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CAN THE MULTIMODAL REAL TIME INFORMATION SYSTEMS INDUCE A MORE SUSTAINABLE MOBILITY ?

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ABSTRACT

Modern cities show an increasing interest in Advanced Traveller Information Systems (ATIS), with a growing attention to real time multimodal information. Through those systems, decision makers hope to achieve a shift from the car to alternative, environment-friendly modes of travel. Unfortunately, few comprehensive assessments have been undertaken in order to verify the actual contribution of ATIS to such modal shift.

This paper aims at assessing the effects on travel behaviour of Optimod'Lyon, a multimodal real-time information navigator for smartphone, developed in Lyon in 2013 and launched in May 2015. To this end, a quali-quantitative approach was adopted, administering a questionnaire and organising focus groups before and after the test of the application. A stratified sample of 50 people living in the metropolitan area of Lyon was, likewise, involved. The Theory of Planned Behaviour was used as the theoretical framework for the questionnaire design, investigating attitudes, subjective norms and perceived behavioural control. To evaluate the behavioural change, data were analysed using parametric and non-parametric tests, factor analysis and binary logistic regression.

Survey participants were initially interested on the Optimod'Lyon and showed a positive attitude towards its use. Prior to the test, they evaluated positively the travel planner , but this lessened over time and, after the test, the use of the different travel modes remained stable, showing a consistency on the most used mode, on behavioural patterns and attitudes, strongly related to habits and to the frequency of the past behaviour.

1. INTRODUCTION

Transport of goods and people is an important driver of the global economic growth and prosperity fostering trading and people accessibility and connectivity. In the year 2012, the transport sector in Europe was responsible for 31.8% of the final energy consumption and 1,173.3 million tonnes of CO_2 equivalent of greenhouse gases, and a continuous escalation of these figures is envisaged (*1*). One favoured solution to offset such unsustainable trend is based on Advance Traveller Information Systems (ATIS) . ATIS are data integration systems delivering accurate, reliable, and timely information to travellers (*2*), helping them to plan their route, to estimate their travel time, and to make informed decisions using real-time information (*3*).

These systems are seen as an encouragement for travellers to make the best use of the available transport modes and to support an integrated, sustainable transport system.

The impact and effectiveness of ATIS critically depend on traveller's responses to these systems, on the typology of supplied information and on the way they are used by those travellers. Abdel-Aty (2002) (*4*) stated that it is not easy to define and quantify ATIS impacts due to the lack of actual situations in which travellers' behaviour can be observed under the influence of ATIS. The potential of ATIS to affect mobility behaviour has hitherto rarely been researched (*5,6*). However, there have been many attempts to assess ATIS benefits gathering data from various sources, predominantly from surveys but also from field observations and simulations (*7*). Most of the surveys concerned the effects of traffic information on car drivers, mainly commuters, to estimate user satisfaction and the effects of ATIS operation (*8,9,6*). Arguably, only few studies have explored the consequences of information on public transport (PT) ridership, notwithstanding its potential role in increasing it and improving customer satisfaction (*10,11*). The effects of multimodal real time navigators are even less analysed. In fact, while the multimodal journey planners are increasingly important, real time navigators and research about their effect on travel behaviour are still in their infancy. The project Optimod'Lyon (2012-2015) was pioneer in developing a real time navigator for smartphone, including all transport modes (car, public transport, bike, bike sharing, foot, car sharing and car pooling) in an integrated way, and this paper presents the results of the test on a panel of users.

Real-time information is the novelty introduced by Smart-Way, one of the first smartphone applications for PT when it was developed in 2010-2011 while, today, more real-time applications, as those developed for Zurich, Vienna, London (*11*) are available. However, an application to allow reaching a destination through a multimodal trip chain suggested on the basis of real time information did not exist before the development of Optimod'Lyon, followed up by the EU project Opticities, developing a similar app also in Torino, Gothenburg and Madrid (www.opticites.org).

Information is a key factor in today's' mobility, having a high potential for optimising the travellers' choice. Abdel-Aty (2002) (*4*) noted that accurate and high quality information are decisive for using public transport.

If systems like these have an effect on modal choice, and how it happens, highly depends on the way they are utilised by users. Obviously, this is not only a technological but also a social process which requires technology assessment (*5*). Farag and Lyons (2012) (*12*) showed how travel behaviour, travel attitudes and socio-demographic features have the strongest effect on pre-trip PT information use both for business and leisure trips. It was also argued that past behaviour and habits are not always a good predictor of future behaviour (*13*).

Complex human behaviour is cognitively regulated and, despite existing bye-laws, it should be subjected to at least some degree of monitoring. As a consequence, the new information provided by ATIS, if relevant and convincing, could produce changes in attitudes, subjective norms and perceptions of behavioural control, affecting intentions and likely to influence subsequent behaviour (*13*).

The objective of this research is, thence, to bridge the gap of knowledge in the existing literature by analysing the effects on travel behaviour of the real-time multimodal information provided by the smartphone application developed within the research project Optimod'Lyon. This paper aims at assessing the effectiveness of multimodal real-time information systems, pointing out the limitations before their use and recording the changes induced on travel behaviour.

The next section describes the methodology for data collection and analysis. The results are presented in section 3 while section 4 discusses those results and compares them with the relevant literature.

2. METHODOLOGY: THE SURVEY AND THE DATA ANALYSIS

The Lyon Metropolitan Area, under the Grand Lyon authority, covers an area of 512 km² (58 municipalities) with a population of about 1.3 million people. Lyon is an important centre of economic development and it is the second French metropolitan area after Paris.

Participants to the survey were selected according to a stratified sampling plan based on gender; age; education; occupation; income; presence of children in the household; travel pattern (travel time, scope, used mode, origin and destination). A sample size of 50 people was recruited by a specialised agency following the defined sampling plan. The sample was not designed to represent the local or national population, but to include different users' profiles so as to better test all possible behaviours and reactions to the use of application.

The survey administered to the sample followed a quali-quantitative approach based on two tools: the web-questionnaire and the focus group that were meant to work in an integrated way.

The web-questionnaire, created with the Google form platform, was addressed to the participants in two stages: in February 2013 (ex-ante) and, five months after testing the application (from June to October), in October 2013 (ex-post). Just few days after the administration of the ex-ante questionnaire the focus groups were organised to investigate the issues contained in the questionnaire, thus allowing both a cross-reference with the topics discussed and a double check of the results of the questionnaire. All the 50 individuals participated in the first stage, while 4 dropped the survey and did not participate in the second stage. During the test of the application, an on-going survey was undertaken to check its functionalities. To properly involve the panel throughout the survey period, a smartphone (Samsung Galaxy S3 mini) was presented as incentive.

The ex-ante and ex-post questionnaires consisted of five sections: travel habits, attitudes towards mobility, environmental issues, familiarity with, and interest on the technological tools, and Optimod'Lyon application. The focus group followed a similar pattern, investigating the personality traits, attitude towards technology, perception about real time information, expectations about Optimod'Lyon application, willingness to pay and barriers for using the app.

In designing the questionnaire and the focus group, attention was paid to attitudes and behaviours related to the most frequent trip made by respondents, disregarding purpose and people occupation (workers, students, retired people, housewives, etc.). The most frequent trip is, arguably, the best known for users in terms of time and general constraints. The most frequent trip could induce a specific mobility behaviour, regardless of people characteristics (employed/unemployed) and trip purpose (work, shopping, etc.): it is more related to people habits, and , hence, less likely to be changed (*14*). The theory underpinning the survey design is that of planned behaviour (TPB), largely applied to understand the link between intention and behaviour, which has shown positive results in many fields, thus becoming a powerful predictive model for explaining human reactions (*15*). The questions regarding several issues (travel behaviour of users, their opinions about private and public transport and about technological tools, etc.), were rated according to a five point Likert scale, as this represented a good compromise in terms of overload for the respondent (*16*). That scale was chosen for consistency throughout the questionnaire as well as to avoid reporting errors (*17*).

Since the total number of participants was 50, it was not possible to use the central limit theorem neither the Shapiro-Wilk test to guarantee the normal distribution of the variables. Assuming that data would never be precisely normally distributed, according to Brown (2011) (*18*) and Fife-Schaw (2013) (*19*) we considered the variables relatively normal if Skewness and Kurtosis values ranged from -1.5 and +1.5. Descriptive analysis, parametric and non-parametric tests, factor analysis and binary logistic regression were used as statistical approaches to analyse the collected data and to assess the effectiveness of the application. The BMDP Statistics Software (*20*) was used for these analyses.

To identify the TPB factors structure, a principal component analysis with quartimax rotation was conducted on 10 questionnaire items. For samples with less than 60 participants, items can only be acceptable if communalities mount at least to 0.60 (*21*). Therefore, two items were removed in the first analysis. In the second analysis, sampling adequacy (Kaiser-Meyer-Olkin) indicated a mediocre compact of correlations (0.608) and the analysis of sphericity displayed a strong relationship between the items (df=28, p<0.001), both of which showed that factor analysis is appropriate for this measure. Factors were extracted on the basis of eigenvalue greater than 1, percentage of variance accounted, percentage of variance explained by each factor, number of items with significant factor loadings and factor interpretability (*22*).

3. RESULTS

Participants are evenly gender-balanced (25 women and 25 men), their ages ranging from 23 to 68. As for education, 32% hold a university degree while 68% have not attended university and two of them (4%) have no diploma.

34% have an average gross household income of 3,000-5,000 €/month, while 48% earn 1,500-3,000 €/month; only 8% get less than 1,500 €/month. As regards household composition. 38% live as a couple; 22% live alone and 28% have a larger family (≤4 people). People living with children represent 44% of the sample.

Almost all respondents have a driving license (90%) and the overall car availability of their households is rather high: 44% own one car while 42% own two cars. However, 10% do not have access to any car within the household.

Analysing travel habits – daily travels and most frequent trip – the most favoured mode is the car as driver (52% in autumn-winter, 36% in spring-summer), while 32% use public transport, showing a strong decrease in the summer time. 10% of respondents declare to use soft modes in connection with public transport. Since most of the participants are part of the employed population, for 74% of them the most frequent trip is to work, while 5 participants travel for leisure and 4 to pick up somebody.

This paper focuses on the quantitative analysis, presenting only the results of the questionnaires, which are actually confirmed by the focus groups outcomes. In the next two sections the results referred to the ex-ante and ex-post stages of the tests are presented: the first section shows the potential barriers for using the app and evaluates the constructs of the TPB. The second section presents the effects of the app on travel behaviour, comparing the answers provided by the panel to the two-stage questionnaire.

3.1 Ex-ante results: barriers to use and behavioural constructs

The majority of the participants owned a smartphone (41 out of 50) and they acknowledged to be skilled users of technology, showing a high level of interest towards technological devices. When choosing a route to an occasional place, they mainly used web sites (e.g. Mappy or Via Michelin) to get the information (44); the second most used tool is the GPS navigator (31), the third one being apps like Google maps (28).

More than half of the participants (27) considered that apps help them in their daily life, and found (31) that some apps are enjoyable to use. As for the willingness to discover new apps, 22 persons liked to do it.

The principal component analysis (PCA) allowed finding out three main factors, matching the theory of planned behaviour. Table 1 shows the rotated matrix and includes all loadings >0.30, highlighting in bold the loadings of the items used to identify each factor. Factors were identified as representing attitudes towards the behaviour (ATT), perceived behavioural control (PBC) and subjective norms (SN). The number of factors was chosen through the scree test, jointly used with the Kaiser criterion of computing the eigenvalues for the correlation matrix, to avoid possible distortions in the results (*23*). The three factors explained a total of 72.422% of the variability of the original eight variables. Parallel analysis was also used to check if the number of factors for this number of observations was significantly different from a parallel random process (*24*), confirming the number of latent constructs. Therefore, the complexity of the data set can be considerably reduced by using these components, with 27.578% loss of information.

The value of mean communality was 0.724, greater than the threshold (0.70), and all items presented a loading factor above 0.60 (*25*). The high loadings on two different items related to both PBC and ATT made the factors meaningful and well matching the theory even though loaded by only two variables.

Cronbach's α was computed for the items used in identifying each factor (SN, α = 0.802; ATT, α = 0.739; PBC, α = 0.532) and all values complied with the threshold (0.70) except the PBC. Despite the PBC construct showed a poor value for internal consistency – even though still acceptable – it was decided to use the PBC construct in the analysis because small samples size can deflate the Cronbach's α value (*26*). Respondents' scores on the scales were calculated considering the mean value on items in each scale (from 1 to 5). For all TPB constructs, the mean values of the 50 participants scored near the middle point of the scale (3). Pearson correlation and Spearman's rho did not show any significant correlation among the three constructs, so that they are independent.

TABLE 1 Rotated Principal Components Analysis (PCA) Structure Matrix

Items	TPB	SN	ATT	PBC
I expect that my family and friends put me under pressure to reduce the environmental impacts of my travels	SN	**.898**		
I expect that my family and friends incite me use Optimod'Lyon	SN	**.762**		
I expect that policy makers incite me use Optimod'Lyon	SN	**.754**		
I expect that policy makers put me under pressure to limit the environmental impacts of my travels	SN	**.753**		.346
I don't like driving for most frequent trip	ATT		**.883**	
I don't like travelling by car	ATT		**.882**	
I would use the Public Transport more often if I had real-time information	PBC			**.809**
I would use more the Vélo'v (bike-sharing) if real-time information was available	PBC			**.784**
Eigenvalues		2.713	1.795	1.286
Percentage variance explained		33.908	22.436	16.078

Note: All factor loadings > .300 (or<-.300) are shown. Loadings of items used to identify each factor are in bold; other loadings are italicized. SN = subjective norms; ATT = attitudes towards the behaviour; PBC = perceived behavioural control.

A 1 to 5 scale was used to inquire about the intention to change transport mode, 1 and 2 expressing of the least willingness to change travel behaviour while 4 and 5 show the opposite. People responding (3) were considered undecided and, thus, left out.. Table 2 shows descriptive statistics for people who expressed the intention to keep or change their travel behaviour (hereafter, *keepers* and *changers*). The higher value showed by PBC *changers* is consistent with the theory as well as the lower value regarding the ATT.

TABLE 2 Descriptive statistics for TPB variables for different intentions

Intention	Constructs	Mean	Min	Max	SD	Variance	n
Keeping travel behaviour (12 using car and 15 PT+soft modes)	ATT	3.259	1.00	5.00	1.259	1.584	27
	SN	2.704	1.00	5.00	1.070	1.144	27
	PBC	2.685	1.00	5.00	1.257	1.580	27
Changing travel behaviour	ATT	2.0000	1.00	4.50	1.275	1.625	9
(6 using car and 3 using PT+soft modes)	SN	2.7500	1.75	4.00	.791	.625	9
	PBC	3.2778	1.50	4.00	.833	.694	9

Mann-Whitney tests did not show significant differences between *keepers* and *changers* about SN (U=121, p=.985) and PBC (U=82.5, p=.149), but significant differences (p<.05) are recorded for ATT (U=56, p=0.016). Thus, it can be argued that the *keepers* are the majority, both using the car and the sustainable modes, showing the strong influence of habits on daily travels.

Spearman's rho (ρ) correlations among variables were calculated, and the three constructs did not show any significant correlation, meaning that multicollinearity would not be a problem in regressions using these variables as predictors (*21*).

A logistic regression was used to understand the ability of the TPB model to explain the modal change intention. SN, ATT and PBC were entered simultaneously in the regression where ATT and PBC constructs were significant ($p<0.05$) and SN construct was not. Then, a model using forward stepwise method was built. ATT were added to the model (Table 3). SN were excluded at the first step because they had significance values larger than 0.05. Finally, even though PBC had a significant value, it was left out on the last step because it did not contribute to better fit the model. For a logistic model, when the intercept is zero, the logit (or log odds) is zero, implying that the event probability is 0.5. This is a very strong assumption that sometimes is reasonable, but more often it is not. Therefore, a highly significant intercept in this model is generally not a problem (*27*).

TABLE 3 TPB Model

Predictor	**Coefficient**	**SE**	**Coef/S.E.**	***p-value***	**Exp(coef)**	**95% CI Exp(coef)**	
						Lower bd	upper bd
ATT	.835	.373	2.24	.043*	2.31	1.08	4.92
Constant	-1.068	.954	-1.12	.302	.344	.050	3.29

* sig. at .05

As a further check, the backward stepwise method was used, not changing the above results, making confident about the reliability of the model. The Hosmer-Lemeshow and the C.C. Brown test report that the model adequately fits the data, since the values are higher than 0.05.

The model is reported in the equation (1):

$$\Pr[\text{ Maintain}] = \frac{e^{-1.068+.835ATT}}{1+ e^{-1.068+.835ATT}} \qquad (1)$$

where the odds of maintaining the used mode increase by a multiplicative factor of 2.31 (Exp(a) = .835)) for each absolute increment of the ATT score. Globally, 80.6% of the cases are correctly classified.

3.2 Evaluation of the effects of the application on travel behaviour

As argued in the methodological section, the analysis carried out after the test involved 46 persons (four participants left the experiment). However, the figures of the initial sample have been retained.

Comparing the stated and revealed potential benefits of the application as declared by the individuals, it is possible to observe that the number of people with a positive view decreased in a statistically significant way from the ex-ante to ex-post survey. Likewise, the intentions to change their travel behaviour as a result of the application significantly differed between the two surveys (Table 4).

Table 4 shows that the only significant statistical difference was related to the use of car thanks to the real time information: the number of participants who admitted using more the car strongly decreased from 16 (ex-ante) to 4 (ex-post).

TABLE 4 Stated and revealed benefits and intentions: statistical differences between ex-ante and ex-post survey

Stated and revealed benefits	Ex-ante (n° of people who agreed to the statement)	Ex-post (n° of people who agreed to the statement)	Paired T-test	p-value	Wilcoxon Test	p-value
Optimod'Lyon as a facilitator towards a mobility behaviour change	19	3	3.64	<.001*	-5.347	<.001*
Optimod'Lyon as an incentive to change mobility behaviour	17	9	9.117	<.001*	-3.20	<.001*
Gain time, thanks to Optimod'Lyon **	42	14	6.84	<.001*	-4.893,	<.001
Optimod'Lyon as a tool that helps to reduce the environmental impact of travels	29	6	8.42	<.001*	-5,374	<.001*
I intend to change my travel habits	8	3	2.003	.051	1.86	.068
I would use the Public transport more often if I had real-time information on timetables and passes	24	16	1.772	.083	-1.741	.082
I would use Vélo'v (Bike-sharing) more often if I had real-time information on the availability of Vélo'v (Bike-sharing) and occupation sites	13	10	N/A	N/A	-1.741	.082
I would use my car more often if I had real-time traffic information	16	4	N/A	N/A	-2.546	.011*
I would carpool more often if I had real-time information on its availability	18	14	N/A	N/A	-1.210	.226

* significant at the 0.05 level.
** In the ex-ante survey there were three questions assessing the Optimod'Lyon influence on limiting travel environment impacts. The three questions showed an excellent alpha of Cronbach's Alpha (α=.911) and with their mean value was produced a new variable.

Concerning the most frequent trip, an overall change towards a more sustainable mobility was not evident. In fact, some participants moved from car to other modes, while other participants switched from more sustainable modes to car. In contradiction with the theoretical expectations, the number of people using polluting modes has slightly increased after the test. The introduction of Optimod'Lyon did not produce any change in the use of car, motorcycles, bicycles and Vélo'v (bike-sharing) in autumn/winter, spring/summer or weekends.

The intention of using the app to plan occasional and daily trips showed significant changes after the test, decreasing in both cases ($Z=-4.564$, $p<0.001$ for occasional trips; $Z=-4.347$, $p<0.001$ for daily trips).

The three decision-making scenarios – pre-trip planning, en-route and re-route – were tested in the ex-post survey: 15 people used Optimod'Lyon for pre-trip planning, 10 for en-route information, while 20 to get re-route information.

Another aspect analysed in the ex-post questionnaire was the usefulness of the app in discovering new routes. Even though a neutral viewpoint is noticeable ($M=2.93$, $SD=1.526$), 16 participants reported that they found new routes using Optimod'Lyon. Furthermore, 14 participants stated that the app allowed them to spare time during their trips; 11 persons both found new routes and saved time. Finding new routes and saving time during the travel thanks to the app showed a significant and positive correlation ($r_s = 0.652$, $p<.001$).

An important issue to understand the potential success of Optimod'Lyon is to assess the willingness to pay for using the application that, after the test, was significantly lower than previously stated ($Z=-2.062$, $p = 0.039$).

The ergonomics of Optimod'Lyon was evaluated through three criteria: easiness to use, problems using the app and time losses in searching information. There is a statistical difference between ex-ante and ex-post survey (easiness to use: $Z=-4.682$, $p <0.001$; facing problems: $Z=-3.062$, $p=0.002$), showing that people faced more difficulties than expected using Optimod'Lyon. The statement "I did not lose a lot of time using Optimod'Lyon", was only present in the ex-post questionnaire; while 21 participants agreed that they did not lose time using the application, 10 disagreed.

3.2.1 Change of constructs of TPB after the test

Before the test, a principal component analysis, using the statements from the ex-ante questionnaire, was used to identify the TPB constructs: ATT, PBC and SN. The same statements were used in the ex-post questionnaire and the Cronbach's α was computed for the items used for each factor, to understand if these constructs continued to be valid also after the test. ATT ($\alpha=.671$) and PBC ($\alpha=.674$) constructs in the ex-post did not reach the threshold, but showed an acceptable value for internal consistency (*26*). SN ($\alpha=.745$) showed a good internal consistency. Participants' scores on reliable scales were computed by taking their mean on items included in each scale, so that scores ranged from 1 to 5. Pair T-test and Wilcoxon Signed Ranks test were performed to verify if there were significant differences on how participants scored the TPB constructs between the two questionnaires.

ATT and PBC did not show any significant difference between the two questionnaires; on the contrary, SN construct presented a significant decrease between the ex-ante (2.75) and the ex-post survey (1.25). These results further confirmed what found earlier about the lack of predicting power of the TPB constructs and will be discussed in the next section.

4 DISCUSSION AND CONCLUSIONS

The results have showed there were no restraint in using Optimod'Lyon, as long as participants are familiar with the technology and with the use of smartphones applications (e.g. Google maps), GPS navigators and websites to obtain travel information. A sample including people of different ages, education and profession showed how the use of technology largely cuts across the socio-economic characteristics as proved by the wide market penetration of the ICT tools. In fact, the rise in mobile devices popularity and the ubiquitous web are changing the way of living; for example, social media have better performed than traditional systems in providing information during emergency situations (*28*). 90% of American adults have a cell phone and 64% have a smartphone; mobile devices are full of sensors and such data can be harvested for multiple uses[1].

Such a revolution, fostered by the ICT, has led decision makers to think that the technological devices could also be the turning point in changing the travel behaviour, encouraging the use of more sustainable transport modes thanks to a better information on them.

To this end the Optimod'Lyon project was funded to develop a so far inexistent tool , including in only one application all transport modes and giving real time intermodal routing information. The panel selected for the test was monitored before, during and after the use of the application to understand and assess its effects on the mobility patterns of the participants.

At the onset of the test, travellers' assessment towards the travel planner was slightly positive, but this waned over time while the use of the different modes remained stable after the test, albeit a small increase of the car for the most frequent trip was observed. 17 participants changed the mode used for the most frequent trip, but their change was not driven by the search for a greater sustainability (changing job location, finding of a better route, meteorological conditions).

This negative ex-post evaluation of Optimod'Lyon can be due, partly, to the application itself as it was not easy-to-use during the daily commuting. Furthermore, during the test, the app was updated three times, adding small changes in terms of content and user interface that could cause some bias on the results. This evaluation showed that Optimod'Lyon did not meet yet all the technical preconditions demanded by the travelers for inducing a change on mobility behaviour. In fact, Fayish and Jovanis (2004) (*29*) had already observed that, in order to encourage the use of ATIS, travelers request that the systems are user-friendly, providing accurate information and pleasant graphical design.

In addition, after the test, the results were in line with previous studies, meaning that few people used this app on a daily basis or for planning daily commuting, while it was most often used to plan occasional trips (*30,31*).

The facts prove that the app alone had no influence on the modal shift and that the users' expectations were higher as regards what they experienced during its use.

The reasons for such a mismatch are several; arguably, the real time feature of Optimod'Lyon did not match the expectations of the participants: 42 people wanted to save time and only 14 actually did it while ATIS should allow for time saving (*31*).

Moreover, there is the evidence that the information is not very effective for the daily trip as the user is unlikely to consult it. Due to the strong habit in making such a trip, the information becomes redundant over time. Skoglund and Karlsson (2012) (*32*), in a study carried out in Stockholm, observed some changes in the respondents' assessment of the planner and the provided service over nine months of the test. The planner was rated as less useful, less effective, less amenable and less stimulating than initially expected. Those researchers also showed that the information provided by the travel planner was relied upon, but the perceived value of the

[1] http://www.pewinternet.org/fact-sheets/mobile-technology-fact-sheet/

service dwindled over time. The service had been re-used by less than 40% of the respondents.

The willingness to pay for its use also lessened after the test, showing a relationship with the lack of time saving allowed by the app. However, the lack of willingness to pay for such applications is largely found in previous studies (*33,34,11*).

The expert group on Urban ITS (2011) (*36*) concluded that the implementation of the Multimodal information system was the most economical method to get a reduction of 24,000 tons of CO_2/year in Lyon, equivalent to 1% of modal shift from cars to bikes and/or public transport. The results of this research lead to mistrust the capacity of those systems, by themselves, to get 1% of modal shift. Those systems have to be part of a wider strategy to achieve sustainable urban mobility, including more investments on public transport, on pedestrian/bicycle routes and measures to cut down on car use.

The participants stated that this app did not help them to reduce environmental impacts to the extent they expected. However, notwithstanding the strong awareness of environmental problems, a low intention to reduce car use is recorded (*36*) and is confirmed in our sample where the intention to use more sustainable modes (PT, bike sharing, carpooling) if real-time information is available decreased after the test, as also showed by the lack of fit of the TPB model.

The intention is the best predictor of the future behaviour unless strong habits towards the target behaviour prevail. However, if there is no intention to change travel habit, the use of a journey planner does not bring any additional information, as confirmed by the literature:

- there is no correlation between the respondents' assessment of the travel planner and their reported change of travel mode (e.g. more by public transport/less by car) as a consequence of access to the travel planner (*32*);
- there is little evidence to suggest that the provision of information has been effective in promoting modal shift (*32*);
- realising changes in people's travel behaviour is difficult (*37*). There are several co-operating factors that determine how the individual perceives his/her 'action space' and the choices that are considered possible. These factors include the design of the transport system but also the household socio-economic situation, accessibility to services, as well as motives, attitudes, knowledge and, not least, habit. Routine habits, such as commuter journeys, are most often undertaken without further thought or reflection (*13,38)*.

As the results of the test showed, the model proposed by the Theory of Planned Behaviour (TPB) was unable to predict the intentions in regard to modal shift. In fact, the intentions to change mode slightly came from the personal assessment of shifting modes (attitude towards behaviour, ATT); the other two constructs, subjective norms (SN) and perceived behavioural control (PBC), did not play a role in explaining intentions.

The ATT, PBC as well as intentions did not change significantly. The stability of intentions and of perceived behavioural control could explain the observed behaviour stability. Those factors presumably determined the behaviour in the past and, as this remained unchanged, prompted the corresponding behaviour in the future (*13*). This observed lack of fit of the TPB can be related to the participants' high frequency of past behaviour, which leads to mobility habits, strongly influencing the process of modal choice. Hence, the behaviour under consideration, rather than being completely reasoned, is partly under the direct control of the stimulus situation, that is, the repetition of the habitudinal performance (*13*).

Aarts et al. (1997) (*39*) found that systematic travels limit the effects that information can have on modal shift because people automatically behave without consulting the available information. Disregarding routines, human social behaviour is always regulated at a certain (even if low) level of cognitive effort. Therefore, for inducing a multimodal behaviour, the use of information should contribute to disrupt the routine behaviour and to initiate reasoned action (*40*).

Mobility habits are a constraint in the process of modal choice. The information can play a role in shifting modes only if it becomes meaningful enough to provide users with significant reasons to break away from their routine, thus changing the cognitive foundation of intentions and behaviour.

Individuals most inclined to use Optimod'Lyon are middle aged car owners, with a high educational level and familiar with technology. However, a motivated use of information through the travel planners is a real challenge and, hence, unlikely to change the travel behaviour of individuals unless some benefits are perceived. Actually, only three out of the eight persons having declared their intention to change their behaviour before the test, have retained such intention.

The conclusions of this study should be considered with caution due to the sample size (ex-ante=50; ex-post=46); nevertheless they are confirmed by the results of the focus groups and they match well the outcomes of other studies. Nevertheless, it is not possible to generalise these conclusions as it was impossible to have a control group since all participants got a smartphone. This limitation is not uncommon in field studies, but it raises the possibility that events other than the introduction of the multimodal app may have produced the observed effects (*13*).

This research provides, nonetheless, added value as regards the impacts ATIS can have on mobility and may be a starting point for future studies.

Even though multimodal traveller information systems are a rather recent concept – albeit nowadays globally used – there is a real need for the assessment of their impacts as many funds are being addressed towards their development, without a real understanding of their effectiveness.

In this research the TPB model was applied to predict the modal shift when using real time information. It can be concluded that, with the available data, this model did not fit the expected behaviour. Thus, the research is continuing within the already mentioned Opticities project, applying this theory to a larger sample and using the findings of this research for the factor constructions. Thence, in the Opticities project, other behavioural models will be tested to understand if they work better to predict the modal shift, in case of multimodal real time information and a mix of models or a new model will be, eventually, constructed to describe and predict this complex behaviour.

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