Evaluation of voluntary travel behaviour change: Experiences from three continents

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Abstract

The past 20 years has seen a rapid growth across the world in the number, range and scale of voluntary travel behaviour change (VTBC) initiatives. These so-called 'soft' measures have challenged the assumption that modal shift is only possible through 'hard' system-based measures, or through regulation.

Among the most high-profile VTBC initiatives is a household-based behaviour change technique known as Individualised Travel Marketing. This dialogue marketing approach was developed by Socialdata (under the brand name IndiMark®) in response to its own research suggesting that a lack of information and motivation, and incorrect perceptions of the alternatives to the car, were significant barriers to modal shift.

IndiMark has been applied in more than 100 pilot and nearly 150 large-scale projects, targeting a total of more than three million people on three continents. A key factor in this widespread take up has been the consistent use of a detailed evaluation design, employing travel behaviour surveys before and after the IndiMark intervention, using Socialdata's KONTIV® survey method. This well-established design uses a self-administered, mail-back questionnaire, coupled with motivation by post and telephone to encourage high response rates (typically between 60% and 80%) helping to provide reliable data on mobility behaviour.

This paper reviews the development of the IndiMark technique and the key features of its evaluation using the KONTIV® survey method. It draws on this experience to address key challenges in the evaluation of VTBC initiatives, and to identify the common threads of an integrated approach which might strengthen the case for all soft measures.

1. The growing importance of 'soft' policies

1.1 Potential for behavioural change

Levels of car dependency across the developed world have grave and growing consequences for the environment and health, and for the many local communities blighted by road traffic. At the same time, delays caused by road congestion are estimated to cost business billions of pounds every year (Eddington, 2006). The global environmental and social costs of greenhouse gas emissions from personal road transport are also high (e.g. Foley and Fergusson, 2003).

Since the 1970s, Socialdata has conducted in-depth research into the reasons for an individual's mode choice for each trip (Brög et al., 1976). The research uses face-to-face interviews to identify the awareness, perception and choice barriers preventing individuals from using non-car modes for actual trips. These analyses – echoing findings from many academic studies (e.g. Anable and Gatersleben, 2005; Steg, 2005; Wall et al., 2008) – have made it possible to differentiate clearly between people's subjective and objective situations and, with this information, to determine the opportunities for travel behaviour change to environmental-friendly modes.

This research (VDV and Socialdata, 1993) showed that in German cities in 1990, 81% of all trips were made by modes other than public transport (PT), and 19% by PT modes. Nearly a quarter of all trips (24%) used another mode because there were constraints to using PT. As these constraints could be because the car is used for business reasons, or to carry a heavy load, these trips are likely to have limited potential for change. A further 32% of trips would have required system improvements, such as the provision of an adequate bus connection or improved service frequencies, before a switch could be made.

However, for the remaining 25% of trips there were only subjective reasons preventing PT use. For these trips, a voluntary behaviour change approach (using so-called 'soft' measures) appeared to be a solution to achieve modal shift without the need for 'hard' measures such as system improvements, pricing, or changes in land use policy.

This research showed for the first time that soft measures could activate large potentials for travel behaviour change, often on the same scale as system measures.

1.2 A personal approach to voluntary travel behaviour change

The findings of this research provided an important underpinning for the growth, across Europe and elsewhere, in policies and measures focusing on voluntary travel behaviour change (VTBC). The late 1980s onwards saw the development of a wide range of interventions aiming to influence the travel mode choices of individuals and organisations through awareness-raising, marketing and education.

Based on its own research, Socialdata pioneered Individualised Travel Marketing (ITM) – under the brand name IndiMark® – as a technique for changing personal travel behaviour. The IndiMark process uses direct contact with households to identify and meet their individual needs for support, and to motivate people to think about their day-to-day travel choices. This conscious consideration is an important precursor to change in a type of behaviour that is notoriously habitual (e.g. Matthies et al., 2002).

The IndiMark process begins with personal contact, either by telephone or on the doorstep, with households in the target area. This initial contact enables the target population to be segmented into three main groups: existing regular users of sustainable travel modes; non-regular users who are interested in receiving information on alternatives to the car; and those who are not interested in taking part.

Most of the ITM campaign focuses on households in the 'interested' group. They receive a TravelSmart® (the brand name for the IndiMark travel behaviour programme, delivered in the UK by Sustrans in partnership with Socialdata) order form enabling them to choose from a range of local travel information materials and other services, provided by the local authority, public transport operators and other partners. The requested items are assembled into personalised packs and hand-delivered to households who requested them.

Households that are not regular users of sustainable travel modes are also offered a range of further services to enable them to try these out. These services include home visits, conducted by a local bus driver or other local travel expert, and the offer of small incentives such as a test ticket for local bus services, a cycle trip computer or a pedometer. Regular users are offered a reward to reinforce their travel behaviour together with a personalised information pack if required (similar to the interested group).

It is this highly customised, dialogue-based approach, together with the focus on households rather than major destinations such as workplaces, that sets IndiMark apart from other VTBC measures. The success of IndiMark schemes in Europe, Australia and North America has spawned a range of similar VTBC techniques also focusing on households, known alternatively as personal travel planning (PTP).

This paper describes the development of the IndiMark technique on three continents (Section 2) and reviews experiences in the evaluation of its effectiveness in changing travel behaviour (Section 3). Drawing on this, Section 4 explores the evaluation challenges faced across the range of VTBC schemes and addresses some common concerns in the debate around their effectiveness. Section 5 makes the case for a more integrated approach to the evaluation of VTBC schemes, using behavioural surveys alongside traffic counts and other output-based, marketing indicators.

2. From promoting public transport to reducing car trips

2.1 Origins of IndiMark and its evaluation

IndiMark was pioneered by Socialdata as a tool for promoting PT in the late 1980s. An overview of large-scale PT projects in Germany – where IndiMark was first developed – and elsewhere in Europe is given in Table 1.

Table 1

PT projects in Europe.

COUNTRY	PROJECTS	LOCATIONS	TARGET POPULATION (people)	PT increase[a] (rel. change)
Germany[b]	59	45	1,007,000	+ 19 %
Austria[c]	23	15	228,200	+ 13 %
Sweden[d]	25	19	163,800	+ 10 %
Switzerland[e]	5	2	20,800	+ 10 %
UK[f]	6	1	286,000	+ 6 %

[a]   Big variations due to different PT-shares

[b]   Augsburg, Bergheim, Berlin, Bielefeld, Calw, Chemnitz, Dessau, Dotzheim, Dransfeld, Dresden, Duisburg, Düren, Düsseldorf, Erfurt (2), Erkrath, Freiburg/Umland, Fürth, Halle (8), Hannover, Hilden, Karlsruhe, Kassel, Köln (2), Leipzig (2), Ludwigshafen, Magdeburg (2), Markgröningen, München, Neukirchen-Vlyn, Potsdam, Remseck, Rohrbach, Rosenheim, Rostock (2), Saarbrücken, Saarbrücken-Region, Stuttgart (3), Sillenbuch, Sachsen-Anhalt, Viernheim, Warburg, Wesel, Wiesbaden (2), Wiesbaden-Biebrich, Wiesloch, Zwickau; without Nürnberg

[c]   Baden, Bruck, Brunn, Eisenstadt, Korneuburg, Linz (6), Maria Enzersdorf, Mödling, Osttirol, Purkersdorf, Salzburg, Schwechat, Tulln, Wien (4), Wolkersdorf

[d]   Ahus, Dalvik, Gävle (2), Gothenburg (2), Hällviken, Helsingborg, Jönköping (3), Karlstad, Linköping, Lundby, Malmö (3), Norrköping, Njurunda, Skanetrafiken, Sundsvall, Trelleborg, Umea, Uppsala, Vellinge
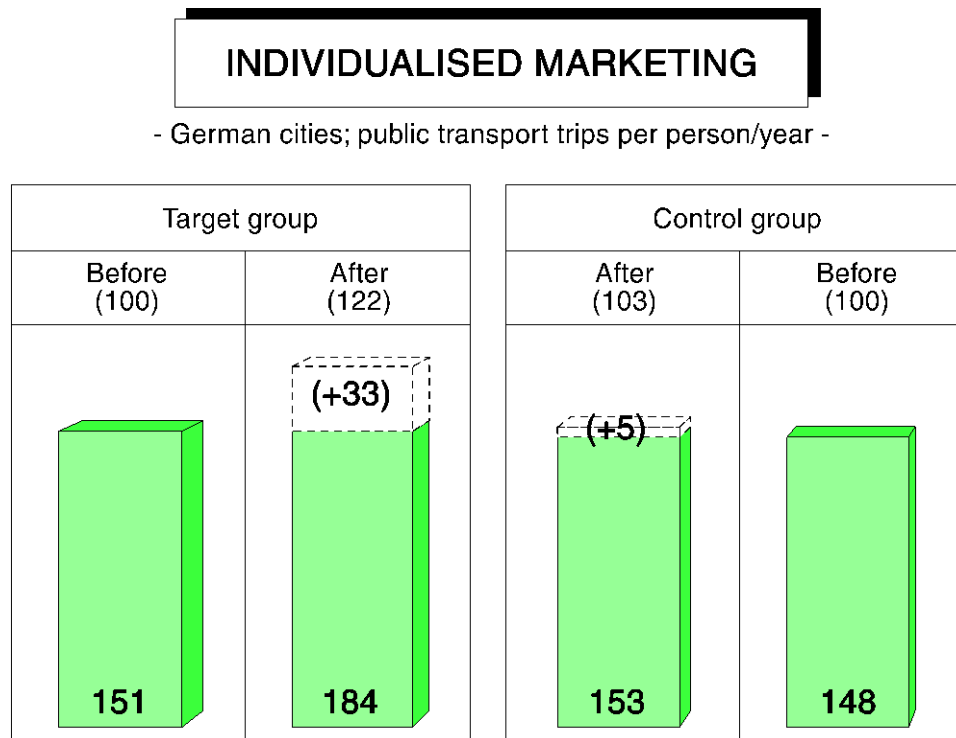
[e]   Basel (4), Bern

[f]   Hampshire; only one project was evaluated

Fig. 1 shows that in the German PT projects there was an average increase of 33 PT trips per person per year among the target groups. The control groups in these same projects showed an increase of five PT trips per person per year. This means

that the net increase in PT trips attributable to IndiMark was 28 trips per person per year (relatively +22% in the target and +3% in the control groups).

The same pre-test post-test control group design has been applied in nearly all IndiMark projects. Results take account of factors such as weather and infrastructure changes, allowing the effect of the ITM intervention to be isolated with reasonable confidence.

INDIVIDUALISED MARKETING

- German cities; public transport trips per person/year -

Target group		Control group	
Before (100)	After (122)	After (103)	Before (100)
151	(+33) 184	(+5) 153	148

Source: Brög (2006)

Fig. 1. Results of IndiMark[®] for German PT projects.

2.2 Evaluation of the ongoing Nürnberg IndiMark programme

The value of the pre-test post-test control group design is evident from work in the City of Nürnberg, Germany (population approximately 500,000), which uses IndiMark to promote PT use on an ongoing basis. This work started in 1996 with a small project of some 5,000 people. Several projects have been conducted in each subsequent year. Since 2006, early target areas have been revisited and by the end of 2007 a total of 600,000 people had participated in the programme. All projects were successful in increasing rates of PT use and, moreover, there is evidence that attitudes to PT across the city have also been changed[1] (Brög, 2006).

Each Nürnberg project has been evaluated separately, but in 2004 all previous evaluation surveys were synthesised to provide an overview of programme results to date. This analysis summarised in Fig. 2 showed an overall increase in PT use of 13%, (fully supported by counts and calculated against control groups), along with – although not targeted – a reduction in car-as-driver trips of 3%.
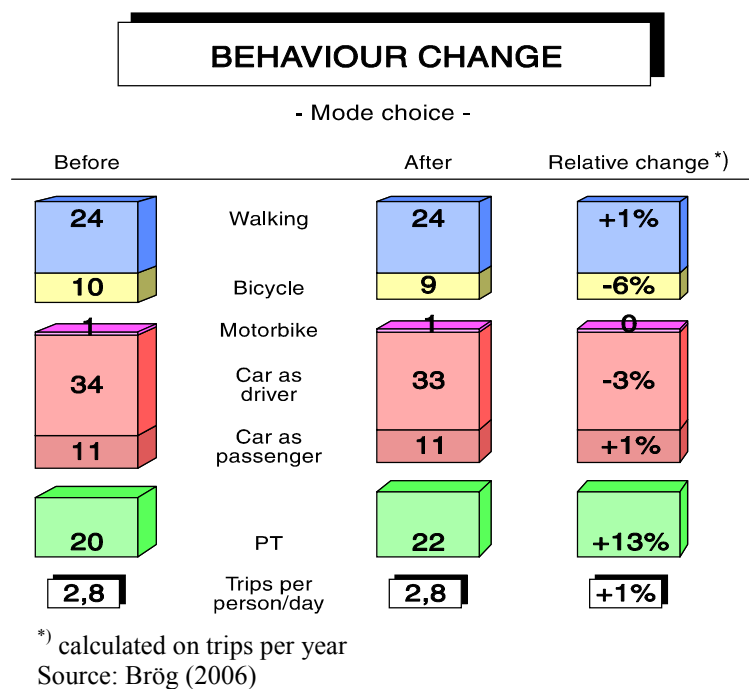
BEHAVIOUR CHANGE

- Mode choice -

Before		After	Relative change *)
24	Walking	24	+1%
10	Bicycle	9	-6%
1	Motorbike	1	0
34	Car as driver	33	-3%
11	Car as passenger	11	+1%
20	PT	22	+13%
2,8	Trips per person/day	2,8	+1%

*) calculated on trips per year
Source: Brög (2006)

Fig. 2. Consolidated behaviour change 1996-2004: Nürnberg, Germany.

That means that there were 20 additional PT trips per person per year, resulting in additional revenue of approximately €2.5 million for the operator (net). Furthermore, there was a reduction in road transport carbon dioxide (CO_2) emissions of approximately 14,400 tons per year; a saving in external costs of approximately €6m

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[1] Travel behaviour research has been conducted continuously in the city since 1989 together with evaluation surveys for each project.
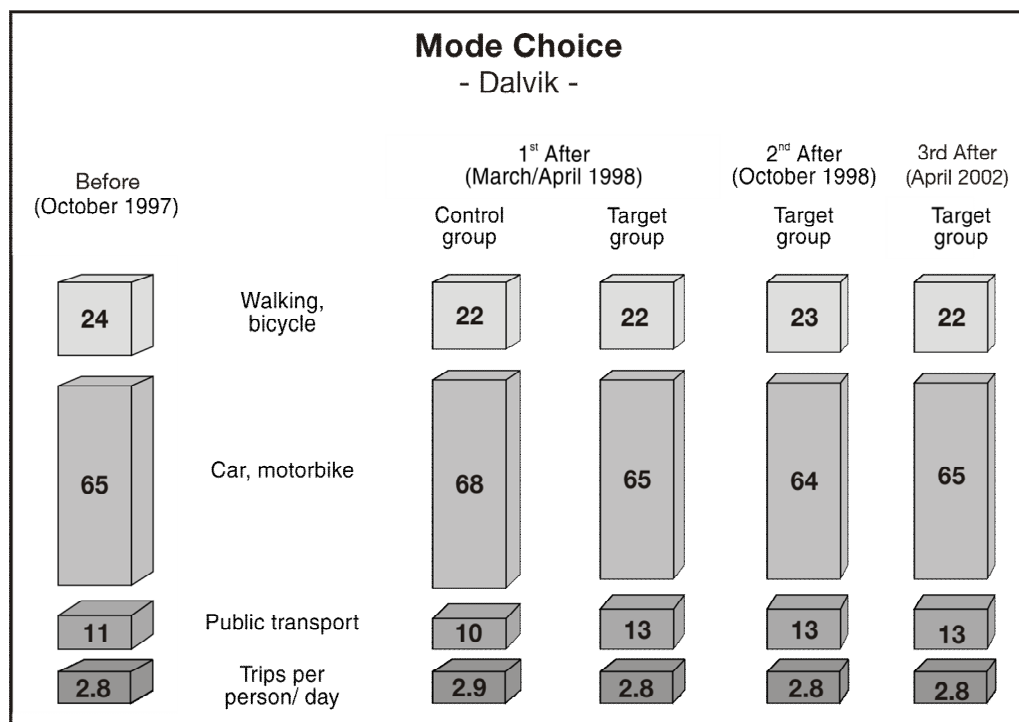
per year; and positive effects on life expectancy in Nürnberg due to increased walk-ing to and from stations (Brög, 2006).

2.3 Sustainability of behaviour change

There is increasing evidence that behaviour changes generated by IndiMark are sustained over time. This may be explained by its focus on enabling voluntary change which helps to make people's lives easier, rather than denying them choice. In addition, the dialogue into which households enter is likely to pro-mote central processing of messages, as opposed to peripheral processing (Petty and Cacioppo, 1986), leading to longer-lasting behaviour change.

Repeat travel surveys conducted up to four years after the large-scale TravelSmart programme in South Perth have shown that the behaviour change achieved by the original VTBC interventions – a 14 % reduction in car-use – has been 'locked in' with a 13% reduction in car-use measured three and four years after the intervention (James and Brög, 2002).

Long-term monitoring of travel behaviour has also been undertaken in the Swedish city of Dalvik following a PT IndiMark campaign. Three post-intervention surveys – the last one five years after the ITM – illustrated the stability of public transport usage increases (Socialdata Sverige, 2002) (see Fig. 3).

Mode Choice
- Dalvik -

	Before (October 1997)	1st After (March/April 1998) Control group	1st After (March/April 1998) Target group	2nd After (October 1998) Target group	3rd After (April 2002) Target group
Walking, bicycle	24	22	22	23	22
Car, motorbike	65	68	65	64	65
Public transport	11	10	13	13	13
Trips per person/ day	2.8	2.9	2.8	2.8	2.8

Source: Socialdata Sverige, 2002

Fig. 3. Long-term changes in mode choice in Dalvik, Sweden.

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2.4 IndiMark with system improvements

While effective in its own right, the case for IndiMark is even stronger when it is combined with transport system improvements ('hard' measures). Eight projects have been carried out in recent years where system improvements and ITM have been combined. Improvements to the system – as illustrated by control group data – lead to an average increase of 23 additional PT trips per person per year. However, when ITM was delivered alongside system improvements, the average increase in PT trips per person per year was more than doubled (see Table 2).

Table 2

IndiMark® with (rail) system improvements.

PROJECTS	LOCATIONS[a]	TARGET POPULATION (people)	INCREASE OF PT TRIPS per person per year	
			Only system	System and IndiMark®
11	9	156,600	+ 23	+ 48

[a]   Baunatal, Karlsruhe, Köln, München (2), Nürnberg (2), Remseck, Saarbrücken, Stuttgart, Portland

Applications of TravelSmart in Australia, Europe and North America are summarised in Table 3 and discussed in Sections 2.5 – 2.8 below.

Table 3

TravelSmart® in Australia, Europe and North America.

	PROJECTS	LOCATIONS	TARGET POPULATION (people)	CAR REDUCTION (rel. change)
Perth	24	1	408,500	-11%
Other Australia[a]	10	4	338,800	-12%
UK[b]	24	12	304,800	-12%
Other Europe[c]	7	6	47,000	-13%
USA[d]	12	9	47,500	-8%
Canada[e]	6	1	4,000	-10%

[a] Brisbane (4), Melbourne (3), Adelaide (2), Townsville

[b] Bristol (4), Cramlington, Doncaster, Frome, Gloucester (3), London, Lancaster (2), Nottingham (2), Peterborough (3), Preston (2), Sheffield, Worcester(3)

[c] Other countries: Austria, France, Germany, Sweden

[d] Bellingham (2), Bend, Cleveland, Durham, Eugene, Portland (2), Sacramento, Salem, Seattle (2)

[e] Vancouver

2.5 Car-use reduction in Perth, Western Australia

The VTBC process was applied as a tool for promoting public transport in the 1990s and has since been developed to reduce car use by promoting all environmental-friendly modes.

The first application of this extended IndiMark approach was in Western Australia. In 1997 the Government of Western Australia commissioned Socialdata to undertake an ITM pilot project covering 400 households in the City of South Perth. This project reduced car trips by 10% and increased use of other modes (walking, cycling and public transport) without constraining mobility (Socialdata, 1998). As noted above, further travel surveys one and two years after the project showed that these changes had been sustained (James and Brög, 2002).

2.6 Further development of TravelSmart in Australia

The success of the small-scale project in South Perth – and the evidence from a detailed cost-benefit study (Ker and James, 1999) – laid the foundations for a large-scale project in South Perth in 2000. This extended IndiMark to a population of 35,000 people. Of 17,500 households in South Perth, 15,300 were identified with a contact name, address and telephone number. Direct contact was made with 94% of these and 55% (of the 15,300) chose to participate in the IndiMark programme. The TravelSmart approach has since been delivered to a total of over 400,000 people in the Perth area, achieving a reduction of car trips of 11% in total, varying between 4% and 14% across individual projects[2].

Following the pioneering work in Perth, Socialdata has implemented projects in other Australian cities including the biggest single project ever realised in Brisbane with 180,000 people (Ker, 2008).

2.7 TravelSmart in Europe

In the UK, the IndiMark concept has been applied in partnership with Sustrans under the TravelSmart programme. A total of more than 600,000 people have been targeted in 24 pilot and large-scale projects since 2001. The average car-use reduction (measured in car trips per person per year) achieved is 12%, but for single projects the range varies between 6% and 13% (ITP, 2007). The largest UK project targeted a population of 120,000 people in Preston and Lancaster. This project was in 2006 winner of the CIVITAS demonstration city award[3].

TravelSmart projects have also been implemented in four other European countries and have delivered an average car-use reduction of 13% (see Table 3).

2.8 TravelSmart in North America

There have been 18 TravelSmart projects in ten locations in North America. Even in the car-dominated US, TravelSmart has proven to be a successful approach to reducing car use. The range of car reduction varies considerably – between 2% and 11% – with an average reduction of 8% (Socialdata America, 2006).

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[2]   Reports on TravelSmart programmes undertaken in Australia are available as follows: Western Australia: www.dpi.wa.gov.au/travelsmart, Queensland: http://www.transport.qld.gov.au/travelsmart, Victoria: http://www.travelsmart.vic.gov.au/

[3] CIVITAS stands for CIty-VITAlity-Sustainability. With the CIVITAS Initiative, the European Commission aims to generate a decisive breakthrough by supporting and evaluating the implementation of ambitious integrated sustainable urban transport strategies. The CIVITAS Awards honour the most ambitious European CIVITAS Member Cities, which have shown their commitment by introducing innovative transport policies or activities aimed to achieve better and cleaner urban transport.

3. Evaluation of behaviour-change interventions

3.1 Indicators of behaviour change

Measuring the effects of marketing interventions on behaviour is a considerable challenge, not least because of the many uncontrolled factors that may have an influence on people's actions (Brög and Ker, 2008). There are several evaluation methods available and each has advantages and disadvantages. As such, when measuring the success of a travel behaviour-change project, it is preferable to use a variety of evaluation methods. If multiple methods all point in the same direction and show more-or-less the same magnitude of change, one can be reasonably confident in the results.[4]

There are three main measures that should be considered in evaluating a behaviour-change intervention.

Marketing indicators. These include the number and type of information requests, and quantitative feedback from residents throughout the project. For example, where one of the desired changes is to increase PT use, researchers might consider the number of stop-specific bus timetables requested by participating households. While it is quite possible that some households may request information that they do not go on to use, it is unlikely that thousands of households will order specific, address-based timetables that they are not interested in and which they will never use . Very often in traditional direct marketing, such indicators are the only measures of success. A reliance on information requests alone may be too courageous, but they are nonetheless reliable, precise and easy to measure indicators which should not be ignored.

In addition, it should be borne in mind that enduring behaviour change is likely to be based to at least some extent on attitude change (e.g. Petty and Cacioppo, 1986). TravelSmart evaluations have provided thousands of comments from participants which suggest that attitude change does indeed occur as a result of the intervention. These qualitative data, whilst not constituting "proof", are arguably as important as changes measured in counts or surveys.

External Indicators. These include measured public transport patronage. In the TravelSmart programme in Western Australia, for example, bus boarding data are collected and the ability to gather and use such data will be enhanced by the recent successful introduction of a comprehensive Smart Card ticketing system (SmartRider). Parker et al. (2007, p. 127) supports the value of this type of "robust corroborative data". This form of monitoring, however, is not without its challenges, most notably isolating the effects of the VTBC initiative from those of other influences.

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[4] One cannot rule out the possibility that all evaluation methods are biased in the same direction, but the likelihood of this decreases as the number of evaluation methods increases.

Behavioural Indicators. The effectiveness of travel behaviour change projects can also be evaluated by measuring changes in the mobility patterns of residents by conducting extensive pre- and post-intervention travel surveys. Data from these surveys for TravelSmart projects describe mode share, activities and travel time, and analysis of these data shows the mode shift from car-as-driver trips to environmental-friendly modes. As with external indicators, it is important to measure changes in behavioural indicators against a control group to account for background (uncontrolled) factors (Parker et al., 2007). This issue is discussed further in Section 3.3.

In recent years, most emphasis in the evaluation of VTBC has been on behavioural indicators, often to the exclusion of marketing and external indicators. Whatever methods are used, acceptance of the results will be highly dependent upon comprehensive and consistent documentation of processes and outcomes.

3.2 KONTIV® Design

An international demonstration project initiated by the UITP (International Association of Public Transport) with scientific leadership from Socialdata (UITP, 1998) showed that a detailed and robust evaluation of the effects of dialogue marketing on travel behaviour is of critical importance. This means that:

(a)   A design has to be used which is fully developed and has already proven its capability to provide reliable and valid results.

(b)   Data on individuals' mobility behaviour should be collected; traffic counts, patronage data and so on will not be enough.

(c)   Information about mobility from all household members should be collected because, for example, one household member might be motivated to change from car to another mode and another household member might then decide to use the available car (instead of another mode).

(d)   Data on all trips should be collected; not only trips within the target area.

Socialdata has developed, applied and continuously improved a research design based on the above criteria and which seeks to ensure data quality and high response rates. This is known as the KONTIV® Design: a mail-back technique using a one-day diary for all household members (Brög, 2000). The survey instrument collects information on individual activities performed at all out-of-home destinations on a nominated travel day and this provides an account of how, where and why respondents travelled (or did not travel). It has been applied in more than 15 countries with consistently high response rates and reliable and valid results.

3.3 Behaviour change in context

Behaviour change initiatives do not happen in isolation. Almost by definition, such schemes are funded because there is a sympathetic policy environment. There is also evidence that increased fuel costs have had a systematic impact on travel behaviour (e.g. Warren, 2008). This requires that, wherever possible, we also measure the travel behaviour of people or households similar to those subject to the intervention so that the impact of factors external to the intervention can be identified and appropriate adjustments made to the measured outcomes in the intervention group. This poses a problem for interventions that do not attempt to measure change over the whole target population, as there is a potentially high degree of self-selection in the intervention group that makes them different from any potential control group.

The only group that, in principle, meets all of these criteria (subject to sampling variability) would be a random sample from the population of the intervention area itself. This is particularly so with a very large-scale application that covers a large and demographically diverse area. In practice, however, even those who are not part of the target population are highly likely to be influenced by the intervention itself. As a result, it is often most appropriate to draw the control group from a geographically close but distinct residential area that is likely to be subject to similar background influences to the target area.

4. Challenges in the evaluation of VTBC

4.1 Background

Getting people to change their (often habitual) travel behaviour on a large scale and at a reasonable cost is undoubtedly a challenge. However, in the context of global climate change, rising fuel costs, and obesity and other health problems associated with sedentary lifestyles, the rewards from achieving real and sustained behaviour change are potentially very great (AGO, 2006).

It has to be expected that the VTBC programmes reporting the most positive outcomes should also be subject to the highest levels of external scrutiny. However many practitioners in the field have been taken aback by the degree of criticism levelled at specific evaluation methods (Stopher, 2003), and by the apparent paucity of robust alternatives (see, for example, Roth et al., 2003).

A welcome contribution to this debate has been provided by a recent, comprehensive study of 'personal travel planning' in the UK and elsewhere (Parker et al., 2007). This report highlights many of the evaluation challenges facing VTBC practitioners. The next section explores these issues in more detail and attempts to make a

contribution to some of the most common arguments in the debate around the effectiveness of VTBC.

4.2 Significance of results

Most of the debate on sample size has concerned sampling error estimation (Richardson et al., 2003). In practice, the error due to systematic factors (e.g. response rate) can be many times larger than sampling error. This is a serious problem, because there are always two types of errors to be considered in empirical studies: random errors (sampling-related); and systematic errors (design related).

Since there are always systematic errors, the calculated random errors are always based on an incorrect assumption (that there are no systematic errors). But the real problem of these two types of errors is that random errors can be calculated exactly, but not corrected, whereas systematic errors can be corrected through survey design changes but cannot be precisely calculated.

A master calculation undertaken for the Dutch National Travel Survey (MON) can illustrate this (see Table 4). The MON 2005 achieved a net sample of 66,500 respondents at a response rate of 72% and with a gross sample of 92,350 people (using KONTIV® Design). The trip rate per person and day (calculated after a detailed analysis of non-response and non-reported trips) was 3.1. With a response rate of only 40%, a gross sample of 166,250 would have been needed to get 66,500 respondents. Using the speed of response technique (described below), the trip rate for the first 40% can be calculated as 3.4 trips per person and day. The random error of this survey would be ±0.02 trips. The systematic error (of only one factor: non response) is fifteen times higher (see Table 4).

Table 4

Random and systematic errors (MON).

Net responses	66,500 respondents (net)	
Response rate	40%	72%
Gross sample required	166,250	92,350
Trips per person per day	3.4	3.1
Random statistical error	±0.02 trips per person per day	
Systematic (response rate) error	+0.30 trips per person per day	

Source: Own calculations.

4.3 Non-response and non-reported trips

One technique of understanding, calculating and correcting systematic errors is through the speed of response technique. In a mail-back survey, the number of trips per person per day can be analysed according to the response rate reached in the different phases of a survey (speed of response). This allows different response rates to be simulated and the result for the variable of interest to be estimated for a full response (Brög and Meyburg, 1981). This approach has been used to analyse the likely shortcomings of a survey that achieved only a 25% response rate (Brög and Erl, 1999). Fig. 4 shows trip rate index on the y-axis (where 100 corresponds to the expected value for the total sample and is the lower bound of the y-axis) and the response rate on the x-axis. This survey showed an over-estimation of trips per person per day (index=121) with a 25% response rate compared to the expected trip rate for the total sample of 2.9 trips per person per day (index=100).
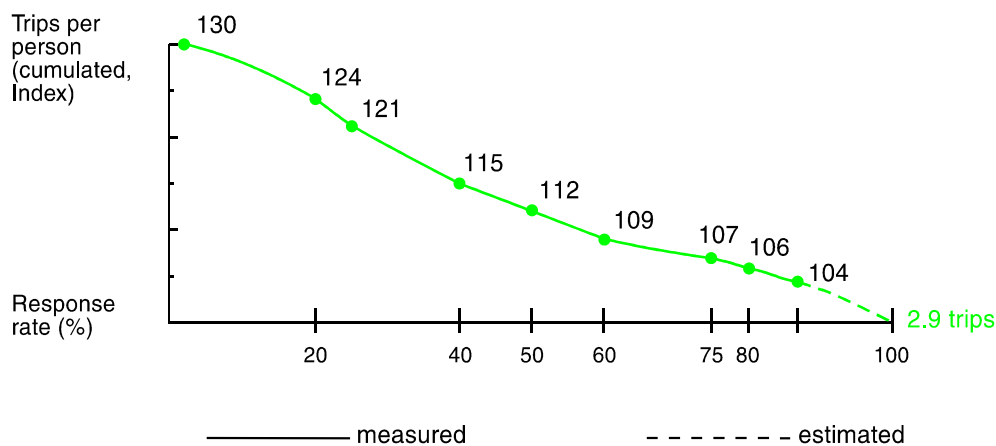
Source: Brög and Erl (1999)

Fig. 4. Trip rate by response rate: Vienna 1993 (response rate 85%).

The speed of response technique has been applied in analysis of the Netherlands National Travel Survey: the only long-running continuous travel survey in the world (Ministerie van Verkeer en Waterstaat, 2007). As a consequence, a specific self-validating design has been developed. This design can correct for non-reported items, non-reported trips and non-response and is not dependent on external data. Fig. 5 shows the effect of response rate on the trips per person taking into account survey non-response and non-reported trips. If we look at the upper response curve we see a curve following in principle the one presented in Fig. 4, just flatter: The non-response effects have been reduced. This is a result of systematic analysis of these non-response effects and continuous improvements of techniques to reduce them.

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The lower response curve is another valuable addition. It shows the percentage of non-reported trips by response rate. This is important because it is often argued that later respondents do not have lower mobility but do not report all their trips correctly. The curve shows that this effect exists, but only to a very small degree. In principle, non-reported trips have a similar proportion, irrespectively of the response rate.
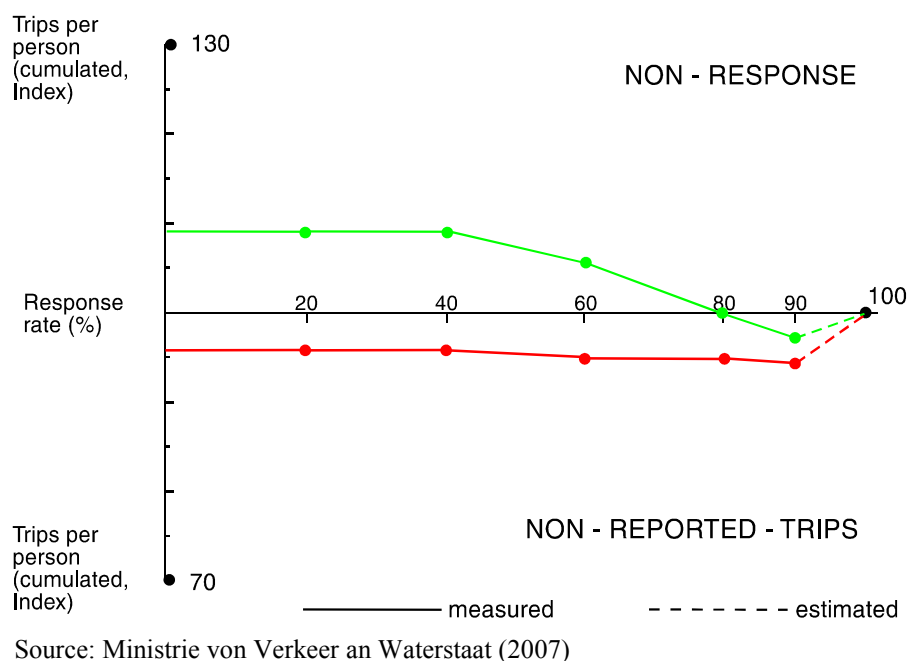

Source: Ministrie von Verkeer an Waterstaat (2007)

Fig. 5. Trip rate and non-reported trips by response rate: Netherlands (MON - Mobiliteitsonderzoek Nederland).

4.4 Panel surveys

Many travel behaviour-change interventions have adopted a cross-sectional survey approach to estimating 'before' and 'after' travel behaviour. With small samples, this can cause problems with statistical reliability when examining differences between the two surveys, but these problems are less severe for larger samples.

It has often been suggested that a panel survey approach, using the same people for both surveys, would be more suitable (Stopher et al., 2009)[5]. However, panel surveys have their own problems that are more systematic and less amenable to treatment by statistical analysis (e.g. aging, attrition, survey fatigue).

While it has been argued that panel surveys require lower samples sizes (Richardson et al., 2003), some of the parameters enabling smaller sample sizes also give rise to survey designs which are more difficult to undertake. For example, panel

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[5] On request of the editors we have put in cross-references to other papers in this issue that there is a means for readers to be aware of related papers in the special issue.

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survey data is more difficult to obtain (with full control of other biases) than repeated cross-sectional data (Richardson, 2002). Acquiring repeated data from the same respondents is challenging and a reduced response rate in the post-intervention survey can lead to sampling bias (Parker et al., 2007).

One example of a panel survey in Melbourne (2004/05) used to estimate the effect of a VTBC initiative had a low initial response rate (49%: 1,346 out of a sample of 2,772 households) for the pre-intervention survey and substantial further loss by the time of the post-intervention survey. Furthermore, in the post-intervention survey only 682 of the 881 households that responded to the pre-intervention survey had the same composition as in the earlier data collection exercise (Richardson, 2005). At the individual level, people may exhibit substantially different travel behaviours at different times for reasons that are purely idiosyncratic and not related to the intervention being investigated.

Table 5 summarises evaluations of three TravelSmart projects (Brisbane North, Victoria Park, and Midland Line, Perth) using both panel and repeated cross-sectional (random) surveys.

Table 5

Sample sizes (respondents and response rate).

	Before	Combined response rate panel[a]	After Cross Section
Brisbane North	1309 (76%)	825 (65%)	1381 (79%)
Victoria Park	905 (80%)	780 (70%)	766 (79%)
Perth-Midland Line	868 (72%)	345 (60%)	920 (72%)

[a] % response rate of before survey x % response rate of after survey

Source: Own surveys.

In Table 6 we compare the results of the panels with the cross-sectional surveys. We see that the behaviour changes captured in the cross-section were always greater than in the panel (Socialdata Australia, 2007a; 2007b; 2008a).

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Table 6

Reduction of car trips[a].

	Panel	Cross Section
Brisbane North	- 11%	- 13%
Victoria Park	- 12%	- 14%
Perth-Midland Line	- 7%	- 11%
Average	- 10%	- 13%

Source: Own surveys.

Note: All reductions in car use are highly significant at least at a significance level of more than 95 %; the difference in the average car reduction between Panel and Cross Section is highly significant.

[a] Calculated with a constant level of mobility

This provides evidence that people who are flexible, move more, and change their behaviour more readily may be under-represented in panels, which tend to focus on stability and status-quo. Behaviour changes measured in panels therefore seem to be smaller than in reality.

This conclusion is supported by current research into travel behaviour change projects for which panel evaluation has been selected. In all three surveys, the response rate for the pre-intervention survey was at least 70% (average of 75%) and the response rate for the post-intervention surveys always above 80%. Thus the combined panel response was always over 60% (e.g. 75% for pre-intervention survey, 82% for post-intervention survey and therefore 62% for combined surveys).

Using the speed of response technique, it was possible to simulate the typical pre- and post-intervention panel which has a response rate in the low forties (pre-) and the low seventies (post-): a combined response rate of about 30% (Socialdata, 2006; see Table 7). In terms of the analysis above, the selection worked even more in favour of stability. This is clearly reflected in the results (see Table 8). Behaviour changes in a panel with a combined response rate of about 30% are smaller than in a panel with a combined response rate of over 60% (Socialdata Australia 2006).

Table 7

Sample sizes of experimental response rates (respondents and response rate).

	Before	Combined response rate panel
Original panel[a]	2988(75%)	2172 (63%)
'Simulated panel'	1753 (44%)	1103 (32%)

[a] Armadale, Cambridge, Marangaroo (Perth)

Source: Own surveys.

Table 8

Reduction of car trips.[a]

	Original panel	Simulated (lower) response rate
Perth Suburbs[b]	- 8%	- 6%

[a] Calculated with a constant level of mobility
[b] Armadale, Cambridge, Marangaroo (Perth)

Source: *Socialdata* Australia (2006).

Note: The original result for car reduction is significant at a level over more than 99 %.

4.5 Odometers

In the recent behaviour change literature, it has been suggested that use of odometers would be a promising tool to improve the reliability of intervention evaluations (e.g. Seethaler and Rose, 2009; Bonsall, 2008). The main arguments to support the use of odometers are that respondents in surveys are self reporting and might want to report what they perceive as desirable results, and that meters are more precise and statistically valid. However, there are some counter arguments.

For example, even in water conservation projects (where meter readings often provide the only means of evaluation), the readings are reported readings. Even where independent meter readers have been used, experience from five projects has shown that such operatives make mistakes, are sloppy, or may not read the meter at all, simply making the results up (Socialdata Australia, 2006b).

In an odometer reading project these problems may be even greater, if data are self-reported by a household member. Respondents may wish to give answers that they imagine researchers would wish to hear and this would be much easier than in a diary-based survey involving all household members. This risk alone may rule out self-reported odometer readings as a viable option. Bonsall (2008) has, for this reason, suggested using odometer readings taken by third parties as part of statutory annual vehicle inspection and re-registration procedures – but this many not be feasible.

In addition, the odometer-reading projects tend to achieve very low participating rates (e.g. Stopher et al., 2007a) and need a strict regime to be kept by the households. Adding to the problems of low participation, in any given wave, about 25% of households will fail to provide odometer readings (Stopher et al., 2007a). At best this increases the required sample size, but in conjunction with low recruitment rates it may cause systematic bias that cannot be addressed by larger samples. In a recent validation survey on odometer readings conducted by Socialdata Australia (2008b) (recruitment rate 80%), about 60% of the readings reported were in doubt (collected at the wrong time; wrong day; wrong car; reading invented; later readings lower than earlier ones; or distances travelled of several thousand kilometres a day).

Finally, even if the odometer reading is correct, it tells us nothing about the type of travel, its frequency, or the trip purpose.

4.6 Projects using GPS

It has been suggested that geographical positioning systems (GPS) can provide a means of directly measuring travel and, by inferential means, mode use (Stophe et al., 2007b, and Stopher et al., 2009). However, this is as yet unproven in at least four key areas:

- The robustness of the algorithms for inferring mode use;
- The potential for the measurement actually to influence travel behaviour – for example, a person 'equipped' with a GPS device might be more aware of their travel behaviour (as distinct from it being habitual) and use transport more efficiently while carrying the device;
- The participants are well aware that every movement is registered and will find ways to omit trips which they want to keep confidential. Moreover, if such concerns become widespread fewer people may be willing to participate in such exercises;
- Even now the willingness to participate in such an exercise is low, the projects are expensive, and yet do not achieve representative samples. This is even more critical because the sample sizes of such projects are traditionally very small (Stopher et al., 2007a).

A recent experiment following the Brisbane TravelSmart projects (Socialdata Australia, 2006a; 2007a) attempted to test the willingness of target persons to participate in a GPS survey.

On offer were two alternatives for a GPS survey: carrying the GPS tool for one week; or repeating this exercise three times at two year intervals. Target persons were survey respondents from the TravelSmart pre- and post-intervention surveys (KONTIV® Design). In order to control for the tendency of survey respondents to

participate again, the Brisbane experiment is contrasted with an experiment in Karlsruhe, where survey respondents were asked to participate in the same survey again for one week and repeat surveys in two-year intervals. All results are calculated for people aged between 14 and 75 years. They show that the well known effects of repeated surveys are evident in the GPS experiment: not everyone who says 'yes' will actually participate, but we can be sure that everyone who says 'no' will not. The results shown in Tables 9 and 10 suggest that researchers must be very alert to biases introduced by recruiting, especially for GPS-type projects.

Table 9

Response rates.

	Survey experiment[a]	GPS experiment[b]
Original response rate (one sample day)	76%	79%
Participate again (one week)	72%	30%
Participate again (three times, two years intervals)	52%	27%
Sample size of experimental survey (persons)	1606	3408

Source: Own surveys.

[a] Karlsruhe, Germany
[b] Brisbane, Australia

Table 10

Reported mobility differences by willingness to participate.

	Survey experiment[a]			GPS experiment[b]		
	Baseline survey	Willing to participate again	Willing to participate three times	Baseline survey	Willing to participate again	Willing to participate three times
Trips per person/day(in base year)	2.9	3.0	3.1	3.1	3.4	3.5
Main mode (%) Walking	22	21	21	8	6	5
Bicycle	15	16	16	1	1	1
Motorcycle	1	1	1	0	0	0
Car as driver	38	39	39	64	72	74
Car as passenger	12	11	12	18	17	16
Public transport	12	12	11	9	5	4
TOTAL	100	100	100	100	100	100

Source: Own surveys.

[a] Karlsruhe, Germany; for the car driver share there is no significant difference the three groups shown
[b] Brisbane, Australia; for the car driver share there are highly significant differences between the 3 groups observed

4.7 Use of control groups

Discussions around the use of control groups often follow an established pattern. There is agreement that a control group should be used; there is agreement that it is often very difficult to identify an (ideal) control group; and then lamentation when the (unavoidably) non-ideal control group is not ideal. Many papers could be written on the subject of control groups alone, but a few practical observations based on more than 300 evaluation surveys (large scale and pilots, which included in most of the cases a control group) illustrate the key issues.

The most important factors to be controlled in travel surveys are: season (including holidays), weather, special events, infrastructure changes, and prices. It is generally possible to find a reasonable control group for each of these factors.

But the most problematic single factor is diffusion. Effective behaviour-change projects can generate enormous momentum and it is often difficult (sometimes impossible) to avoid control group results being contaminated to a degree (which always makes the changes look smaller than they really are).

Control group evaluation adds substantially to the cost of a travel behaviour change project. In practice, the change in the control group has consistently been small, largely because the time between 'before' and 'after' measurement is short (one year) and designed to remove the strongest seasonality impacts. Whilst this may change with rapid change in fuel prices and volatile economic conditions, other more general indicators of car use (e. g. road traffic volumes and public transport patronage) may be able to provide the necessary baseline information.
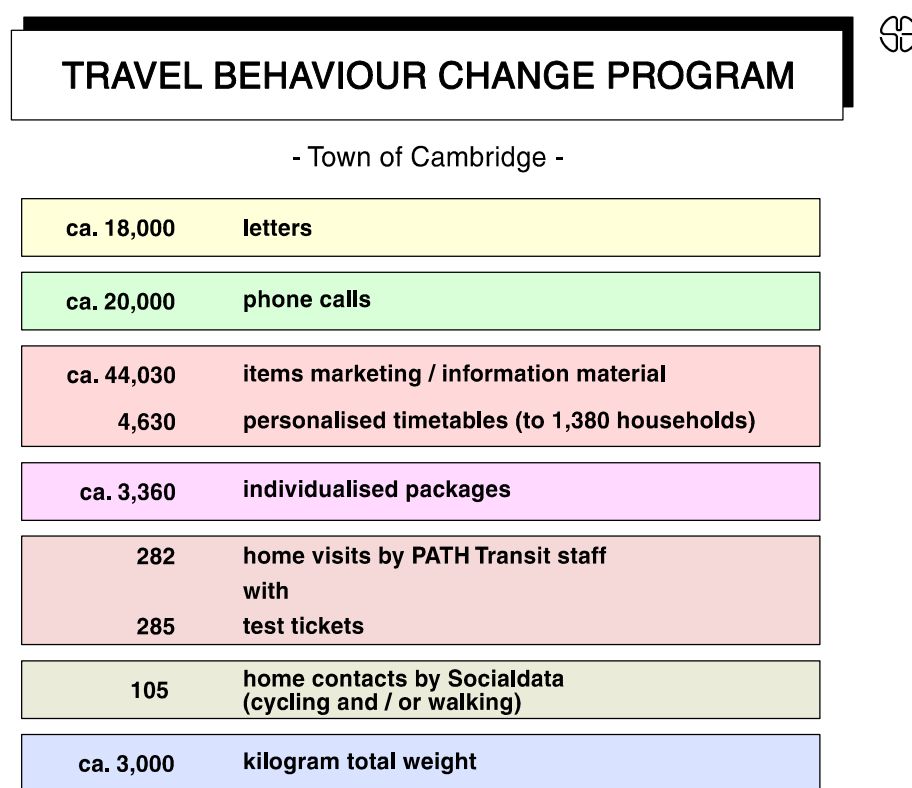
5. Integrated evaluation

The focus on evaluation through measurement of travel behaviour instead of concept and tools means that large proportions of the project money are spent on research instead of on behaviour change (in projects using the IndiMark approach, the evaluation consumes between 25 and 75% of the total budget).

As experience in the field develops, an increasing number of VTBC programmes are seeking to broaden the mix of tools used for monitoring and evaluation. One of the first to use all three types of indicator (as defined in section 2.1) was in the town of Cambridge, Western Australia (Socialdata Australia, 2003). Cambridge is a suburb in Perth, on the coast. The project was conducted in 2002 with a base population of 24,000 people.

- *Behavioural indicators.* The project saw a 7% reduction in car-as-driver trips and a 17% increase in use of sustainable modes (walking, cycling, PT).
- *Marketing indicators.* Of the base population, 90% were successfully contacted and 58% agreed to join a dialogue about their day-to-day mobility. (Fig. 6 summarises other important features of the project conduct.)

There were 20 different marketing items on offer, plus 175 different stop related timetables. Total orders of these (each item is individually recorded) amounted to 44,030. These were delivered in 3,360 individual packages: 95% using bicycles (and trailers) and 85% within one week from the initial order. This is an important indicator because, according to the principles of dialogue marketing, participants should become actively involved and should receive only those materials that they specifically request.

Bus drivers conducted 282 home visits with an average duration of 32 minutes (ranging from 10 to 90 minutes) and 92% of visited households rated this service as being positive (cycling home visits had an average duration of 34 minutes and a 98% positive rating).

TRAVEL BEHAVIOUR CHANGE PROGRAM

- Town of Cambridge -

ca. 18,000	letters
ca. 20,000	phone calls
ca. 44,030	items marketing / information material
4,630	personalised timetables (to 1,380 households)
ca. 3,360	individualised packages
282	home visits by PATH Transit staff with
285	test tickets
105	home contacts by Socialdata (cycling and / or walking)
ca. 3,000	kilogram total weight

Source: http://www.dpi.wa.gov.au/mediaFiles/ts-Cambridgebusdata.pdf

Fig. 6. Travel Behaviour Change Program – Cambridge, Western Australia.

These factors are, for marketing people, arguably just as important as the measured behavioural changes measured and in conjunction with those behavioural measures they make a strong case for the effectiveness of the intervention. This effectiveness is further evidenced by hundreds of unprompted comments from participants, some examples of which are presented below.

General: ◆ 'Every little helps, especially as I get older I need the encouragement.'

◆ 'The phone discussion and personal visit helped me to overcome some of my unconscious misconceptions about public transport and clarify my resistance i. e. didn't know about tickets, how to validate and purchase, where bus routes went and about safety on trains and walking home after dark. It was useful to talk about these things.'

Public transport: ◆ 'It gave me the confidence to use a bus that goes near my home. In 8 years it was the first time.'

◆ 'It's good to get people used to public transport as there are various advantages like meeting people and doing some walking to get to the transport.'

Home visits: ◆ 'Our bus driver made us feel that the transport system belongs to everyone; that there is a strong desire to make it work for everyone; that we are more connected in City Beach than we generally feel.'

◆ 'An efficient and knowledge based visit. My bus driver was an expert and really inspired me to make an effort to get our and enjoy the travel available.'

Walking: ◆ 'I will use my car less and walk more.'

◆ 'I think in general the initiative has made me walk more e.g. instead of driving to school I walk.'

Bicycle: ◆ 'Just bought it back into awareness, and made me get my bike out.'

◆ 'A good idea; for me the local visit to my house and the incentive on discount for bike service actually got me onto the road.'

- *External indicators.* The above findings are supported by long-term independent monitoring of bus ticketing data, showing a sustained 23% increase in patronage four years after the TravelSmart programme (Fig. 7).

Source: http://www.dpi.wa.gov.au/mediaFiles/ts-Cambridgebusdata.pdf
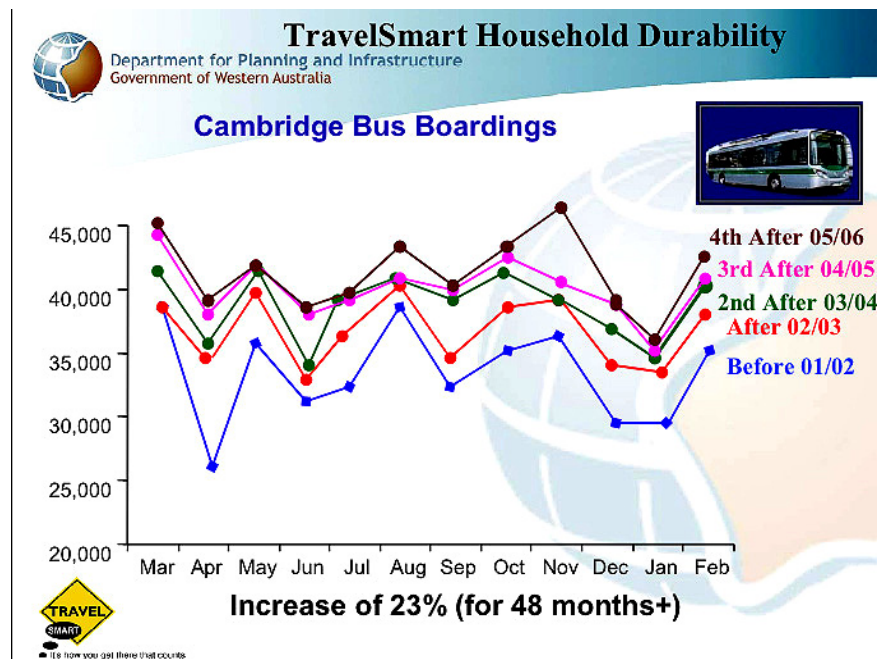
Fig. 7. Long-term monitoring of bus patronage in Cambridge, Western Australia.

It is notable that this evaluation happened under ceteris-paribus conditions. In other words, there was no change in population size, social structure, or PT supply in this period of time.

Furthermore, there is (since 2003) a quality control procedure in place which means that at least 50% of households are contacted by telephone after they have received their delivery. In a limited number of cases, the behavioural surveys are also supplemented by in-depth interviews. These have shown, for example, that in South Perth (Socialdata Australia, 2001) the information about and perception of non-car modes has improved, although the transport system has not been altered. Interviews in Portland (USA) have also shown that a combination of 'hard' policy (provision of nearby light rail) and 'soft' policy (IndiMark) not only changed behaviour, but also led to perceived changes in context, giving people more subjective choices over their travel behaviour (Socialdata America, 2006).

Despite some challenges in obtaining bus patronage data of the required scope and quality, similar integrated evaluations are being adopted in all UK TravelSmart programmes.

6. Conclusions

Voluntary travel behaviour change (VTBC) programmes aim to reduce car-as-driver trips without investment in physical infrastructure or transport services, or regulation of transport activity (including pricing). The principal techniques used in VTBC programmes with households differ in a number of ways: whether they attempt to engage the whole population of the target area: the means of identifying those who participate actively: the methods of participation; and the methods used to assess the extent of behaviour change.

VTBC is almost unique among transport initiatives in that it has been developed from a strong theoretical and observational basis, through a series of interventions using experimental design (generally a pre-test post-test control group design), and has been subject to comprehensive monitoring and evaluation of outcomes, widely documented in the public domain.

Reported estimates of travel-behaviour change achieved by IndiMark have consistently been in the range of a 5% to 15% reduction in car-as-driver trips. This consistency, repetition of results from successive applications, and the cumulative sample size now achieved can be seen to have successfully countered any doubts about effectiveness based on the method of evaluation. Confidence in these estimates is further enhanced by consistently high survey response rates, which minimise the effect of non-response bias.

Further development is required to realise the potential for direct or indirect measurement of car-as-driver trips as an alternative to surveys, to provide robust estimates of the primary travel behaviour outcome. This might be achieved through measurement related to household vehicles rather than to individual members of households. However, such approaches do not automatically overcome issues related to sampling and non-sampling errors associated with surveys.

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