The Challenges of Developing an Online Tool to Measure the Quality of the Passenger Experience in a PanEuropean Context

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Abstract. METPEX is a 3 year, FP7 project which aims to develop a PanEuropean tool to measure the quality of the passenger's experience of multimodal transport. Initial work has led to the development of a comprehensive set of variables relating to different passenger groups, forms of transport and journey stages. This paper addresses the main challenges in transforming the variables into usable, accessible computer based tools allowing for the real time collection of information, across multiple journey stages in different EU countries. Non-computer based measurement instruments will be used to gather information from those who may not have or be familiar with mobile technology. Smartphone-based measurement instruments will also be used, hosted in two applications. The mobile applications need to be easy to use, configurable and adaptable according to the context of use. They should also be inherently interesting and rewarding for the participant, whilst allowing for the collection of high quality, valid and reliable data from all journey types and stages (from planning, through to entry into and egress from different transport modes, travel on public and personal vehicles and support of active forms of transport (e.g. cycling and walking). During all phases of the data collection and processing, the privacy of the participant is highly regarded and is ensured.

Keywords: Adaptive and personalized interfaces, Entertainment and game user interface, Human Centered Design and User Centered Design, Internationalization and Localization, New technology and its usefulness, Qualitative and quantitative measurement and evaluation, Universal usability, transport.

1 Introduction

Public transportation improves the quality of life in communities by providing safe, efficient and economical services, and delivering a vital component necessary for a healthy economy. Thus public transport is central to people's lives and well-being, especially vulnerable groups (e.g. less mobile, elderly and disabled). The need to encourage greater public transport use is critical in achieving sustainability targets.

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For many, the perception and reality of public transport does not encourage use, especially when multimodal forms of transport are needed. A holistic understanding of the passenger experience is critical to develop and support transport accessibility. Whilst previous research has focused on different aspects of passenger experience, the diversity of tools developed limits their usefulness, effectiveness and transferability. Given the maturity of research, there is a need to synthesize methods and knowledge, to produce a pan-European standardized tool for use across transport modes and with different passenger groups to focus attention away from the design of discrete elements to the whole journey experience.

Taking a holistic approach to the study of the passenger experience will provide a bridge between transport, sustainability, design, accessibility and land use; acknowledging the central importance of mobility to quality of life. To plug this gap, the authors present the work undertaken by METPEX to develop a computer based inclusive passenger experience measurement tool for European transport providers, passenger groups and municipalities validated through its use across 8 sites of varying transport complexity.

The development of such a tool is the first step in creating high quality, user-centric, integrated, accessible public transport services which are capable of attracting and retaining public transport users whilst meeting sustainability targets. Such a tool will provide reliable data which can be used by transport providers, policy makers, vehicle designers and municipalities to measure and benchmark their services and to assess where changes need to be made which will increase efficiency and effectiveness of service delivery. Enabling wider access to safe, secure, convenient, comfortable and economical public transport will in turn support the EU's carbon reduction targets as this will lead to an increase in the number of people who use public or active forms of transport. The data collected will enable the creation and dissemination of service quality and accessibility benchmark indicators.

This paper presents the initial work that has led to the development of a comprehensive set of variables relating to different passenger groups, forms of transport and journey stages. The paper will address the main challenges in transforming the variables into usable, accessible computer based tools allowing for the real time collection of information, across multiple journey stages in different EU countries.

The next section presents a brief review of data collection technologies. Section 3 presents the work conducted by the METPEX project team to develop the questions for the measurement instruments. Section 4 presents the two applications developed for the collection of data. The first application is based on GPS navigation technologies, while the second application uses gamification techniques in order to motivate the participant to fill in the questionnaires. Section 5 summarizes conclusions to date and the remaining challenges.

2 Background

The changing trends in technology have been the driving force in the evolution of surveying methods (Couper 2005). The advent of Web2.0, and the second wave of websites and applications offering a much richer experience has contributed to major innovations in survey data collection. This trend will expand with the mainstream use of new interaction devices such as Google Glasses and HMD displays.

The first travel surveys were introduced in the United States in the 1950s and were conducted by pen and paper using interviewers who went from door-to-door, interviewing survey participants in person. By the 1970s, telephone surveys became more popular, but still relied on pen and paper (PAPI Surveys). The major breakthrough in survey design was introduced in the early 90s with the introduction of Computer-Assisted Telephone Interviewing (CATI) (Taylor 2000), see Figure 1.

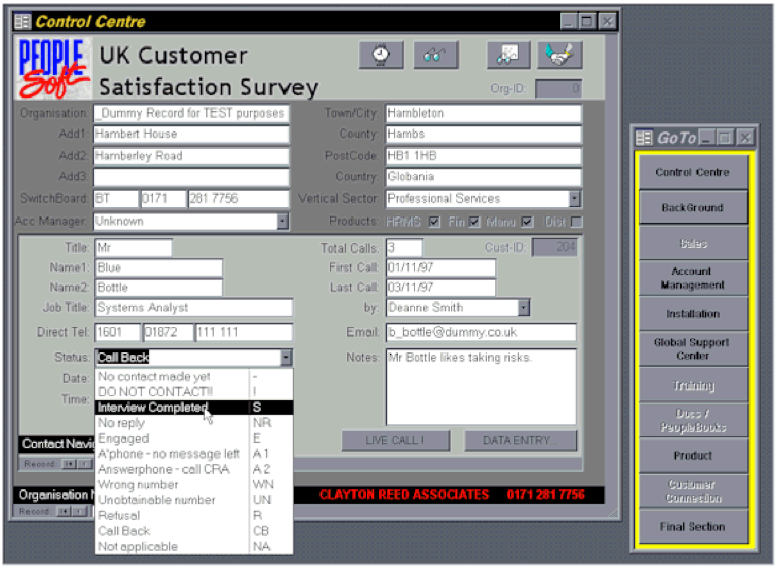

Fig. 1. CATI Survey System

At that point, travel survey methodology started a transition from a single-stage survey to multi-stage surveys which included the following steps: telephone the household/business to obtain demographic information, mail travel logs to the participants to record travel on an assigned travel day, then telephone to retrieve the details or have the participants mail them back (Sudeshna Sen 2009).

Multi-stage surveys improved the quality of the data obtained and enabled more refined data analysis. This increased demand for higher quality / finer resolution data resulted in the introduction of other technologies such as location-based tagging via Global Positioning Systems (GPS), web-based surveys, use of bar codes, and mobile phone devices.

Despite the advantages, CATI surveys are experiencing rapidly falling response rates (Owen 2002, Curtin 2005), due to the exponential increase of mobile phones and the increasing growth of mobile phone only households. This change present a challenge to the traditional household telephone surveys (Kempf 2007, Sen 2009). Through the technological improvements on the quality and speed of the WorldWideWeb two new survey systems were introduced: Computer-Assisted Personal Interviewing (CAPI), a widely used method that enables interviewers to conduct face-to-face interviews using laptops. Following the interview, the data are sent to a central computing network, either electronically via the web; or by mail (Bosley 1998)) and the Computer-Assisted Self Interviewing (CASI) in which computers take the place of interviewers in guiding respondents through the questionnaire (Tourangeau 2007). A variation of CAPI is the Computer-Assisted Survey Information Collection (CASIC), which refers to a variety of survey modes that were enabled by the introduction of computer technology. The first CASIC modes were interviewer-administered, while later on computerized self-administered questionnaires (CSAQ) appeared. A typical example of CSAQ and CASIC is survey monkey (SurveyMonkey 2013).

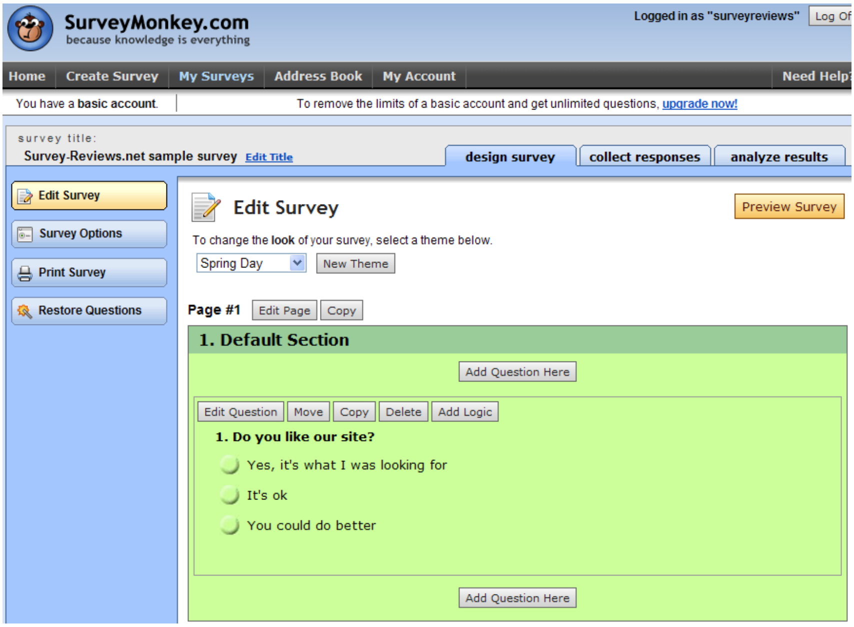

Fig. 2. A Typical CSAQ Survey tool

In addition to the advances in CASI systems mentioned above, the dramatic uptake of mobile phones in the last decade is expected to strongly influence data collection over the next decade (Sudeshna Sen 2009). The rapid growth of smartphones can be attributed to enhanced features and user interfaces, constant connectivity with the web through 3G/4G networks or through WiFi hotspots. GPS-enabled Smartphones are an emerging data collection technology that allows researchers to collect accurate information on location and travel details such as travel time, speed, acceleration, and direction of travel. Several traffic studies have demonstrated the potential of GPS-enabled Smartphones. These Smartphones provide exhaustive spatial and temporal coverage of the transportation network that help traffic monitoring and computation of reasonable estimates of travel time with GPS-level accuracy (Fontaine 2007, Sudeshna Sen 2009).

Furthermore the introduction of gamification technologies on such devices provides incentives to survey participants to complete surveys by offering them rewards on completing the survey using lessons learned from the gaming industry.

The power of games to immerse and motivate (Garris 2002, Panzoli, Peters et al. 2010) and the capabilities of games to change perceptions and views have created a more positive approach to games and new game genres (de Freitas 2009). More use of games in non-entertainment contexts such as training (e.g. Mautone 2008) are transforming everyday lives. Multiplayer and social games communities are changing social interactions, leading to greater capabilities for social learning and interactions and importantly more fun in everyday contexts (e.g. McGonigal 2011). Efficacy can be further achieved by better understanding the target audience and pedagogic perspectives, so as to make learning experiences more immersive, relevant and engaging. A recent survey by the International Software Federation of Europe (ISFE, 2010) revealed that 74% of those aged 16-19 considered themselves as gamers (n=3000), while 60% of those 20-24, 56% 25-29 and 38% 30-44 considered themselves regular players of games. However, a major challenge lies in translating interest and potential into actual adoption and use.

Deterding (2011) defined gamification as the application of game elements and digital game design techniques to non-game problems, such as business and social impact challenges. To motivate users to work toward these goals, gamification implements an accomplishment based reward system. Points, stars and badges are often "given" to users for completing important tasks. In the METPEX Game application users will be drawn in to briefly rate their journey, through their engagement in a 'game', and then to log on to the METPEX website to provide a more extensive rating and to receive a reward in the form of a downloadable content.

3 Development of the METPEX Measurement Instruments

For METPEX, the whole journey from inception to arrival is the main unit of interest. We aim to provide an inclusive set of measurement tools which can be used to assess a particular stage of a journey, or the whole journey, including modal transfers. This may include journeys made wholly or partly by active, public or private forms of transport. Providing inclusive measurement instruments, which can be used by a wide range of respondents, is key to evaluating transport service provision. Therefore METPEX is developing a suite of measurement instruments, including CASIC (on line survey using SurveyMonkey), PAPI systems (e.g. semi structured interviews) and focus groups for targeted user groups. The game app and dynamic questionnaire presented here only represent a small portion of the final suite of tools, in the understanding that these may only be used by a certain section of travelers.

In order to develop this suite of measurement instruments, the first year of the project was used to understand and consolidate previous research and research instruments, through both desk based research and interviews with stakeholders (e.g. municipalities and transport operators) in our partner countries. The subsequent analysis showed that over 400 variables would need to be considered if the whole journey was to be analysed. A pilot questionnaire, administered to over 200 people from Lithuania, UK, Greece, Ireland, Portugal, Italy, Sweden and Romania in both on-line and pen and paper formats showed the operational complexity of such a survey and the lack of appreciation of respondents who would need to fill in such a questionnaire (either in real time or retrospectively). The subsequent analysis showed the importance of some factors in determining overall satisfaction (e.g. the longest leg of the journey, overall satisfaction and mood) and the relationship between the variables.

Following this, the original categorization of variables into political, organizational, functional, environmental, technological, and social dimensions was removed (from the users perspective, although each item can be traced back to these dimensions). The variables have been recategorised to make them more respondent and journey oriented, prioritized, filtered and mapped on to different measurement instruments (on-line survey, structured interviews, diary studies and dynamic questionnaires) so that only the most useful and highly prioritized variables for each user and journey type will be presented. In this way METPEX will meet one of its objectives, i.e. to support and encourage adjustability and adaptability according to the context of use, e.g. time period, targets' framework and resource limitations. Therefore, the full list of variables can be filtered so that only the most useful and preferred variables for each condition (e.g. user, mode of transport and journey stage) are included. The filtering can be undertaken by a researcher, who can use subsets of the 'full survey' to initiate targeted campaigns, or create a set of rules to generate appropriate research instruments. The subsequent sections of the paper discuss the development of dynamic, on-line surveys which will be used for real time data collection.

4 METPEX Tool Functional Requirements

One of the major challenges that METPEX faces is the standardization of the passenger satisfaction surveys. As outlined in the previous section, the 400 variables and the items included in the pilot questionnaire have been collated into a 'full survey' database, from which subsets of questions can be drawn. One of the problems with the paper based and full on-line survey is that they may be too unwieldy to gather information on short journeys in real time. Therefore, research instruments are needed which can be used in real time, to capture the actual journey experience. In order to do this mobile phone applications and games have been created which are both adaptable and adjustable, and responsive to the information collected automatically by the device itself or user input. The smartphone applications will support:

- Multiple campaigns (i.e. according to different means of transport, participant type and location),
- Multiple questionnaires per campaign based on means of transport/location and user profile (multiple sets of questions, multiple target-groups),
- Dynamic selection of questionnaire (i.e., the app will be able to query the 'METPEX' server, identify the currently active campaign, or randomly choose one, then choose a questionnaire (randomly, or based on the user's profile, demographics, etc.) The user's profile may contain settings such as: preferred language, age/gender and will be communicated to the server strongly encrypted in order to protect the participant's privacy.

The questionnaire form, as presented to the user may contain multiple tabs, with each tab representing a different part of the passenger's journey, or a different travel mode, in a multi-modal journey. The passengers may fill in the questionnaire at their own pace, while en route, postpone doing so or cancel it. As soon as the passenger's response is uploaded to the METPEX servers, is can be processed, stored and the database updated. The management of the campaigns, surveys and responses can all be conducted via a web-based application.

4.1 METPEX Gaming Application

The proposed METPEX Gaming Application consists of two mini-games and one mobile survey tool that uses gamification elements in order to increase the motivation of participants to fill the questionnaire and to increase their engagement with the METPEX system via offering rewards, and unlocking several level of the application. The games will be available via the web and for Android and iOS (iPhone, iPad) devices.

The first two mini-games are standard memory games (e.g. memory pairs), but the items included are based on the passenger's experience at the time of playing (e.g. if the journey is being undertaken by trolleybus, icons related to trolleybus travel will be included). The games will be unlocked as the participant completes the survey so the terminology and icons will be closely related to the passenger's experience. If a respondent chooses to use the app many times, each time they log on their profile will change slightly, generating new word and icon sets. The table below shows a selection of keywords that are included in the memory game. In addition the application is fully integrated with social networking sites such as Facebook and Twitter.

Table 1. METPEX Keywords

Carbon footprint	Public transport
Reliability	Planning trip
Fares	Travel
Frequency	Quality of Passenger experience
Passenger	Performance
Quality	Bus, train and metro

As the user provides key information at the start of the game in relation to their transport mode and demographics, key, relevant questions can be asked that specifically relate to their journey drawn from the full METPEX questionnaire.

In order to increase the participants' motivation to fill in the questionnaire, we have represented the participant as a travelling musician / band member, who needs to build up tracks from musical bars created through completing the survey activity when they travel. On each trip, they unlock a one-bar looping sample by dragging notes to complete the METPEX survey. Each sample is in the same key and tempo, meaning these samples can be sequenced and layered to create original pieces of music. According to the answers, the application will create a unique music piece, representing the passenger's experience

Social mechanics are applied though a website component to the game, which allows people to upload their tracks and comment on those others have created. The motivation to play would be expected to arise from the **ownership** players develop of their content, and **curiosity** in seeing how additional samples might allow them to create more complex pieces of music. Furthermore, the **free** nature of the game, and its underlying **meaning**, that by playing the game players are contributing to improvement in public transport, can also be drivers.

A key consideration would be how a limiting factor is applied to ensure players are actually reporting on their actual journey rather than reporting fictional travel to progress the game and create different forms of music. This is a consideration in any design which will seek to motivate players to complete a survey.

The game interface will also direct the user to the METPEX website (www.metpex.eu) from which they will be able to complete a more detailed on-line survey, relating to all journey stages. The reward for this will be an entitlement to download a free game.

4.2 METPEX GPS Navigation Application

The second smartphone application that will host the METPEX surveys ("METPEX Tool") is the **SBOING GPS navigator**, called "sbNavi™", a product launched in November 2013 in Apple's app store (iTunes) and due to be launched for Android smartphones by April 2014. The SBOING GPS navigator is a satellite navigation application, developed for smartphones, which implements SBOING's crowdsourcing methodology for improved routing and faster map updates. Its community version is offered for free, together with free maps covering the entire world. The main functional characteristics of sbNavi™ include:

- Use of custom maps, based on the free and open maps of OpenStreetMap (OSM, www.openstreetmap.org).
- By utilizing historical traffic data, it leads to more accurate routing decisions, compared to existing commercial PNAs, which are based on static traffic information (i.e. the speed limit of each road),
- Distinguishes and provides better time estimates, depending on the type of vehicle (e.g., pedestrian, fast / slow motorcycle, fast / slow car, truck, bus, taxi), weather and corresponding road conditions (sun, rain, snow, etc.), time-of-day, day-of-the-week, holiday and season-of-year,
- An inherent, independent mechanism: a) to produce new maps (for uncharted areas), and b) to self-update existing maps (crowd sourcing support by entering user input about road hazards, police blocks, traffic lights, traffic signs, POIs, favorites, road network changes, etc.)
- Route simulation mode
- 2D and 3D map viewing with pan, zoom, and rotate functionality,
- User routes can be recorded and recorded routes can be managed, securely uploaded to SBOING, sent by email and replayed
- Searching: a) by free text search, b) in Favorites, c) in POIs, d) by coordinates, e) by proximity
- Easy definition of multi-waypoint lists and multi-waypoint (multi-legged) routing
- Multi-lingual support for text and voice guidance
- Ability to accommodate the maps of the entire planet in a single memory card
- Uses strong security (strong encryption) in all data uploads carried out by the user, thus ensuring the confidentiality of its private information.

The SBOING Concept. Instead of the static speed limit of a road used by today's navigators, the SBOING technology is based on a collaborative methodology, which consists of the statistical recording, for each road section, of the average travelling time for every combination of vehicle type, weather conditions, road conditions, season, day-of-the-week and time-of-day. Thus, for example, for a 100m section of road XYZ average travel time may be 40 sec., on Tuesday afternoon, or 15 sec., on Sunday morning, etc. While driving, the SBOING GPS navigator records and stores a number of parameters, including the vehicle's GPS position (GPS coordinates), velocity, altimeter and timestamp. In addition, the user may also add extra map information, such as road hazards, traffic cameras, points-of-interest (POIs), map corrections, etc. The user subsequently securely uploads its collected traces to the SBOING web-site and in return they get updated maps for its PNDs, through a "credit-debit" system (based on credit units, which are called "SBOING Credit Units", or SCUs). SCUs can then be bought/exchanged/traded as any virtual currency, i.e. with other virtual currencies (Farmville gold or Facebook currency), or for products and services at reduced prices (with targeted and location-based push advertising).

The uploaded data undergoes certain statistical validity checks, carried out by the SBOING backend (to filter out malicious or invalid data) and it is statistically integrated inside SBOING's database and world maps. Uncharted areas are updated and new roads and pathways are added to the existing maps, just by users' driving around and recording GPS traces. Based on their collected SCUs, the users can download at will maps and SBOING traffic data for any region of the world, through SBOING's web-site, which will enable them to enjoy better routing and faster map updates. The functionality and crowdsourcing methodology makes it more likely to attract a user's attention and interest and makes a passenger more motivated to respond to a survey by being given a reward (a number of SCUs) in exchange for their response.

Another advantage of using a GPS navigation application as a host application for the METPEX Tool is that the application can record and upload useful information that the passenger need not be asked about or need not be asked to provide, such as:

- User profile information, such as age, sex, demographics, etc.
- The date and time
- The place (geo-coordinates), where the questionnaire was filled in
- The route that the passenger travelled with real-time attributes.

4.3 Dynamic Surveys

Both smartphone applications aim to receive the passenger's input or feedback (i.e., responses to a questionnaire) in real time and upload it to the METPEX backend server for further processing. The back end server will hold the data derived from each measurement instrument, in each country, in a standard format enabling a variety of different queries and comparisons to be made.

Definitions: For the purposes of the following presentation,

- we define a "**survey**" to be a questionnaire of the METPEX tool,
- we define a "**campaign**" to be a class of surveys, targeted to certain user groups, or carried out for a specific purpose or goal,
- we define a "**response**" to be a passenger's response to a survey.

A survey will be defined using XML. This definition will specify each question's type (e.g. multiple choice, text, integer value, etc.), the visual components to be used in the questionnaire (e.g., checkbox, radiobutton, combobox, slider, etc.), the default response, etc.

A campaign will also be defined using XML. The definition will identify its name, type, a free-text description and the set of surveys it contains.

The surveys can be generated either statically (manually), or dynamically (e.g., with an SQL query followed by an SQL-to-XML script-based conversion). Alternatively, the XML may be replaced with JSON format messaging (more Java friendly, for Android platforms).

The passenger's response will also be formed in XML and it will be uploaded with strong encryption to the METPEX backend servers. From the application's point of view the process of dynamic survey selection will adhere to the following protocol,

Step 1: Read the active campaign (in XML / JSON format), either by calling a PHP script or by direct file retrieval. The application could place a query, based on the demographics and profile of the passenger and receive a targeted campaign.

Step 2: Choose randomly one survey, out of the class (list) of surveys defined in the campaign and load its definition (in XML / JSON format, as above). Note here that, if the passenger (based on his/her profile) is not compatible with the particular campaign, i.e., he is a Greek male and the campaign is targeted to French females, then the application should not launch the questionnaire.

Step 3: Dynamically generate the questionnaire form, from the survey description.

Step 4: When the user uploads his/her response, the application uploads / posts a response (in XML / JSON format) with a unique file ID.

5 Conclusions

This paper has presented the two applications, which are currently under development for the METPEX project, which will allow targeted data collection in real time from transport users using dynamic surveys, generated either from information automatically collected by mobile devices or from user input. The information which the user provides in real time can be later augmented through completion of the on-line questionnaire.

The development of the apps raises a number of technical and nontechnical issues including the best way to create dynamic surveys, the linking of information collected in real time with data collected from other research instruments, the demographics of the users and their motivation to participate once or many times, the ability of on-line tools to capture information about different stage of the journey using different modes of transport (e.g. cycling and walking and modal interchanges), the extent to which the information collected automatically about the journey (e.g. its speed) can be mapped on to user experience, ethical issues, the extent to which participating in a game may bias responses, and the validity /reliability and usefulness of information derived from these tools when compared to more traditional forms of data collection.

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