can be observed how the rate of cycling is overstated in the survey. This is most likely due to people who cycle having an interest in participating in a survey on cycling whereas people who do not cycle might not have an interest in partaking in the survey. It can be seen in Table 3 that cycling is overstated in the survey by a factor of approximately 15. If the results from the survey were extrapolated to the population within the catchment zone, one would infer that there are 38,422 people cycling to and from work and education, whereas the census results state that there are 2,443 people cycling to and from their place of work and education. This overstates the actual numbers that cycle by a factor of over 15. This overstatement may also be as a result of the potential understatement of the cycle rate in the local area from the POWSCAR dataset due to restrictive nature of the commute section of the results. The results from the survey indicate that approximately 50% of respondents who presently do not cycle, but would cycle to and from their place of work and education, if a cycling facility was constructed as proposed. If this figure was used in the HEAT analysis, it would suggest that of the 103,335 people that fall into this category within the catchment area, 51,845 people would start cycling to and from work. This would represent an approximate 2,000% increase in people cycling. This type of increase in modal shift is very unlikely, in the author's opinion, and the results of any analysis conducted based upon this assumption would be unreasonable and inaccurate.

TABLE 3 Census Statistics from the Electoral Districts that Lie Within the 5km Buffer Zone around the Preferred Route and the survey results Combined

Census Statistics and the Survey Combined	
Population in 5km buffer	141,777
People who Cycle to and from work (Numbers)	2,443
People who Cycle to and from work (Percentage of Populations)	1.72%
Extrapolating Results from the Survey to Population in Study Area	
Estimated Population who Cycle to Work	38,422.41
Actual Population who Cycle to Work	2,443
Extrapolating the Number of People who said they would Cycle to the Population	51,845
Survey Predicts People Cycling will increase	2,122%

It was therefore decided to complete a modal shift analysis on the surrounding population. Farrell et al (12) completed a modal shift study on a rural town. The authors of this paper sought to evaluate the potential environmental benefits of a modal shift of certain percentages from those commuting by unsustainable modes to sustainable modes. The authors used modal shifts in the population of 5% and 10%. It was determined that similar percentages would also be appropriate for the analysis of the population in the study area, given the unrealistic changes in cycling number suggested previously. Table 4 displays the present population and the present cycling percentage rate and the number of people cycling. Table 4 then displays the numbers if this cycling rate were to increase to 2.5%, 5% and 10%. It can be seen that if the cycling rate were to go from 1.72% to 2.5%, the number of people cycling would increase from 2,443 to 3,544, and if the cycling rate increased to 10%, the numbers cycling would be 14,178.

TABLE 4 Population and Cycling Rates

Cycling Rate	Percentage	Numbers
Presently Cycling in Study Area at 1.72%	2	2,443
If the cycle rate was to increase to 2.5%	3	3,544
If the cycle rate was to increase to 5%	5	7,089
If the cycle rate was to increase to 10%	10	14,178

Another important factor for the HEAT analysis is travel distance and the days travelled. Presently in Ireland, the Central Statistics Office does not compile information on travel distance. For the HEAT analysis, the average distance commuted by cyclists in the survey was used. The number of days per year cycled is also required for the HEAT analysis. This figure again is not in the Census statistics, and therefore the figure from the survey was used. The number of days that people cycle on average in a year by those sampled is displayed in Table 5. This is accompanied by the potential increase if the Greenway were constructed. It can be seen in Table 5 that if the Greenway were constructed, the number of days cycled could potentially increase from 48 days per year to 78 days per year. This represents an increase of 30 days or approximately 63% from present day figures. This was calculated by firstly establishing the average days commuted by those who presently commute by bicycle only. The average days that would be commuted by those that stated they would commute by bicycle was then calculated. This allowed the potential increase in days cycled to then be estimated. This was repeated for the average distance. The average distance commuted by those who presently cycle was calculated first by omitting the responses of the other modes. The responses of those who said they would cycle if the proposed cycling facility were built were then detached from the overall group. The average distance commuted by this group was then calculated. It can be seen that presently the average distance commuted by those presently cycling is approximately 8km. The average distance commuted by those who presently do not cycle but would if the proposed cycle infrastructure was built is approximately 12km. We can see in Table 5 that this represents a growth in the cycling commute distance of 4km or 50%.

TABLE 5 Days and Distances Presently Cycled and Predicted

Number of Days Cycled on Average Per Year	48 Days/year	
If the Greenway were built, Number of Days Cycled on Average Per Year	78 days/year	
Increase in Days Cycled on Average Per Year	30	63%
Average Distance Commuted by those who Cycle	8km	
Average Distance Commuted by those who Don't Cycle and Would Cycle	12km	
Increase in Distance Cycled on average per year	4km	50%

The information from Tables 4 and 5 were inputted into the HEAT tool. Presently, the population that cycles has reduced their risk of mortality by 16%. If the facility was built and the predicted increase in cycling was to occur, the reduction in the risk of mortality would be 35%. This represents an average decrease in mortality in the population who cycle of 18%. As shown in Table 6 that if the cycle route were constructed, the numbers commuting by bike and the distances commuted would increase substantially and lead to a major increase in health benefits for those presently not cycling. Depending on the modal shift, the increased numbers that would stand to benefit from this would vary from 1,101 for a modal share of 2.5% and up to 11,735 for a modal share of 10%. The results of the cycling summary can be viewed in Table 6.

TABLE 6 Cyclist Summary from HEAT

Summary of cycling data	2.5% Modal Shift	5% Modal Shift	10% Modal Shift
Pre-intervention cycling data			
Average number of cycling trips per person per year:	96	96	96
Average distance cycled per cycling trip (km):	8	8	8
Average distance cycled per person per year (km):	803	803	803
This level of cycling is likely to lead to a reduction in the risk of mortality of:	16%	16%	16%
Total number of individuals regularly doing this amount of cycling:	2,443	2,443	2,443
Post-intervention cycling data			
Average number of cycling trips per person per year:	156	156	156
Average distance cycled per cycling trip (km):	12	12	12
Average distance cycled per person per year (km):	1,933	1,933	1,933
This level of cycling is likely to lead to a reduction in the risk of mortality of:	34%	34%	34%
Total number of individuals regularly doing this amount of cycling:	3,544	7,089	14,178
Average amount of cycling per person per year increased between pre and post data.			
This change results in a decrease in the average mortality risk for your population of cyclists of:	18%	18%	18%
Number of individuals cycling increased between pre and post data.			
Additional individuals regularly cycling, compared to the baseline	1,101	4,646	11,735

The proposed cycle route is planned to be of a very high standard and therefore in order to prevent an overestimation of the benefits, a conservative figure of €200,000 per km was used for the estimation of the construction costs of the cycle route. This cost was based on the cost of another cycle way in Ireland (13 and 14). This would lead to a total construction cost of €12,000,000. This was the figure that was used for the estimation of the cost of intervention for the HEAT analysis and was used in the calculation of the benefit cost ratio. The statistical value of life used in the estimation was €1,574,000 which is the average statistical value of life in the European Union. This value is the suggested value from the WHO for the HEAT estimation.

From Table 7, the decreased mortality risks can be seen for the varying modal shifts. The number of deaths reduced per year from the decreased mortality rate varies between 3.39 and 17.93, depending on the modal shift. The HEAT model assumes that once the facility is constructed, that it would take two years for the uptake in cycling to expand and it would take five years before the benefits of this uptake would apply. Therefore, for an assessment over a ten year period, HEAT estimates that the benefits are between €37,080,000 and €196,163,000 over ten years or between €3,708,000 and €19,616,000 per year dependent on modal switch. HEAT estimates that the benefits are maximized in year 7 when the health benefits have fully accrued and the rate of cycling has been maximized. The HEAT model is able to calculate the maximum financial health benefits from year 7 on. After year 7, the annual financial health benefits are between €5,335,000 and €28,225,000, dependent on the modal switch. As this analysis is undertaken over a ten year period, it is important to take inflation into consideration. The WHO suggested a discounted rate of 5% per annum for HEAT estimation. Therefore, with the discounted rate applied to the benefits

over ten years, the benefits vary between €26,695,000 and €141,222,000 or on average between €2,669,000 and €14,122,000 per annum. Therefore, with an initial investment of €12,000,000, this represents benefit cost ratios of between 2.22:1 and 11.77:1. It is important to remember when viewing these results that HEAT does not calculate risk reductions for individual persons, but an average across the population under study. The results should not be misunderstood to represent individual risk reductions.

Table 7 HEAT Estimate

HEAT estimate	2.5% Shift	5% Shift	10% Shift
This change results in an decreased in the average mortality risk for your population of cyclists of:	18%	18%	18%
The number of individuals cycling has increased between your pre and post data.			
Additional individuals regularly cycling compared to the baseline.	1,101	4,646	11,735
Taking this into account, the number of deaths per year that are prevented by this change in cycling is:	3.39	8.19	17.93
Financial savings as a result of cycling			
The value of statistical life applied is:	€1,574,000	€1,574,000	€1,574,000
Based on a 5 year build up for benefits, a 2 year build up for uptake of cycling, and an assessment period of 10 years:			
Average annual benefit over 10 years is:	€3,708,000	€8,964,000	€19,616,000
Total benefits over 10 years are:	€37,080,000	€89,640,000	€196,163,000
The maximum annual benefit reached by this level of cycling, per year, is:	€5,335,000	€12,898,000	€28,225,000
This level of benefit is realised in year 7 when both health benefits and uptake of cycling have reached the maximum levels.			
When future benefits are discounted by 5 % per year:			
Current value of the average annual benefit, averaged across 10 years is:	€2,669,000	€6,453,000	€14,122,000
The current value of the total benefits accumulated over 10 years is:	€26,695,000	€64,534,000	€141,222,000
Benefit–Cost Ratio			
The total costs of:	€12,000,000	€12,000,000	€12,000,000
Total savings over 10 years of:	€26,695,000	€64,534,000	€141,222,000
Assuming 5 year build up of benefits, 2 years build up of uptake, discounting 5 % per year			
The benefit to cost ratio is therefore:	2.22:1	5.38:1	11.77:1

The HEAT analysis was also performed on the predicted group from the survey alone where approximately 50% was to switch commute travel mode. This predicted group led to a benefit cost ratio of over 45:1, and over 10 years, would produce approximately €500,000,000 in health benefits. From reviewing other economic appraisals of cycling facilities it is known that a figure of this level is extremely unusual and to utilize this figure in the appraisal of the route would be inaccurate.

CONCLUSIONS

The results presented in this paper show that if the cycle route was constructed along the canal towpath, the economic health benefits from present day non cycling commuters switching their travel mode for commuting to cycling, would reduce their mortality rate as a group by 18%. It was investigated how if the modal share of cycling was to increase from 1.72% to 2.5%, 5% and 10% would impact the health of the population in the study area. The increase in cycling rates would reduce the number of deaths per year by between 3.39 and 17.93, depending on the modal switch. Using the European Union's statistical value of life at €1,574,000, it can be inferred that over a 10 year period with a 2 year uptake of cycling and 5 years for the buildup of the health benefits, that the benefits accumulated over 10 years would be between €26,695,000 and €141,222,000, dependent on the modal switch. These benefits would result from an initial investment of €12,000,000. This would lead to benefit cost ratios of between 2.22:1 and 11.77:1, dependent on the mode switch. For a transport facility, the ratios are very favourable and indicate that this would be a very worthwhile infrastructure project for the area. More indepth analysis is presented in Deenihan and Caulfield (15).

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