

Developing the UK International Passenger Survey in Blaise 5 on Tablet Computer

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1. Introduction

Over the last years, stringent budget cuts have placed tremendous emphasis on the need for ONS to modernise our data collection process in order to continue producing high quality and timely outputs, while coping with increasing demands on the complexity of the information to collect.

In this paper, we report on our latest progress towards transferring the International Passenger Survey (IPS) from paper form to electronic questionnaire on tablet. The focus will be placed on design concepts and usability assessment of the new survey instrument. This is also the opportunity to showcase the many possibilities offered in Blaise 5, not only in terms of routing and validation checks, but also – and above all - in terms of questionnaire layout.

2. What benefits for the survey?

The IPS is a continuous survey that has been conducted by ONS since 1961. Between 700,000 and 800,000 interviews are collected every year at all major airports, seaports and tunnel routes to and from the UK. This is the main source of information used by the UK governing bodies for planning, monitoring and informing decisions on tourism and immigration policies.

At the moment, the IPS data are collected on paper forms which are then manually keyed into the CADI system in Blaise 4.8. The data are then transferred electronically to ONS headquarter where further cleansing and validation take place.



It has been a goal for ONS for some time now to computerise the IPS data collection. However, until recently, we felt that the hardware was not ready [1]. With recent progress made on hand-held devices, as well as the availability of Blaise 5 on Windows tablets and the prospect of using the software on cheaper Android tablets in a near future, ONS has started exploring this option again. Our vision is three-fold.

1. Speed up the data collection and processing time thanks to the elimination of the CADI task. Take advantage of the in-built data validation checks and logical routing capability in Blaise to cut down on human errors, hence improve data quality.
2. As a direct consequence of the previous objective, assess whether this innovation offers a cost-effective solution that allows ONS to make savings.
3. Last but not least, exploit the layout capability in Blaise 5 to design a survey instrument that is fit-for-purpose, more user-friendly to interviewers and more engaging to respondents. This will improve the image of ONS as a modern organisation that embraces changes and stays on top of the latest technologies.

3. First prototype of the Blaise 5 questionnaire on tablet computer

The project started in July 2014 with an initiative of the IPS research team in Newport who organised a visit to Bristol airport. A Blaise developer was invited along to shadow IPS interviewers for a day in order to understand the nature of field work and to investigate where an electronic questionnaire on tablet could add value. Three main areas for improvement were identified.

1. **Survey flow:** the IPS questionnaire has a complex routing with a Main Questionnaire and various trailers e.g. Immigration Trailer, Employee Trailer, Student Trailer short/long forms [2][3], making it sometimes difficult to quickly identify the next question to ask, especially for inexperienced interviewers. There are potentials for human errors and possible negative impact on response rate.
2. **Coding frames:** IPS interviewers usually carry a folder with all the lookup tables that they need for filling out the survey. Examples include flight numbers, airport IATA codes, country codes, region codes, UK towns, to name only a few. Other documents they carry include the trailers mentioned above, as well as “show-cards” in 16 different languages. It is quite difficult to shuffle through the folder to quickly find the correct forms, even more so because IPS data are collected on the move. During busy shifts, interviewers often need to navigate through crowded areas while conducting the survey.
3. **Data keying (CADI):** this process is unanimously perceived as very time consuming and cumbersome. So much so that most field managers have to take work home to complete their tasks on time. Manual data keying also has potential to introduce many errors, the elimination of this step is probably where the most significant improvement can be achieved, both in terms of efficiency and data quality.

The good news is that most of the problems mentioned above can be solved with Blaise routing capability, in-built checks, lookup features. Thus, a first prototype of the electronic questionnaire was very quickly developed and deployed on a test tablet computer - a Lenovo Miix2 8-inch Windows 8.1 – in order to explore what could be done. Examples of screenshots are shown in Figure 1.



Figure 1- Look-and-feel of the first prototype of the IPS questionnaire in Blaise 5. Different background colours were used to differentiate various trailers and the main questionnaire.

By end of August 2014, the IPS research team organised a focus group meeting in Newport during which the prototype was demonstrated to a selected group of interviewers and field managers from Bristol, Manchester and Liverpool airports. The main aims of this meeting were to gauge users’ first reactions to the new survey instrument and to gain feedback on what could be improved. The results are summarised in Table 1 below.

Positive	
Survey Routing	Perceived as a major benefit in moving from paper to tablet
Lookup / Coding frames	Perceived as a major benefit for new interviewers. However, for seasoned IPS interviewers who know by heart most of the coding frames, it would be faster to type the code than use

	the lookup
General look-and-feel	Perceived as engaging and user-friendly
Number of questions per page	Good choice of number of questions to display per page. Questions that are logically related are displayed on the same page. Good use of conditional visibility (e.g. show free text field only if user clicks on "Other", hide it otherwise)
Fonts and colours	Good choices of fonts and colours. Interviewers like the use of different background colours to differentiate main questionnaire and various trailers
Edit checks	Are very helpful but to be used with moderation. Too many checks can be frustrating and cause respondents' drop out. Should allow skipping of "soft errors"
Need improvements	
Screen space usage	Need to maximise space allocated for displaying the questions. Interviewers unanimously suggested that the title panel be removed to save more space for displaying the questions
Lookup	Reduce number of items shown in lookup shortlist. Currently showing too many items which hides part or most of the screen, including the question
Use of radio buttons	It may be difficult to select the radio buttons and some of the answer options
Minimise user action	Make the best use of Blaise to implement as much as possible what can be automated e.g. time of interview, currency conversions, summing and checking expenditure etc. so interviewers will have less to fill in
Other suggestions/requirements	
Introduction page	Add an informative first page that looks official with ONS logo that interviewers can use to introduce themselves and the survey to respondents
Streamline paper questionnaire	There exists a number of issues with the current paper questionnaire in relation to question wording and routing. This is a good opportunity to streamline the survey questions
Coding frames	A number of inconsistencies have been found in the current coding frames during the implementation of the electronic questionnaire. A review and cleansing of these databases will improve the performance of the lookup search
Edit checks/Key questions	A review of the current edit checks by the IPS research team is necessary in order to specify hard checks and soft checks. The interviewer can ignore soft errors and skip non-key questions. A mechanism needs to be agreed on how to deal with soft errors at a later stage
Routing/Formatting	When transferring the questionnaire from paper to tablet format, some formatting and question ordering need to be modified. Further discussions with the IPS research team will be needed to ensure that such modifications will not introduce any bias to the survey
Use of Date picker	As a real life example, to the question "When did you last arrive in the UK?", respondents often do not answer with a precise date, but rather something along the line of "2 weeks ago", "last July" etc. On the paper form as well as in the first electronic questionnaire prototype, date fields are presented as a text box to fill in dd/mm/yyyy. Interviewers prefer the use of a date picker that would be more helpful to identify the correct date.
IPS sample selection	Can the electronic questionnaire be programmed to handle IPS sample selection such that the adequate form will come on screen at the right time? The IPS samples every 10th person, of which only a selected number will be interviewed on migration
Survey flow/ Navigation	To speed up the interview process, it is preferable to set the survey to automatically advance to the next field/page as soon as the current question has been answered, without the interviewer having to click on the "Next" button. (Request added subsequently after tests carried out with field managers in Titchfield)

Table 1 - Summary of main findings from the first focus group meeting with interviewers and field managers from Bristol, Liverpool and Manchester airports in August 2014.

4. Findings from literature review

In addition to the research undertaken with the IPS focus group, a literature review was also carried out, which aimed to gather useful information on questionnaire design for mobile devices and to gain awareness on the major pitfalls specific to conducting Passenger Surveys.

4.1 Questionnaire design best practices

Although various guidelines exist for best practices in design matters, one of the most exhaustive studies is no doubt “The Design of Every Day Things” by Don Norman [4], who is widely considered an authority in the fields of artificial intelligence, usability engineering and human perception. In a nutshell, a subset of the standard usability principles outlined in his book that are relevant for questionnaire design are summarised below.

- Visibility: use large Sans Serif Fonts that look crisper on a computer screen (e.g., Arial instead of Times New Roman), use large selection boxes, and contrasting colours. Provided orienting information such as question number and use bold text, underlined text for important information.
- Feedback: give users information about what action has just happened, for example boxes change colour when selected, providing users confirmation that the response was registered. Informing users that something is happening during delays e.g. “Loading... please wait”.
- Constraints: Limiting choices can prevent errors, e.g. remove the internet browser buttons so that users would not accidentally use them.
- Mapping: this refers to the relationship of the application controls to their effect in the application. Response options are presented in order of their numeric scale values, lowest on the left to highest on the right. Navigation boxes with Back on the left and Next on the right.
- Consistency: use the same elements in the same way throughout the application, which reduces the need for explanations and enhances memorability. All questions in the survey must be presented consistently with the same font. All navigation buttons are the same colour and appear in the same position on all pages.
- Affordance: provide hints or clues about how the application works. For example, a labelled square on a touch screen “affords” pushing; users recognize that the square works as a button. Using only clickable buttons as input controls makes the survey simpler and more intuitive.

4.2 Lessons learned from related works on conducting Air Passenger Surveys

The Transportation Research Board (TRB) of the US National Academies has invested significant research effort in the field, the result of which is reported in the Airport Cooperative Research Program (ACRP) Guidebook [5]. This is a valuable reference for planning all aspects of Air Passenger surveys, with supporting evidence from two recent examples of implementation at Los Angeles Int’l airport in 2011 [6] and at Phoenix Sky Harbor Int’l Airport in 2012 [7].

Overall, recommendations that can be found in these report are to great extent in agreement with Don Norman’s principles, and in addition, they offer many interesting insights into the practicality of conducting Air passenger Surveys.

These include in particular the reality of having to deal with strict security measures inside airports (e.g. no Internet connection, therefore no online fancy applications such as Googlemaps). Another challenge is the nature of the travelling public. Someone completing a survey questionnaire in the comfort of her home will be more cooperative than someone who is walking through a busy airport terminal and is anxious to catch a flight. Therefore, great care needs to be taken to design a short survey that flows smoothly: making the right decision on navigation ease, routing, lookups, deciding on the optimum number of edit checks etc. are essential.

5. Second prototype of the Blaise 5 questionnaire on tablet computer

Feedback gained from the focus group discussions and results of the literature review shape the development of the second prototype of the Blaise questionnaire as shown in Figure 2. With this new version, the routing remains very much unchanged. The main improvements concern the look-and-feel of the electronic questionnaire and the survey flow (ease of navigation).

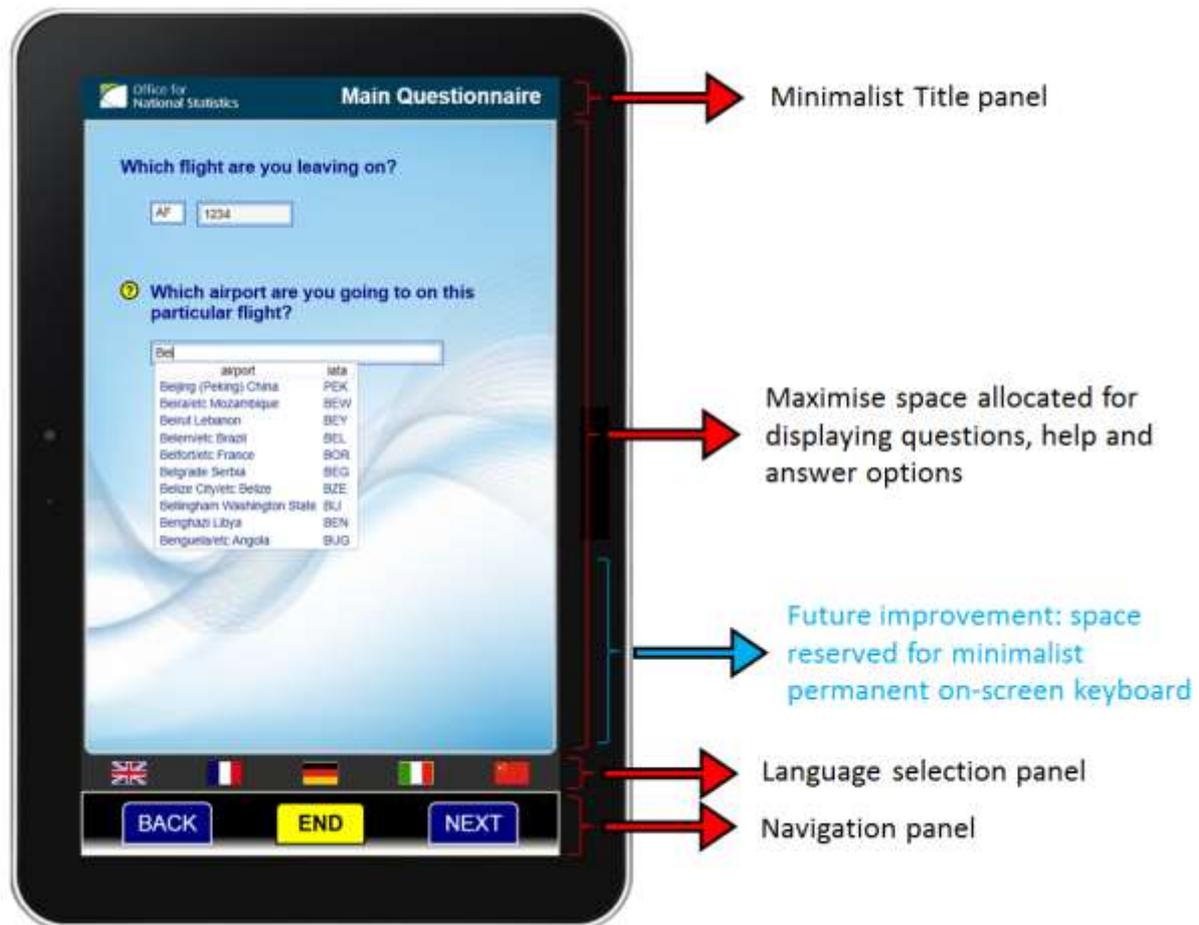


Figure 2 - Look-and-feel of the second prototype of the Blaise questionnaire on tablet

5.1 Page layout

The main improvement in the page layout is the application of Don Norman's principle of *Consistency*. The page template is now designed with fixed sizes such that the various components of the page always appear at the same positions as the user navigates through the survey. This is different from the first prototype where, for example, the navigation buttons BACK and NEXT changed their vertical positions between pages.

Don Norman's principle of *Visibility* is also enforced by the use of contrasting colours and panel borders to better differentiate the various components of the page. For the most important part of the page - the content area where the questions are displayed - a lighter colour is applied to make it stand out more and ensure that the user's attention will be focused in priority on this area than on the rest of the page. Another part of the page that is of importance is the navigation panel. Shading and border are applied to make the panel raise in relief, while other panels that are less often used e.g. the Language panel and the Title panel are designed to look more "retreated".



Figure 3 - Use of different background colours for different parts of the survey

Taking into account feedback from the focus group, the title panel is now made minimalist, with only the ONS logo and the “Page Title” to indicate whether the user is within the Main Questionnaire or within one of the various trailers. Different background colours are also used to indicate various parts of the survey as shown in Figure 4, interviewers previously fed back that they found this useful.

5.2 Answer selection. Font and font size

One major design element was deciding how interviewers would select their responses for the survey questions. A standard radio button's target area for selection was perceived as too small.

Applying Don Norman’s principles of *Visibility* and *Feedback*, we use answer boxes and design these as large as possible. Gradient shading is applied to the boxes to create an “embossed” impression and make these look more like buttons, thus enforce the principle of *Affordance*. A visual cue is added to feedback to the user when a response had been selected; the colour of a selected response button immediately changes to green, as shown in Figure 3.

Large Sans Serif fonts are used for question text, answer options and help text. The same templates are applied across the whole questionnaire, in accordance with the principle of *Consistency*.

- Arial 30 Blue Font for Question text.
- Arial 22 Black Font for answer options.
- Arial 20 Dark Slate Grey Italic Font for Help text.

A question mark is displayed next to each question if Help text are available. Clicking on the question mark will expand the help. Clicking again on the question mark will collapse the text.

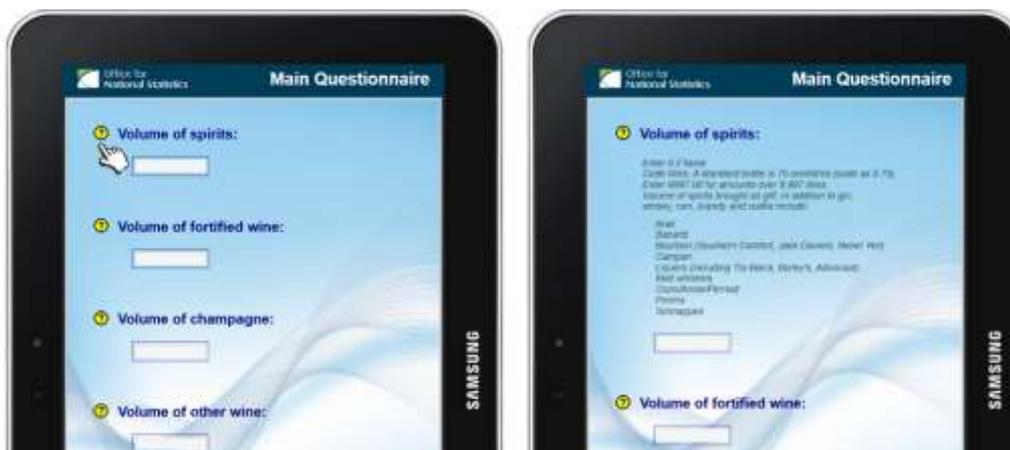


Figure 4 – Help text expand/collapse

For questions where the answer options exhibit a logical order or scale e.g. satisfaction survey questions, we display the answer options in the order lowest value at the bottom of the page to highest value at the top, in agreement with the principle of *Mapping*, as shown in Figure 5.



Figure 5 – Applying Don Norman’s principle of *Mapping*

5.3 Survey flow. Navigation ease

To improve navigation ease, when a question is answered, the survey automatically advances to the next question. This is achieved by setting the ‘On Value Change’ action of the button to ‘Next Field’ in the Blaise 5 Resource Editor. This has been for most questions whenever it is possible e.g. selection buttons, text lookups, number lookups, date pickers, dropdowns etc. However, there exist a number of exceptions where the user has to explicitly click on the NEXT button to advance to the next question:

- Questions where multiple answer options can be selected e.g. “*In which countries have you been living/working/studying for the last 12 months?*” There is no a priori knowledge of how many options the user is going to select so we cannot set the automatic advance to next field.
- Fields using String Text Box or Number Text Box. If we set the ‘On Value Change’ action of the button to ‘Next Field’, as soon as the user types the first letter or number, the cursor jumps to the next field/page, which is not the desired behaviour.

This is a trade-off between *Navigation Ease* and *Consistency* where, in order to improve the survey flow, we choose to implement the automatic advance feature. But we lose in consistency.

5.5 Multiple languages. Lookups. Coding frames

With the second prototype is introduced the multiple language feature, as shown in Figure 6. Clicking on the national flags at the bottom of the page will spontaneously switch the screen display to the desired language.



Figure 6 - Multiple language questionnaire. Examples shown for English, French and Chinese

As discussed earlier in Section 3, the IPS employs a large number of coding frames and multiple “show-cards”. These need to be examined on a case-by-case basis in order to identify the best implementation for each type. For example, a date picker is the most suitable implementation for date fields, while a lookup text box with Trigram search would be the best choice for airport IATA codes, country codes, UK towns, etc. as shown in Figures 7 and 8.



Figure 7 - Lookup text box with Trigram search is the most suitable implementation for fields where the user may be unsure of the correct spelling e.g. airport codes, UK towns, country codes



Figure 8 - A Date picker is used for date fields. In some cases, when the number of options in the lookup list is limited, a simple dropdown is sufficient, as for "Reason for Visit"

A particular type of lookup needs to be designed for question 6 in the IPS questionnaire. If the respondent’s country of residence is either Belgium, Canada, Germany, India or Spain, then he/she will be asked to select his/her city of residence from a list of important cities within the corresponding country. If a city cannot be found from that list then ask for the region/state/province of residence.

6. Residents of Belgium, Canada, Germany, India and Spain	X	→(a)
All other foreign residents	Y	→20
(a) Do you live in any of these cities? IF NO, ASK WHICH REGION		
Use cards to ensure correct coding Use code 98 for queries - code 99 for DK		
<input type="text"/> <input type="text"/> <input type="text"/>		→ 20

The IPS research team and IPS field managers have indicated that an implementation using interactive maps would be highly desirable. However, in the absence of Internet connection inside airports, we cannot rely on any off-the-shell solutions such as Googlemaps etc. and we have to design an offline in-house solution, as shown in Figure 9.

Here, an example is shown for Germany. The respondent is presented with the map of Germany, displaying the main regions. After selecting the region

of residence, the respondent is presented with a further list of cities to select from. Compared to the paper form, the order is reversed *tablet:(regions → cities)* instead of *paper:(cities → regions)*. The main reason for this is because there is no sufficient space to display all the cities on the map. Changing the order of the questions should not introduce any bias to the survey in this case since the answer is of deterministic nature.



Figure 9 - In the absence of Internet connection, an offline solution was designed to allow the user to select regions/provinces on a map

The implementation of this feature is by far the most cumbersome in the whole project! The country map is applied as the background of the page. The Title panel and the Language Selection panel are removed to save more space for displaying the map. Over the map is superimposed a complex network of grids inside each cell is a selectable button. The button has a transparent background and no border, the button text is the name of the region. The button "On Click" action is a collection of actions: when the user touches on the region name, the region code (e.g. 14 for Antwerp in the example shown in Figure 10 below) is assigned to a field called *RegionCode*. Based on this value, the list of cities for Antwerp will be displayed on the next page for the user to select.

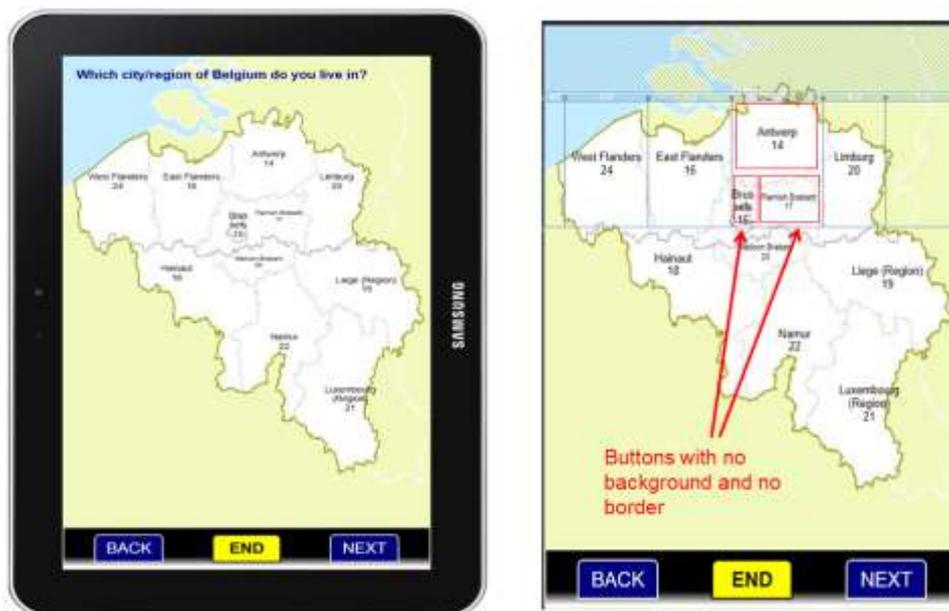


Figure 10 - Map of Belgium with selectable provinces names. On the right hand side: how it is designed in the Blaise 5 Resource Editor

Designing the network of grids for the maps is quite time consuming. This is necessary because in the Blaise 5 Resource Editor, a button can only be placed inside a grid cell. Below is an example shown for the map of Canada. Designing the network of grids for Germany, Belgium and Canada is relatively easy, but for countries with numerous regions, provinces and states, the grid networks can become quickly very intricate, as for India and Spain.



Figure 11 - Designing the network of grids becomes quickly very complex for countries with numerous provinces and regions such as India or Spain

6. Testing

For the time being, it has been decided that the first Usability study would only focus on testing the IPS Air Departure questionnaire at a limited number of airports.

The IPS questionnaires used for seaports and tunnel routes are very similar to the airport questionnaire, the wording is slightly different for Arrival compared to the Departure questionnaires, but not much, so a minimal effort will be needed to adapt the Air Departure questionnaire for these purposes at a later stage.

In the upcoming months, a series of tests will be carried out in various stages as follows.

- First of all, the questionnaire needs to be thoroughly tested and debugged before any other tests, or the validity of these may be compromised by errors in the programming. This test will be performed by people other than the programmer and ensure that all possible response options and question branches are explored.
- After the debugging phase is the Usability testing phase, the aim of which is to assess whether the questionnaire is easy to use. A usable product is one that helps users achieve their goals quickly, successfully, and with satisfaction. Jakob Nielsen, widely considered an authority on usability testing, demonstrated that 85% of usability problems could be identified from testing on the first 3 to 5 subjects, whereas 15 subjects were required to identify 100% of usability problems [8]. But instead of testing once with 15 subjects, he recommended testing on 3 to 5 subjects, modifying the application, then retesting 3 to 5 new subjects in iterative cycles until no new major problems were identified.

Typically, the test subjects will be asked to conduct an IPS survey using the tablet questionnaire. We plan to collect behavioural measures via different means such as capturing paradata but also with post-test evaluation forms.

- Paradata: for this first series of test, we only wish to capture basic information (e.g. click locations, information entered, time on tasks), therefore setting the Audit Trail to FIELD level will be sufficient. We will use Blaise API and C# to extract the paradata from various tablets used for testing. We plan to purchase a small number of different tablets (8-inches and 10-inches screen size) for our pilot. Analyses will be carried out with any suitable software package e.g. SAS, SPSS, Matlab or R.
- Post-test evaluation forms/self-report: this is used to capture qualitative information such as users' perception of the survey instrument. Criteria include: validity, reliability, internal consistency, replication and ease of use. These can also be quantitatively measured using a 5-point Likert scale: (strongly disagree, disagree, neutral, agree, and strongly agree). In terms of user experience, a good survey instrument is one that users can fill out in an efficient manner without making errors, and without getting frustrated. Therefore, accuracy is an important criteria to capture. This can be quantitatively measured e.g. the percentage of forms completed correctly, percentage of drop out and associated reason for drop out, number of errors etc.
- At the moment, there is no plan to test the questionnaire itself because we very much keep the same wording and survey flow as in the paper form, and the same interviewer scripts.

We are also currently exploring suitable ways to evaluate/measure the benefits of removing the CADI stage. In fact, we only assume that eliminating manual data keying would cut down on human errors and thus improve data quality. However, research has not yet provided evidence to substantiate the claim that computerised interviews are less error prone. If the electronic questionnaire is badly designed and difficult to use, and/or if the program has not been thoroughly debugged etc. we may even introduce new type of errors that we need to capture and adjust for. This is why the upcoming Usability tests are extremely important.

7. What next?

At the moment, there exist a number of on-going investigations the results of which will shape the design of the third prototype of the IPS questionnaire. These include:

- A health and safety check carried out by IPS field managers in Titchfield to decide on logistic aspects in particular suitable screen size of the tablet, colours to be used that will have a direct impact on the questionnaire design.
- A review of the hard/soft edit checks by the IPS research team.
- A possible streamline of the current IPS questionnaire in respect of question wording and routing. This is also motivated by the fact that some questions – as they are currently layout in the paper form – do not lend themselves very well to be routed/displayed in similar manner on a computer tablet screen. We need to investigate whether modifying their order and appearance would introduce any bias to the survey.
- Investigation of the end-to-end process to understand how the new electronic questionnaire will fit into the existing system as a replacement of the current (paper forms + CADI). As the existing system is in Blaise 4.8, some major adaptations are to be expected. In the worst case scenario, the current Blaise questionnaire may need to be reverted back to Blaise 4.8.
- A field test of the second prototype is planned for the second week of May 2015, the feedback from which will also be taken into account for the third prototype.

8. References

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