APPENDIX

1 Travel behaviour surveys

To prove the effects of the IndiMark® pilot project in each of the four cities behavioural travel surveys were conducted to measure the change achieved in travel behaviour. The surveys used the New KONTIV®-design, a self-administered mail-back survey technique with follow-up by post and telephone.

The survey concept was planned with one 'before' and one 'after' survey, the later one split up in one approaching the IndiMark® target group and one approaching a control group not included in the marketing intervention. The surveys in the target group were in 3 of the 4 cities (Cleveland, Durham, Sacramento) random samples among the target population, based on matched samples (panel); this gives the advantage of reducing the statistical variance between samples.

The control group surveys were cross-sectional surveys based on independent randomly drawn samples of households not participating in the Individualised Marketing process.

Table 1 shows the net sample sizes for each of the surveys.

Table 1: Response (Persons, net)

	BEFORE	AFTER	
	Total	Target group	Control group
Bellingham	2196	659	868
Cleveland	1583	894	920
Sacramento	1288	744	780
Durham	1043	581	593
TOTAL	6110	2878	3161
(Contracted)	(3200)	(1600)	(1600)

The survey samples are constructed to ensure an acceptable level of statistical significance in the key outcomes presented (see Section 5 of this Appendix).

2 Contact and segmentation phase

During the contact phase all households in the defined target areas were contacted. The aim in this phase is to collect information for the following segmentation phase. Feedback from the contact phase was analysed to segment the total of 3,900 persons into four groups as follows:

- Group **'I'** (interested / interesting participants) the 'respective' persons are more likely to change and continue to use environmentally-friendly modes with personal contact, motivation and information. This group is selected to receive the most attention.

- Group **'R'** (participants already using environmentally-friendly modes) benefit from encouragement and support, and they are rewarded with a small present.

  Group **'R'** is distinguished between those who do not require further information **'R without'**, and **'R with'**, as some users may also be interested in updated information.

- Group 'N' (not interested / not interesting households). These are households who do not wish to participate, or have no interest, intention or possibility of using environmentally-friendly modes. They receive an AAA brochure on how to use their car more efficiently, a rideshare guide, a brochure on health effects of air pollution, a brochure for motorists on sharing the road with cyclists, and a local area access map.

The results of the segmentation are shown in Table 2.

Table 2: IndiMark® groups

	Bellingham %	Cleveland %	Sacramento %	Durham %	TOTAL %
I	37	40	39	51	41
R with	7	8	5	4	6
R without	25	11	7	5	12
N	31	41	49	40	40
Total	100	100	100	100	100

3 Evaluation

In three of the four cities (Cleveland, Durham, Sacramento) the following process was applied. The different Bellingham case is shown at the end of this chapter. The sample for the (before) survey was drawn randomly within the population of the target areas. The 'after' survey was carried out using the same process as before, with one randomly selected part of the respondents to the 'before' survey involved in the IndiMark® process. The control group was randomly selected in the same area neither involved in the before survey nor in the IndiMark® Demonstration Program.

It has to be proved if responding to the after survey leads to selectivity ("panel effect"). So the mode choice between the total (representative) before sample and the before survey results for the respondents to the after survey is compared (Table 3).

Table 3: Mode choice before IndiMark®

	All respondents of before survey %	All respondents of before and after survey %
Walking	7	7
Bicycle	1	1
Motorcycle	0*)	0*)
Car as driver	71	72
Car as passenger	19	18
Public transportation	2	2
TOTAL	100	100

*) less than 0.5 %

The comparison shows that the results for the respondents of the before and after survey are nearly the same as for the total population of the before survey with a maximum change of two percent-points between two modes (car as passenger). This is a piece of evidence for the stability of the sample and the data quality.

The changes in mode choice are the central indicators for the success of an IndiMark® campaign. To separate the effect of Individualised Marketing from other (seasonal and external) influences, a survey design with a control group which was not exposed to the IndiMark® campaign was applied.

Table 4 shows the findings of the before survey and the after survey for the control group (in three cities). Before the IndiMark® campaign, 7 % of all trips were made (exclusively) on foot, 1 % by bicycle, less than 0.5 % with a motorcycle, 71 % with car-as-driver and 19 % with a car-as-passenger. Public transportation accounted for 2 %. After the campaign in the control group the share of walking trips had risen to 8 % whereas the share of car drivers decreased to 70 % and the share of car-passenger, bicycle, and public transportation remained the same.

The observed changes for the control group between before and after – would also have been to be expected in the target group. These changes are projected on to the target group before data giving the reference 'without IndiMark®' for the target group as shown in the next table (Table 5).

Table 4: Mode Choice –After Survey

BEFORE SURVEY		AFTER SURVEY
%		Control group %
7	Walking	8
1	Bicycle	1
0*)	Motorcycle	0*)
71	Car as driver	70
19	Car as passenger	20
2	Public transportation	1
100	TOTAL	100

Table 5: Mode Choice – Target group

	AFTER SURVEY	
	Without IndiMark®	With IndiMark®
	%	%
Walking	8	9
Bicycle	1	1
Motorcycle	0*)	0*)
Car as driver	71	68
Car as passenger	19	20
Public transportation	1	2
TOTAL	100	100

*) less than 0.5 %

This shows that following the after survey there would have been without IndiMark® a 8 % walking share, 1 % bicycle, 71 % with the car as driver and 19 % as passenger and 1 % public transportation trips. The true changes due to IndiMark® can then be measured, showing an increase in walking (from 8 to 9 %), car as passenger (from 19 to 20 %) and public transportation (from 1 to 2 %). The car-driver decreased from 71 to 68 %.

In Bellingham a different sample design was used – cross-sectional samples for each target and control group before and after – and the following figures (Table 6) were used so the same procedure for determining the control group effect could be applied.

Table 6: Mode Choice – Bellingham

Control Group			Target Group	
Before	After		Before	After "Without IndiMark®"
%	%		%	%
8	6	Walking	12	9
2	2	Bicycle	5	5
0*)	0*)	Motorcycle	0*)	0*)
65	70	Car as driver	59	64
23	20	Car as passenger	22	20
2	2	Public transportation	2	2
100	100	TOTAL	100	100

*) less than 0.5 %

So following effects were achieved by IndiMark® (Table 7). Walking increased from 9 to 12 %, cycling from 5 to 6 %, car passenger from 20 to 21 % and public transport from 2 to 3 %. This led to a decrease in car-use as driver from 64 to 58 %.

Table 7: Mode Choice – Target group – Bellingham

	AFTER SURVEY	
	Without IndiMark® %	With IndiMark® %
Walking	9	12
Bicycle	5	6
Motorcycle	0*)	0*)
Car as driver	64	58
Car as passenger	20	21
Public transportation	2	3
TOTAL	100	100

*) less than 0.5 %

4 Total effects

For showing the total effects of the IndiMark® program, the four cities are shown as an integrated total, giving each city the same weight.

The mode choice can now be shown in trips per person per year. An average person undertakes 1,123 trips per year (without IndiMark®) on 341 days at place of residence. 111 out of these trips are (exclusively) made on foot or with a bicycle (NMM = non-motorized modes), 212 with a car-as-passenger and 780 with a car-as-driver.

This can be shown again for the situation without IndiMark® and the factual situation after the IndiMark® campaign (Table 7).

Table 8: Mode Choice – Target Group

Trips per person per year	Without IndiMark® %	With IndiMark® %
NMM	111	133
Public transportation	20	25
Car as passenger	212	224
Car as driver	780	738
TOTAL	1,123	1,120

Basis: 9,841 trips before; 9,462 trips after

This leads to a change in trips per person per year and to relative changes (Table 8).

Table 9: Mode Choice – Change

Trips per person per year		Relative change %
+22	NMM	+20
+5	Public transportation	+25
+12	Car as passenger	+6
-42	Car as driver	-5

Basis: 9,841 trips before; 9,462 trips after

The NMM trips per person per year increased by 22 (+20 %). This is the greatest increase (in trips) observed. The public transportation increased by 5 trips (+25 %) what is the greatest relative change observed.

IndiMark® resulted in a decrease in use of the car of 42 car driver trips per person and year (-5 %). Car passenger increased by relatively 6 % (12 trips per person per year).

So the IndiMark® campaign has reduced the car use by 5 % and increased the share of the environmentally-friendly travel modes walking, cycling and public transportation by 27 trips or 21 % relatively.

5 Statistical Significance of the Changes in Mode Choice

5.1 Independent audit of Socialdata evaluation concept

The evaluation concept was developed and used for the first large-scale application of TravelSmart in Perth (Australia). In this case, an independent audit was undertaken, commissioned by the Western Australian Ministry of Transport, by Prof. Dr. Goulias, Professor at the University of California in Santa Barbara. He states in his audit report that all documents were accessible, enabling an unlimited verification of the correctness of the method and the results, and concludes that the procedure used by *Socialdata* '...exceeds (the standard) in other survey applications in Europe and US' and 'in all components the *Socialdata* planned assessment follows high standards of practice. The procedures ... are excellent' (in: Goulias, K. G.: Audit of South Perth Individualised Marketing Evaluation Survey, comm. by Western Australia Transport, 2001).

5.2 Environmentally-friendly Modes

Concerning the statistical significance of the changes in mode choice expert opinions differ whether this test should be based on persons or trips. For that reason the following test was implemented for both person and trips. The statistical significance of change in mode choice is located between the results of these two tests. Basis for the test are persons in a matched sample (panel) before and after in three of the four cities (Cleveland, Durham, Sacramento). In spite of this fact, the test is calculated for independent samples to use the most strict test conditions. For a panel the variance between the two surveys is much lower.

The statistical significance of the changes in mode choice was first tested for the achieved increase of the share of environmentally-friendly modes (EFM = walking, bicycle, public transportation).

Persons

The zero-hypothesis and the alternative-hypothesis now are:

$H_0: P_1 \geq P_2$
$H_1: P_1 < P_2$

P_1 = share of EFM without IndiMark®
P_2 = share of EFM with IndiMark®

The zero-hypothesis postulates that the share of EFM without IndiMark® is larger or equal than with IndiMark®. If this zero-hypothesis can be rejected, there is an impact of IndiMark® on the increase of the share of EFM.

The surveys before and after are two dependent samples in three cities and two independent samples in one city. Nevertheless the calculation is done as a t-test for independent samples. This assumption is very restrictive because the variance for panel data is always lower than the variance for independent samples.

The share of EFM without (12 %) and with IndiMark® (14 %) and the number of observed persons are the input (before: n_1 = 3,222; after: n_2 = 2,878).

For the test value following formula exists:

$$T = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}} = \\ = \frac{-0{,}05}{\sqrt{0{,}0004}} = -2.7916$$

Test-decision:

$$\varphi(y,y) = \begin{cases} 1 & \text{if} \quad T < -z_a \\ \\ 0 & \text{other} \end{cases}$$

$z_{0.01}$ = 2.326 (critical value for a level of significance of 99 %).

It follows that based on this test the zero-hypothesis (no increase of the share of EFM with IndiMark®) can be rejected with a probability of over 99 %; the increase in EFM usage achieved by the IndiMark® campaign is statistically highly significant.

Trips

For testing on the basis of trips the same test can be performed. The zero-hypothesis and the alternative-hypothesis are:

H_0: $P_1 \geq P_2$
H_1: $P_1 < P_2$

P_1 = share of EFM without IndiMark®
P_2 = share of EFM with IndiMark®

The zero-hypothesis postulates that the EFM share without IndiMark® is larger or equal than with IndiMark®. If this zero-hypothesis can be rejected, there is an impact of IndiMark® on the increase of the EFM share.

The calculation is done again as t-test for independent samples. The share of EFM before (12 %) and after IndiMark® (14 %) and the number of observed trips are the input (before: n_1 = 9,841; after: n_2 = 9,462).

For the test value following formula exists:

$$T = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}} =$$

$$= \frac{-0.05}{\sqrt{0.0001}} = -4.9729$$

Test-decision:

$$\varphi(y, y) = \begin{cases} 1 & \text{if} \quad T < -z_a \\ \\ 0 & \text{other} \end{cases}$$

$z_{0.01}$ = 2.326 (critical value for a level of significance of 99 %).

It follows that based on this test the zero-hypothesis (no increase of the share of EFM with IndiMark®) can be rejected with a probability of over 99 %. The increase in EFM usage achieved by the IndiMark® campaign is statistically highly significant.

So the significance tests performed produced a significance level of more both based on persons and trips of more than 99 %.

Table 10: Overview of significance tests for increase environmentally-friendly modes

	Persons	Trips
Level of significance	> 99 %	> 99 %

These values are proving definitely an increase in the use of environmentally-friendly modes (walking, bicycle, public transportation).

The same test was performed for each of the four cities; the significance for an increase in trips with environmentally-friendly modes is over 97,5 % in one and over 99 % in three of them.

5.3 Public Transportation

The statistical significance of the changes in mode choice was also tested separately for the achieved increase of the public transportation share.

Persons

The zero-hypothesis and the alternative-hypothesis now are:

H_0: $P_1 \geq P_2$
H_1: $P_1 < P_2$

P_1 = share of public transportation without IndiMark®
P_2 = share of public transportation with IndiMark®

The zero-hypothesis postulates that the public transportation share without IndiMark® is larger or equal than after. If this zero-hypothesis can be rejected, there is an impact of IndiMark® on the increase of the public transportation share.

The calculation is done again as a t-test for independent samples. This assumption is very restrictive because the variance for panel data, what is the case in three of the four cities, is always lower than the variance for independent samples.

The share of public transportation before (1.8 %) and after IndiMark® (2.2 %) and the number of observed persons are the input (before: n_1 = 3,222; after: n_2 = 2,878).

For the test value following formula exists:

$$T = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}} =$$

$$= \frac{-0{,}01}{\sqrt{0{,}0001}} = -1.2517$$

Test-decision:

$$\varphi(y, y) = \begin{cases} 1 & \text{if} \quad T < -z_a \\ \\ 0 & \text{other} \end{cases}$$

$z_{0.1}$ = 1.282 (critical value for a level of significance of 90 %).

It follows that based on this test the zero-hypothesis (no increase in the share of public transportation after) can be rejected with a probability of about 90 %. As mostly panel data are the basis, the increase in public transportation usage achieved by the IndiMark® campaign is definitely over 90 % and statistically significant.

Trips

For testing on the basis of trips the same test can be performed. The zero-hypothesis and the alternative-hypothesis are:

H_0: $P_1 \geq P_2$
H_1: $P_1 < P_2$

P_1 = share of public transportation without IndiMark®
P_2 = share of public transportation with IndiMark®

The zero-hypothesis postulates that the public transportation share without IndiMark® is larger or equal than with IndiMark®. If this zero-hypothesis can be rejected, there is an impact of IndiMark® on the increase in the public transportation share.

The calculation is done again as t-test for independent samples. The share of public transportation without (1.8 %) and with IndiMark® (2.2 %) and the number of observed trips are the input (before: n_1 = 9,841; after: n_2 = 9,462).

For the test value following formula exists:

$$T = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}} =$$

$$= \frac{-0.01}{\sqrt{0.0001}} = -2.2297$$

Test-decision:

$$\varphi(y, y) = \begin{cases} 1 & \text{if} \quad T < -z_a \\ \\ 0 & \text{other} \end{cases}$$

$z_{0.025}$ = 1.96 (critical value for a level of significance of 97.5 %).

It follows that based on this test the zero-hypothesis (no increase of the share of public transportation after) can be rejected with a probability of at least 97.5 %. The increase of public transportation usage achieved by the IndiMark® campaign is statistically highly significant.

So the significance tests performed produced a significance level of more than 90 % based on persons and more than 97.5 % based on trips and the real value will be in between.

Table 11: Overview of significance tests for increase in public transportation

	Persons	Trips
Level of significance	> 90 %	> 97.5 %

These values are proving definitely an increase in public transportation use.

The same test was performed for each of the four cities. There the base for public transportation is quite small, but nevertheless the significance for an increase in public transportation trips is between 90 % and 95 % in each of them.

5.4 Car as driver

Persons

The following test can be performed. The zero-hypothesis and the alternative-hypothesis are:

$H_0 : P_1 \leq P_2$
$H_1 : p_1 > p_2$

P_1 = share of car as driver without IndiMark®
P_2 = share of car as driver with IndiMark®

The zero-hypothesis postulates that the car driver share with IndiMark® is not lower than before. If this zero-hypothesis can be rejected, there is an impact of IndiMark® on the reduction of the car driver share.

The calculation is done as t-test for independent samples, in spite of the fact that the surveys before and after present a panel in three cities. The share of car as driver without (70 %) and with IndiMark® (66 %) and the number of observed persons are the input (before: n_1 = 3,222; after: n_2 = 2,878).

For the test value following formula exists:

$$T = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}} =$$

$$= \frac{0{,}06}{\sqrt{0{,}0006}} = 3.0499$$

Test-decision:

$$\varphi(y, y) = \begin{cases} 1 & \text{if} \quad T < z_a \\ \\ 0 & \text{other} \end{cases}$$

$z_{0.01}$ = 2.326 (critical value for a level of significance of 99 %).

It follows that based on this test the zero-hypothesis (no decrease of the share of car as driver after) can be rejected with a probability of more than 99 %. The reduction of car usage achieved by the IndiMark® campaign in the target area is statistically highly significant.

Trips

For testing on the basis of trips the same test can be performed. The zero-hypothesis and the alternative-hypothesis are:

$H_0 : P_1 \leq P_2$
$H_1: p_1 > p_2$

P_1 = share of car as driver without IndiMark®
P_2 = share of car as driver with IndiMark®

The zero-hypothesis postulates that the car-share with IndiMark® is not lower than without IndiMark®. If this zero-hypothesis can be rejected, there is an impact of Indi-Mark® on the reduction of the car-share.

The calculation is done again as t-test for independent samples. The share of car as driver without (70 %) and with IndiMark® (66 %) and the number of observed trips are the input (before: n_1 = 9,841; after: n_2 = 9,462).

For the test value following formula exists:

$$T = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}} =$$

$$= \frac{0.06}{\sqrt{0.0002}} = 5.4330$$

Test-decision:

$$\varphi(y, y) = \begin{cases} 1 & \text{if} \quad T < z_a \\ \\ 0 & \text{other} \end{cases}$$

$z_{0.01}$ = 2.326 (critical value for a level of significance of 99 %).

It follows that the zero-hypothesis (no decrease of the share of car as driver after) can be rejected with a probability of at least 99 %. The reduction of car usage achieved by the IndiMark® campaign in the target area is statistically highly significant.

So the significance tests performed produced a significance level of more than 99 % based both on persons and trips.

Table 12: Overview of significance tests for car reduction

	Persons	Trips
Level of significance	> 99 %	> 99 %

These values are proving definitely a reduction of car use.

The same test was performed for each of the four cities; the significance for a reduction in car use as a driver is over 90 % in one and over 97,5 % in three of them.

6 Results

This section shows the effects on public transportation achieved by IndiMark®. The results are for the total of the four cities, where every city has the same weight.

6.1 Mode choice by trip purpose

Table 12 shows the effect on mode choice for different types of trips by public transportation.

IndiMark® resulted in an overall 25 % increase in use of public transportation modes for all trip purposes (increasing from a set baseline of 100 to 125). Although there were increases for all trip purposes, these were proportionally greater for shopping, personal business and leisure than for trips with fixed destinations (work and education).

Table 13: Activities

	Public Transportation	
	Without IndiMark® (100)	With IndiMark® (125)
Work	47	53
Education	18	20
Shopping, personal business	22	31
Leisure	13	21
Other	0*)	0*)
Total	100	125

6.2 Mode choice by time of day

Table 13 shows how the increases in use of public transportation achieved by IndiMark® were distributed by time of day. The use of public transportation modes increased throughout the day with greater relative increases occurring between 9 am and 7 pm.

This confirms the potential of IndiMark® to make a significant contribution to increase public transportation use in off-peak hours.

Table 14: Time of day – FTA four cities

	Public Transportation	
	Without IndiMark® (100)	With IndiMark® (125)
5 am – 9 am	34	38
9 am – 3 pm	29	48
3 pm – 7 pm	33	35
after 7 pm	4	4
Total	100	125

6.3 Mode choice by age and gender

The distribution of travel behaviour change by age and gender achieved by IndiMark® is shown in Table 14. Increases in use of public transportation were measured throughout the age and gender groups with the most significant relative increase occurring in 60+ years, followed by 20-59 years female.

Table 15: Sociodemography – FTA four cities

	Public Transportation	
	Without IndiMark® (100)	With IndiMark® (125)
under 20 years	15	17
20-59 years female	38	45
20-59 years male	21	26
60+ years	26	37
Total	100	125

6.4 Spatial distribution of trips

An analysis of the spatial distribution of trips by residents of the project areas shows the importance of local trips to everyday travel demand. It also demonstrates how IndiMark® can influence the pattern of local versus longer-distance travel.

Table 15 shows that the proportion of trips to or from destinations within each target area itself increased from 38 % to 40 % following the IndiMark® program. This increase in travel within the local neighbourhood appears to have been at the expense of longer trips to other destinations, down from 40 % to 21 %of trips, and trips outside the city areas also down from 22 % to 21 %.

Table 16: Spatial distribution – FTA four cities

Without IndiMark® %		With IndiMark® %
38	Within target area	40
40	To, from, within other city	39
22	Outside	21
100		100

6.5 *Active modes*

Table 16 shows the time spent travelling with the “active modes” walking and cycling. This analysis is based on trip legs including the access and egress to transit and car. This shows that there were increases in time spent on active modes from 62 hours per person per year to 74 hours per person per year. This increase of 12 hours per person per year equals a relative increase of 20 %.

Table 17: Active modes – FTA four cities

Hours per person per year	Without IndiMark®	With IndiMark®	Change	With IndiMark®
	62	74	+12	+20 %

The IndiMark® program in the cities of Bellingham, Cleveland, Durham and Sacramento resulted in significant travel behaviour change among the target population. It was successful in increasing environmentally-friendly travel modes, among them public transportation, and contributing to reduction in car use.