

WEB SURVEYS AND CO₂ FOOTPRINTS

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1. INTRODUCTION

1.1. Travel Planning

At Colin Buchanan we regularly undertake surveys as part of in-depth travel plan assessments. Incorporating a “bolt-on” CO₂ footprinting tool into travel plan surveys could therefore tap into the environmental conscience of the respondents. It may also allow them to recognise their contribution to CO₂ emissions as a direct result of their travel behaviour.

Providing CO₂ footprint feedback would be time consuming and expensive with a paper-based survey as this would require the data to be entered into a database manually, processed and the results posted back to the respondents. This approach would also lack immediacy – the respondents may have forgotten about the survey by the time the results were posted back to them. A web based approach would therefore be desirable as feedback could be immediate and automated and presented in an interesting manner.

Colin Buchanan was recently commissioned by both the University of Edinburgh and the City of York Council to design, manage and analyse staff and student travel surveys. The use of web-based travel surveys to provide an estimate of the CO₂ footprint of the respondents' travel to work is a relatively new and novel approach to travel planning. This paper describes the how we went about implementing the surveys and also summarises the Co2 footprint survey results.

1.2. CO₂ Footprints

A “CO₂ footprint” is generally defined as a “measure of the impact human activities have on the environment in terms of the amount of green-house gases produced, measured in units of carbon dioxide”. Our CO₂ footprint is now an issue which is hard to ignore. Typing “carbon footprint travel” into Google currently yields 1.24 million results worldwide (or 200,000 UK wide). Newspapers print stories every day which concern our impact on the environment. A selection of recent newspaper headlines follows below:

- “Transport tickets should show carbon footprint, says report”, The Guardian, 5/3/08
- “Want to cut your carbon? Join our club”, The Observer, 24/2/08
- “Scotland’s bid to cut carbon emissions by 80% ‘bound to get harder’”, The Scotsman, 1/11/07

- “Britain must set example by cutting our carbon footprint”, The Times, 30/10/07
- “Change to make airlines responsible for their carbon footprint”, The Herald, 10/10/07
- “Tesco faces attack over carbon footprint”, The Observer, 9/9/07
- “Charles’s income rises as carbon footprint falls”, The Guardian, 27/6/07

Becoming more aware of, and subsequently lowering, our personal or corporate CO₂ footprint is obviously seen as desirable. Therefore at Colin Buchanan we thought about how we could incorporate some aspect of CO₂ footprinting into our travel planning work.

2. SURVEY DESIGN

Whilst paper-based surveys can be successfully carried out there are a number of important problems with them:

- Return rates can be low
- Significant expense in printing, distributing, returning and coding questionnaires
- No interactive validation of data leading to variable data quality in terms of accuracy and completeness
- Ability to offer feedback is limited and cannot be instant
- Limit to the amount of text which can be presented to explain purpose of questionnaire or provide help with individual questions
- Survey navigation requires respondents to read, interpret and carry out instructions correctly

For the University of Edinburgh the main transport priority since 2000 has been to reduce its environmental impact from travel through the adoption of an Integrated Transport Policy. Measures have been put in place to encourage a reduction in the proportion of staff and students travelling by car. In order to monitor the effects of these measures, the University has undertaken periodic travel surveys in 2000, 2004 and the survey reported on here in 2007.

The 2007 travel survey was designed to provide data which would complement previous data from the 2000 and 2004 surveys and, additionally, to estimate the University’s travel to work carbon footprint. In total there were approximately 8,000 staff and 18,000 students at the University at the time of the survey.

The City of York Council staff travel survey was implemented to ascertain the current travel patterns of staff when travelling to and from work and to determine the likely future travel patterns of staff travelling to the new council headquarters at a different location. The survey was designed to provide data with which to monitor the progression of the existing council Travel Plan and to ensure its appropriateness in delivering sustainable travel choice to the new location. The

City of York Council employed approximately 4,500 staff at the time of the survey.

Both surveys were conducted predominately online with a very small proportion of respondents, who did not have web access, completing paper based questionnaires (which, incidentally, can be entered online by support or third party staff).

Before each survey was activated there was a period of extensive consultation with the clients. This was to ensure that the surveys met the clients' expectations and to test the surveys for errors and a logical question progression. We generally also pilot surveys, particularly if new question types are being used. Unforeseen ambiguities in question design can, and do, occur and it is therefore important to expose the questions to the scrutiny of a pilot. The best laid plans...

The City of York Council survey comprised 17 questions several of which were split into different sections. The Edinburgh University student survey had 16 questions while the staff survey had 14 questions. Again some of these questions were split into sections. Each survey took respondents approximately 5-10 minutes to complete.

The basic structure of the surveys was as follows.

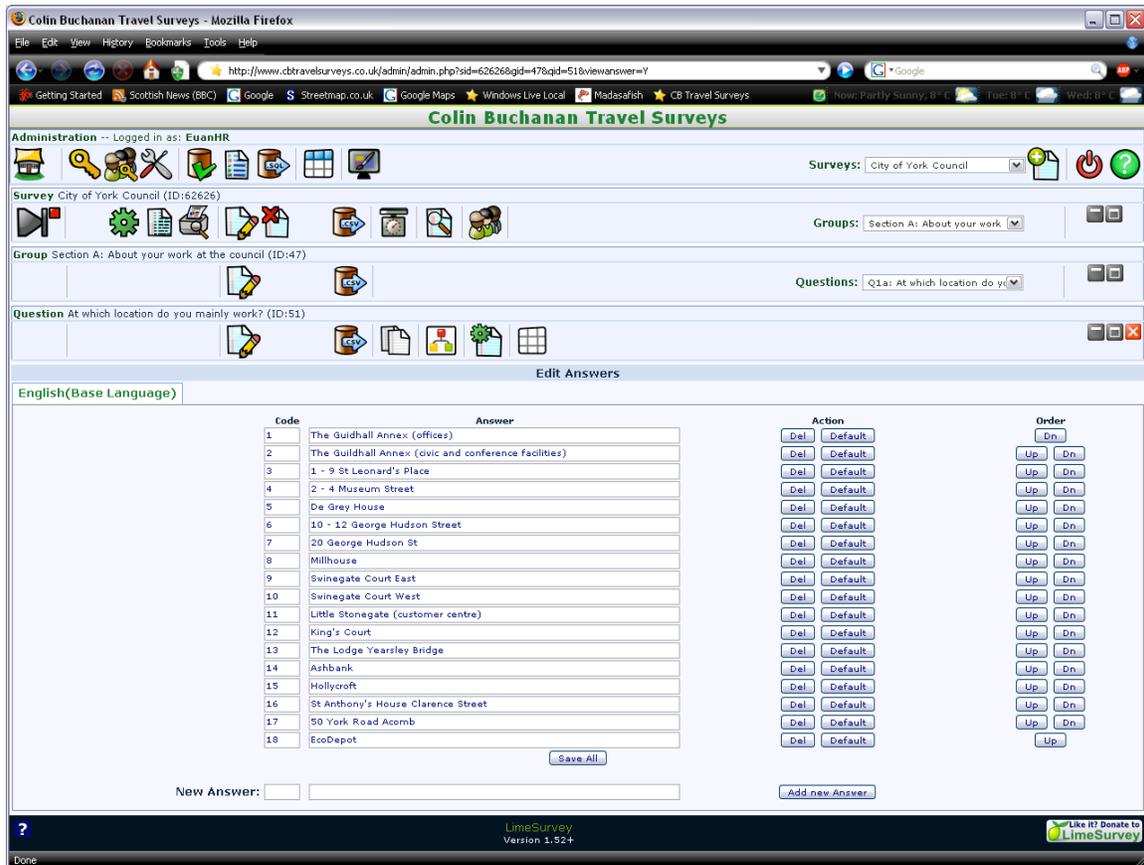
- Tell us about your work/study location and how often you are at that location
- How do you travel to your place of work / study and why do you use this mode of travel?
- Are there any other travel options for your journey?
- Are you aware of measures put into place to reduce reliance on car use?
- What is your home postcode and do you have any further comments?

This structure allowed us to collect all of the information required in a logical and straightforward fashion which is important to avoid too many spoiled responses.

3. WEB SURVEY SOFTWARE AND ADMINISTRATION

3.1. Limesurvey

The software we used to conduct our web-surveys was *Limesurvey* (www.limesurvey.org). This is an open source survey application which means that it is free to use and that the source code is available to be amended or augmented by anyone. The advantages of cost are immediately apparent but the real benefit of this software is its ease of use. A simple web survey can be set up in less than an hour while more complex surveys like those reported on in this report can also be created and activated very quickly.



Typical *Limesurvey* administration interface screen

3.2. Conditional Questions

The structure of a survey is important as it can help make completing the survey as quick as possible for individual respondents. It can also help to ensure that all answers are correctly completed. In our surveys we used conditional questions to ensure that respondents had to answer the fewest possible questions.

For example, when asking respondents when they arrived at and left from work we used the following series of questions:

- “Which days of the week do you normally work?” [Check days that apply]
- “Do you usually work the same hours everyday?” [Yes/No]
- IF “Yes” then answer “What time do you start and finish work?”
- IF “No” then answers a series of questions for separate start and finish times on only the days worked

Using these conditional questions we can ensure that those people who work the same hours everyday do not have to spend longer than necessary filling out answers for individual days. Using similar conditions, questions particular to

certain forms of transport were excluded if respondent indicated that they did not use that form of transport. This helped avoid cyclists being asked what capacity their engine had or car drivers being asked how long they waited for the bus.

3.3. Online Data Validation

If data is validated as the respondents answer questions then we can ensure that the raw survey data is of the highest quality. This can save time and expense checking data after the survey is complete.

Limesurvey allows rigorous on-line validation of survey answers. This is accomplished using *Regular Expressions* (as well as size restricted text boxes, clickable lists etc. to a lesser extent). Regular expressions can be used to validate postcodes, phone numbers, dates, in fact any text string which must use a specific format.

We use the following simple regular expression to validate time (e.g. “time you started work”) in our surveys:

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/^[01][0-9]2[0-3])(:|.)[0-5][0-9]$/
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This expression ensures that time is entered in 24 hour format with either a colon or a full stop separating the hours and minutes (e.g 08.12 and 16:00 are OK but 08.87, 99:05 and 12_45 are not).

The (*slightly* more complex) postcode validation expression is as follows:

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(((^[BbEeGgLI MmNnSs][1-9]d?)|(^[Ww][2-9])|(^([Aa][BbLl][Bb][AaBbDdHhLlNnRrSsTt][Cc][AaBbFfHhMmOoRrTtVvWw][Dd][AaDdEeGgHhLlNnTtYy][Ee][HhNnXx][Ff][KkYy][Gg][LIUuYy][Hh][AaDdGgPpRrSsUuXx][Ii][GgMmPpVv][Jj][Ee][Kk][AaTtWwYy][Ll][AaDdEeLlNnSsUu][Mm][EeKkLl][Nn][EeGgNnPpRrWw][Oo][LlXx][Pp][AaEeHhLlOoRr][Rr][GgHhMm][Ss][AaEeGgKkLl-Pi-pRrSsTtWwYy][Tt][AaDdFfNnQqRrSsWw][Uu][Bb][Ww][AaDdFfNnRrSsVv][Yy][Oo][Zz][Ee])d\d?)|(^[Ww]1[A-Ha-hJjKkSsTtUuWw0-9])|(((^[Ww][Cc][1-2])|(^[Ee][Cc][1-4])|(^[Ss][Ww]1))|AaBbEeHhMmNnPpRrVvWwXxYy)))(s*)?[0-9][AaBbD-Hd-hJjLlNnP-Up-uW-Zw-z]{2}))$|(^[Gg][Ii][Rr]'s?0[Aa][Aa]$)
```

This expression will validate all UK postcodes. It is a relatively long expression because it not only checks the format of the postcode (e.g. XX99 9XX is allowed while 99XX 9XX is not) but also allows only valid UK postcodes (eg. EP11 2NR is

not allowed whereas EH14 2NR is). Postcode data provide a core part of the travel plan, therefore having an extremely robust postcode validation expression is very important.

3.4. Survey Administration

Web surveys are stored on and accessed from a remote web server. When a survey is activated it is important to ensure that backups of survey responses are made to ensure that in the unlikely event of a server outage minimal data is lost. *Limesurvey* allows backups to be made in comma separated variable (.csv) files which are easily converted to excel format.

Surveys are controlled through a web interface which allows regular monitoring of survey results. Indeed we can perform rudimentary analysis of current survey results directly from the web interface.

4. CO₂ FOOTPRINT CALCULATOR

4.1. Concept

A unique CO₂ footprint is calculated for each respondent after completing our comprehensive web-survey. This is calculated using responses about their journey to work and CO₂ emissions data from UK Government sources. Suggestions are then made as to how this footprint could change if they changed the way they travelled. For example, someone travelling to work using a car would receive a CO₂ “quote” for public transport, cycling and for reducing the engine capacity of their car. This serves to both inform the respondent of their current impact on the environment and provide realistic options for reducing this impact.

4.2. Design

A recent DfT paper¹ which looked at attitudes toward CO₂ footprinting tools suggested that a “successful carbon calculator” should have:

*“simple yet personalised information requirements;
meaningful and understandable results;
personal and realistic follow-on action”*

These key features are incorporated into our calculator. The information requirements are met through a series of questions in the travel plan survey. These refer to the respondent’s journey to work and mode of transport currently used. Respondents are asked about the modes that they use on their normal journey to work, the distance they travel by each mode, and, if they travel by car, what size of engine the car has and what type of fuel it uses. It is important to note that only information about the journey to work is required. We assume that

the journey is reversed for getting from work to home. If the respondent travels in a car with more than one occupant then the total number of passengers for the majority of the journey is requested. Different carbon conversion factors (CCFs) are used for each mode of transport as follows:

Mode	Carbon Conversion Factor (Kg of CO₂ per mile or per passenger mile)	Source of Data
Walk	0	
Cycle	0	
Motorcycle	0.024	National Atmospheric Emissions Inventory. 2005 data for petrol motorcycles (average taken of rural, urban and motorway emissions)
Bus	0.045	All Party Parliamentary Climate Change Group: 25/5 Challenge
Train	0.024	As above
Taxi	0.23	assume to be large diesel (see below)
Petrol, small, car	0.28	DEFRA: Environmental Reporting - Guidelines for Company Reporting on Greenhouse Gas Emissions
Petrol, medium, car	0.36	DEFRA: As above
Petrol, large, car	0.44	DEFRA: As above
Diesel small, car	0.19	DEFRA: As above
Diesel, medium, car	0.19	DEFRA: As above
Diesel, large, car	0.23	DEFRA: As above
LPG, small, car	0.20	Assumed 30% less CO ₂ produced than by an equivalent sized petrol car
LPG, medium, car	0.25	As above
LPG, large, car	0.31	As above
Hybrid	0.08	0.1283kg/km as provided by DfT for registered weighted average of Hybrid vehicles

At the end of the survey the respondent's travel to work CO₂ footprint is calculated as follows. The respondent's daily CO₂ footprint (DCF) is calculated by summing the CO₂ footprints for each mode as follows:

$$DCF = (CCF_{\text{Mode A}} \times D_{\text{Mode A}} \times 2) + (CCF_{\text{Mode B}} \times D_{\text{Mode B}} \times 2) + \dots$$

where CCF_{Mode} is the carbon conversion factor for that particular mode and D_{Mode} is the distance travelled to work by that mode. For “car” modes where more than one person travelled in the car then the CCF is divided by the total number of people in the car. The annual CO₂ footprint (ACF) is then calculated as follows:

$$ACF = DCF \times D \times W$$

where D is the number of days worked per week and W is the number of weeks worked per year (W assumed to be 47 for Edinburgh University staff, 30 for undergraduates, 44 for postgraduates and 45 for City of York Council staff).

The results of the calculator are easy to understand as they present the respondent's ACF value along with a summary of their journey to ensure that they realise what the footprint relates to. The ACF is then compared with that of the average Briton (currently 810kg, calculated in a 2006 study carried out by the Carbon Trust²) so that the “number” has some wider relevance.

The CO₂ calculator then offers the respondent a chance to change sections of the journey to more sustainable alternatives. Each alternative is rated for CO₂ emissions so that it is obvious what effect the change in mode will have on the Co₂ footprint of the journey. This is a simple yet effective way to educate and inform the respondent in a non-patronising way. Below is a screenshot from the CO₂ footprint summary screen.

Your Carbon Footprint...

What you told us about your journey:

- You work 1 day per week.
- Your total journey length is 8 miles.
- You cycle for 3 miles and drive a car for 5 miles.
- You drive a petrol vehicle with an engine size of more than 2.0 litres.
- You travel by yourself in the car for most or all of your journey.

Your annual carbon footprint is 207kg CO₂*.

For comparison, a study by the Carbon Trust showed that the average British citizen has a travel-to-work carbon footprint of 810 kg CO₂ per year.

The table below gives you information on how you can reduce your carbon footprint further. To see what the impact of changing a section of your journey might be, select an alternative from one of the drop-down lists; your revised carbon footprint will be shown in the final column.

Journey Section	Distance (miles)	Carbon Footprint	
		Existing	Revised
Walking, Running, Cycling or by mobility equipment	3.0	0.0 kg	0.0 kg
Driving a car (more than 2.0 litres, petrol) <input type="text" value="Use a hybrid vehicle instead"/>	5.0	206.8 kg	37.6 kg
Total	8.0	206.8 kg	37.6 kg

Screenshot of carbon footprint summary webpage

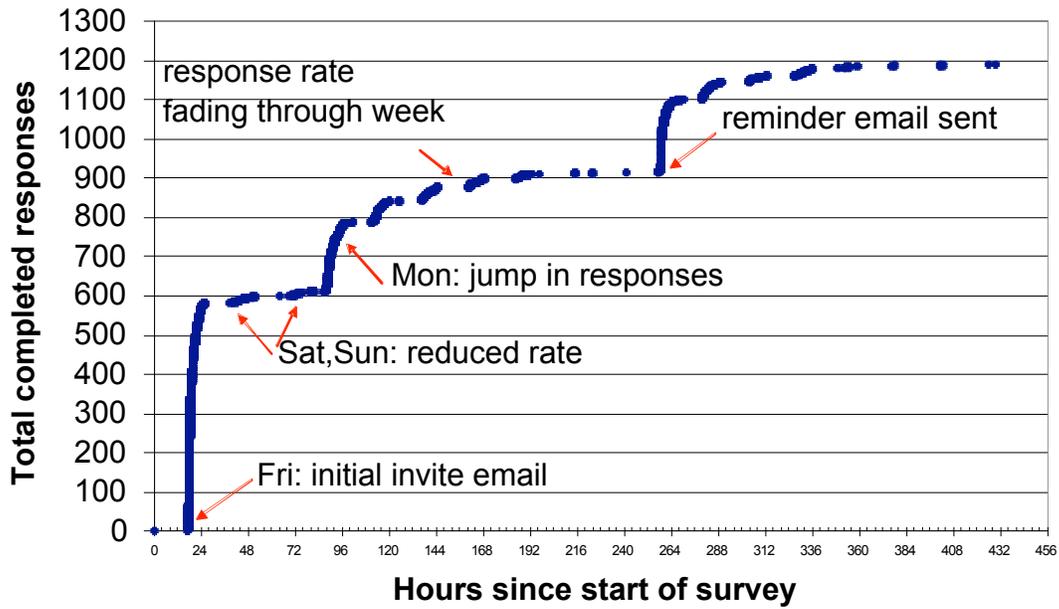
5. RUNNING THE SURVEY

After the surveys were activated an email invitation was sent to all potential respondents. This email contained a link to the web survey which was short enough that it could be noted down quickly in case the respondent did not wish to complete the questionnaire immediately.

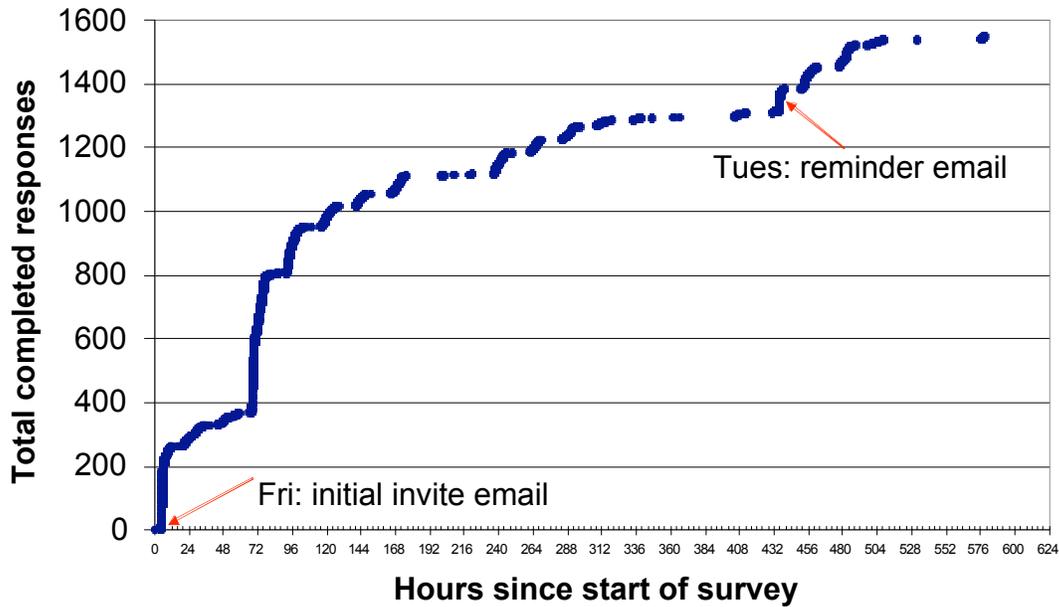
In the case of the Edinburgh University survey a prize draw was used as an incentive to respond. The first 100 respondents were entered into a prize draw to win a £100 high street voucher or one of four £25 vouchers. This tactic was used to encourage respondents to complete the survey promptly on receiving the invitation email. City of York Council employees were also given an incentive to complete the questionnaire. This took the form of a prize draw in which every survey respondent was entered to win a £250 cycle voucher.

Edinburgh University email invitations for staff and students were sent separately in order to stagger the responses and reduce the load on the server hosting the questionnaire. Email reminders were also sent a week or so after the initial email and proved very effective in encouraging more respondents to complete the questionnaire. The graphs below show the response rates for each survey. After the reminder email was sent to City of York Council employees we received an additional 300 responses. A reminder email sent to the staff of Edinburgh University resulted in an additional 200 responses while the reminder sent to students produced 500 additional responses.

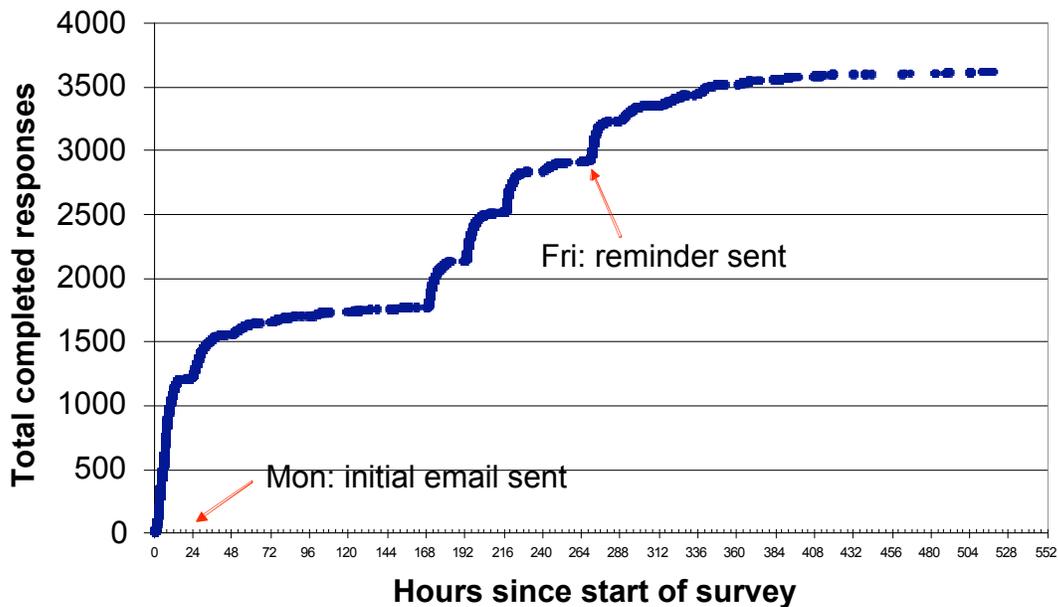
York Council survey response rate



EU Staff survey response rate



EU Student survey response rate



6. RESULTS

The CO₂ footprints of individual respondents are used to estimate an annual CO₂ footprint for each organisation as a whole. Alongside continued monitoring of staff travel behaviour, this has significantly enhanced our clients' understanding of their overall impact caused by travel.

The response rates for the different surveys are as follows: 26% of York Council staff completely filled out a questionnaire in the 18 days the survey was active; 22% of Edinburgh University staff and 14% of students completed a questionnaire in the 22 days the survey was active. These rates are reasonable compared with other travel surveys completed for universities and councils in the UK.

Averaging the individual travel to work carbon footprints for each organisation yields the following results:

- York Council staff average yearly CO₂ footprint = 0.38 tonnes CO₂
- Edinburgh Uni. student average yearly CO₂ footprint = 0.07 tonnes CO₂
- Edinburgh Uni. staff average yearly CO₂ footprint = 0.41 tonnes CO₂

To put these figures into context at the end of 2006 the Carbon Trust put the average travel to work carbon footprint at 0.81 tonnes CO₂. The total yearly footprint for the average UK citizen was estimated to be 10.92 tonnes CO₂. Therefore both Edinburgh University and City of York Council have better than

average travel to work carbon footprints but there are obviously still improvements to be made.

The organisations' total annual travel to work CO₂ footprint is then calculated from the survey results. Edinburgh University's travel to work footprint is estimated to be 4,689 tonnes CO₂ while City of York Council has an estimated travel to work footprint of 1,750 tonnes CO₂.

Interestingly, when asked about their attitude to climate change 47% of York staff responded that they believed they had already made changes to their travel arrangements to reduce carbon emissions. A further 17% indicated that they would be open to encouragement to change their travel arrangements. When staff and students who currently drive to work at Edinburgh University were asked the same question over 70% replied that they are conscious of the contribution their travel has to carbon emissions. The majority of respondents are therefore conscious of how transport relates to climate change. The addition of a carbon footprinting tool to these surveys therefore has the potential to further influence travel behaviour change.

7. CONCLUSIONS

In the context of increasing awareness of CO₂ footprints and their effect on the environment we have implemented travel plan web surveys with a "bolt-on" CO₂ footprint calculator. We have discussed the benefits of web-based travel surveys over paper surveys. The main advantages are lower cost, real time validation of data, ability to offer instant feedback on survey results and reduction of incorrectly completed survey forms. We have used the open-source survey tool *Limesurvey* to implement our web surveys with success. In the future we hope to contribute to the *Limesurvey* project by adding new question types specific to travel questionnaires.

By adding a carbon footprint tool to our web surveys we are able to provide an accurate estimate of the respondents' travel to work carbon footprint. The majority of respondents are aware of the effect their travel has on climate change and thus the additional information supplied by the carbon footprint tool has the potential to influence their travel choice.

8. FURTHER WORK

Following the Edinburgh University and City of York Council surveys Colin Buchanan has been working with the Energy Savings Trust (EST) to consult on, and subsequently design, a web-based travel plan monitoring tool which will incorporate a CO₂ calculator. This tool will be made available to businesses with travel plans in order that they can monitor the progress they make toward

sustainable travel to work. This will also be an important opportunity for EST to learn which measures make the most efficient steps towards sustainable travel.

More widely, Colin Buchanan is increasingly working with public and private organisations who want to balance the financial incentives associated with implementing travel plans with a significant reduction in their carbon footprint. Employees can set Carbon Footprint reduction targets and monitor these through future travel surveys. Furthermore, by providing an online Carbon Footprint calculator to staff as a means of monitoring personal impact, an organisation can actively encourage more sustainable behaviour.

Notes

¹Department for Transport - Exploring public attitudes to personal carbon dioxide emission information –

<http://www.dft.gov.uk/pgr/sustainable/climatechange/co2attitudes>

²<http://www.independent.co.uk/environment/climate-change/your-carbon-footprint-revealed-climate-change-report-finds-we-each-produce-11-tons-of-carbon-a-year--and-breaks-down-how-we-do-it-427664.html>