Discovering Functional Requirements and Usability Problems for a Mobile Tourism Guide through Context-Based Log Analysis

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Abstract

The actual usefulness, adoption and success of a mobile information system much depends on the appropriate design of the available functionalities and of the interaction interface. A thorough elicitation of functional requirements carried out during the system design phase is certainly essential, though it is often difficult to identify and analyze in advance all possible use-scenarios. This paper describes an evaluation method to discover additional functional requirements and usability problems through the context-based analysis of session logs. The method has been applied to evaluate a mobile tourism support system in ecological conditions to understand non-biased, free usage. The results provide evidence to the impact of contextual conditions over users' interaction behaviour and informational needs. Some general design guidelines have been derived for functionalities and forms of adaptivity to be integrated in mobile services for the tourism sector.

Keywords: Context-Aware Mobile Services; Session Analysis; Usability Evaluation; Functional Requirements

1   Introduction

Ten years ago, when mobile access to Internet was mostly in the form of WAP navigation, market analysts were already perceiving the potential big advantage of mobile electronic commerce for the tourism domain (Marcussen, 2002). Certainly, the market reaction to the new opportunities offered by the mobile Internet has outraged the early expectations, with the recent proliferation of a variety of mobile services aimed at, for example: assisting tourists in finding information about tourist products (destinations, accommodation, events, attractions) or providing them with structured location-based tour guides; supporting users in booking or getting in contact with service providers; providing useful practical information on the local services, on mobility, or on environmental conditions; providing memos and updates about travel details; allowing the sharing of travel traces and opinions with social networks (Grün et al., 2008; Rasinger et al., 2007; Ricci, 2011).

The benefits of mobile services compared to generic online services can be summarized into four main factors: the possibility of accessing services anywhere, regardless of location (ubiquity); the availability of services at all times, with the convenience for the user to access them at the point of need; the tailoring of service contents to the user location (localization) and the additional customization according to other personal variables (personalization) (Clarke and Flaherty, 2003). Indeed,

mobile service delivery opens up several opportunities for service customization by potentially taking into account several contextual factors, such as: the type of device, the user profile and interaction behaviour, location, time, social context, environmental conditions, etc. (Dey, 2001; Dourish, 2004). The customization may impact on different aspects of the service; for example on the content data (e.g., which specific products are suggested to users), the information presentation (e.g., graphical rendering, language), or the interaction mechanisms (e.g., which browsing options or activities are proposed to users at certain points of interaction). In addition, the initiation of the service delivery may be triggered by specific user's requests (pull mode) or may be fired automatically on system initiative according to contextual factors and appropriateness strategies (push mode) (Ricci, 2011).

The actual usefulness, adoption and success of a mobile information system much depends on the appropriate design of the available functionalities and of the interaction interface, as in a mobile scenario the user typically cannot engage in complex browsing or query building, due to the many contextual constraints (e.g., device and connection limitations, concurrent activities, environmental factors, social context, etc.). For this reason, it is highly important to understand users' actual information needs and the actual patterns of usage and to adjust the user-system interaction in order to enlighten the effort required to the user to retrieve and inspect information. A thorough elicitation of functional requirements carried out during the system design phase with the direct involvement of stakeholders and final users is certainly essential, though it is often difficult in the user-centred design process to identify and analyze in advance all possible use-scenarios. This is particularly true for mobile applications conceived to be accessed anytime, anywhere and for varied purposes, for which an iterative revision of design choices is required starting from the analysis of actual usage. Controlled usability evaluation experiments might provide useful guidelines for revision, however it may not be completely clear which aspects need investigation or the organizational costs may be too high to cover all the planned activities (Tullis and Albert, 2008).

This paper describes an evaluation method for mobile systems combining techniques of web analytics and of remote usability testing, to discover functional requirements and usability problems through context-based analysis of session logs. The method has been applied to evaluate a commercial mobile tourism support system in ecological conditions to capture and understand non-biased, free usage. The results emerged from the analysis provide evidence to the impact of contextual conditions over users' interaction behaviour and informational needs. Some general design guidelines have been derived for specific functionalities and forms of adaptivity to be integrated in mobile services for the tourism sector.

2   Background

Several sources of information can be exploited in web-based travel support systems to derive the actual informational needs of website users. A significant amount of data comes from the search queries users make and their navigation and interaction behaviour within the pages of the eTourism portal. Session analysis techniques can be applied to fruitfully interpret the frequency of page accesses, path lengths, typical entry and exit points, to identify the most successful or weak parts (and products) of

the observed sites. More advanced Data Mining techniques –like unsupervised learning, association rule mining, sequential pattern matching– can be applied on the same data to discover meaningful groupings of pages or products that tend to be accessed together (Liu, 2007). For example, (Pitman et al., 2010) show the benefits of combining query term analysis and user clustering in the tourism domain to single out user groups with significantly differing informational needs. (Not and Venturini, 2011) explain instead how added value comes from the analysis of data contained in users' personal travel plans.

However, in a mobile application setting, web usage analysis requires the appropriate consideration of additional contextual factors (e.g., distance, time, weekday, weather,...) that may impact on the users' informational needs (Baltrunas et al., 2012). For this reason, when evaluating actual system usage, it is highly important to conduct data collection in an ecological setting, with users using the system whenever the actual need arises, and tracking the contingent contextual factors. Techniques for synchronous remote usability testing (Madathil & Greenstein, 2011) have been studied to allow the organization of controlled experiments that involve users out of the lab, but with a live connection with the experimenters who can monitor exactly what the user is doing, thinking, and perceiving. Though facilitating the involvement of a higher number and more varied types of users than in traditional in-lab experiments, these techniques suffer from high organizational costs (in terms of time required to experimenters to recruit users, conduct the live experiments and interpret the output). Also asynchronous (unmoderated) remote usability testing (Nelson & Stavrou 2011) is not always adequate, as it still requires the definition of specific controlled tasks to be monitored, additional hardware/software machinery to capture screen interaction and the recruitment of an appropriate sample of users agreeing to perform the task and willing to provide additional feedback.

For combining wide-scope usability problem discovery and the analysis of actual information needs and patterns of usage for mobile applications, a mixed evaluation approach is required that integrates the data collection and analysis techniques from both web analytics and remote asynchronous usability testing. A sample approach to this type of wide-scope investigation is described in the following sections of this paper.

3 Methodology

Web analytics services are typically used for business and market research to monitor web traffic, understand the impact of advertising campaigns, discover weak and strong points of e-commerce strategies, but also to discover usability issues in the online information system (like for example, hardly reachable pages or complex interaction procedures that hamper the actual online purchase process) (Clifton, 2010). Web analytics tools trace users' page visits and interactions in an unintrusive and seamless way; they allow the setting of specific contextual variables to be used for data segmentation; they apply appropriate data anonymization strategies to comply with privacy concerns, and they are able to deal with scalable volumes of data. Our approach takes advantage of the flexibility offered by web analytics tools in terms of log collection, to design and set up interaction evaluation experiments on free system usage, according to a set of specific research hypothesis aimed at

discovering phenomena of context-dependency in informational needs and usage patterns in mobile e-tourism information systems.

3.1 The Evaluated System

The evaluation method was applied to the first release of Biella Mobile, the mobile version of the official tourism destination portal of the province of Biella, located in the north-western part of Italy (www.atl.biella.it). The main Biella e-tourism portal, recently renovated, is a medium sized DMO portal, with an average of 74.000 unique visitors per year. Users accessing any page of the main portal from a mobile device are automatically redirected to the home page of Biella Mobile (Fig. 1.a). The mobile system was launched online at the end of March 2012. During July and August 2012 it registered an average of 780 unique visitors per month.

| a. Biella Mobile home page | b. Sample results list | c. Map for accommodation |
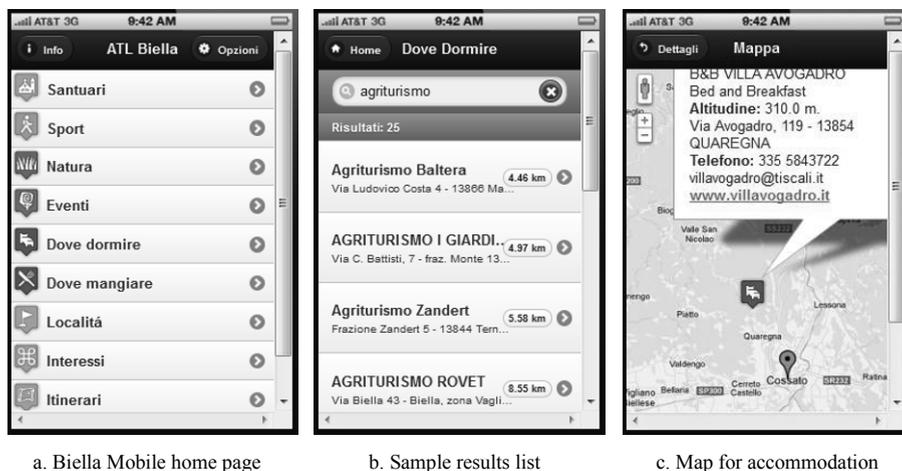
Fig. 1. Snapshots of the Biella Mobile system interface

The information architecture of the first release of Biella Mobile is simple and uniform for all product categories. The home page provides access to thematic sections (Sanctuaries, Sports, Nature, Events, Accommodation, Restaurants, Places, Interests, Itineraries) containing lists of POIs of the corresponding category (Fig. 1.b). Items are shown in reverse order of distance with respect to the user's current location (if available). Ten items are shown at a time; a "Show more" button is available at the end of the list to get more distant items. Text-based search filters allow to select specific subsets of items. By clicking on the short descriptions of the items in the list, a page containing the detailed description of the POI is displayed, which also includes shortcut buttons to make a phone call, send an email or view the main web site of the POI. From the details page, a link is available to a map displaying the position of the POI and the current position of the user (Fig. 1.c).

3.2 Research Objectives and Hypothesis

The general research objectives of the study included both wide-scope usability problem discovery and the identification of context-dependent informational needs and behavioural patterns of mobile users, to eventually: (i) understand whether the current system functionalities are easily identifiable by users and are used as expected; (ii) understand how users navigate in the information tree in different interaction contexts, to possibly identify interaction modalities or forms of adaptivity that would improve usability; and (iii) identify additional functionalities that would provide added value to the current system. In particular, the following specific research hypothesis were formulated:

H1: The number of visits to Biella Mobile and the type of information searched by users depends on some specific contextual factors, in particular week day, location and type of user (i.e., whether she is a frequent visitor).

H2: Map-based functionalities have a relevant role in supporting mobile users' informational needs.

H3: Different product categories are characterized by different search and decision-making patterns.

3.3 Logs Collection

To analyse the interaction phenomena considered in the research hypothesis, a data collection was set up to trace both users' actions and contextual variables. The Piwik open source web analytics suite (piwik.org) was used to collect anonymized individual logs and local variables for the accesses to the Biella Mobile web application. Data collection was performed for the regular users of the system over a time span of four weeks, in the period 25 June – 22 July 2012. The following information was collected in the logs: the visit duration, the actual sequence of visited pages, the action buttons used (e.g., the "show more" button activating the display of additional POIs in a results list, the radio buttons and the bar for setting localization preferences, the buttons for activating a phone call, an email or the redirection to the personal web site of a POI), the usage of text strings to filter search results, the position in the result list and the distance from the user's current location of the POIs for which the details page is selected. In addition to information about users' actions, the following contextual variables were explicitly collected: the current position of the user (if available) and her distance from the area of the province of Biella, day and time of access, type of user – whether new or returning -, operating system and browser used.
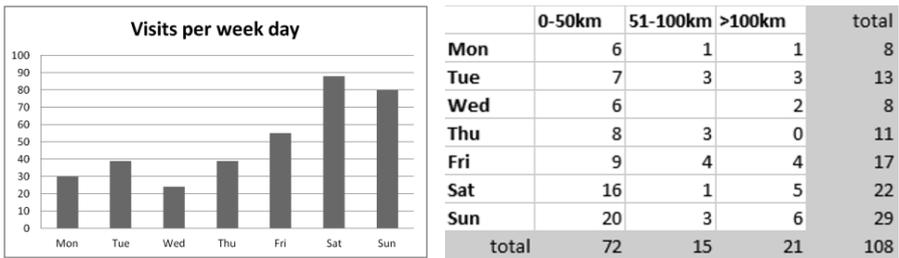
During the considered four-week period, 747 sessions of usage were collected (a session automatically expires after 30 min), with an average duration of 2:09 minutes and 20,48% of returning users. As a term of reference, we observed that in the same period the main non-mobile web site received 9.012 visits (from 6,650 unique visitors), with an average visit duration of 3:28 minutes and 35,73% of returning users. To exclude, right from the beginning, interactions that may hamper the analysis, a pre-processing phase helped remove from the logs: data relative to sessions performed by researchers and 305 sessions without any meaningful interaction (i.e., with an immediate bounce away from the home page). In the considered period of

four summer weeks, 355 valid interactions were retained for the analysis. For a subset of 108 interactions, the position of the user is known.

4   Results

4.1 Influence of Context on Frequency of Visits

To understand if and how different contextual conditions in time and space have an influence on informational needs of mobile users, we first analyzed the general distribution of visits according to the week day and to the user's location associated to the interaction session.

|	0-50km	51-100km	>100km	total
Mon	6	1	1	8
Tue	7	3	3	13
Wed	6		2	8
Thu	8	3	0	11
Fri	9	4	4	17
Sat	16	1	5	22
Sun	20	3	6	29
total	72	15	21	108

Fig. 2. Overall distribution of visits per week day (left) and distribution of visits whose user's location is known, per week day (right)

The chi-square test computed over the distribution of the 355 visits segmented by week day (Fig. 2, left) confirms that there is a significant difference in the number of active users per day (for $\alpha = 0,001$), with Saturdays and Sundays being more trafficated and Wednesdays more calm in terms of accesses. Repeating the same test on the distribution of the 108 visits for which the location is known (Fig. 2 right, last column), we get similar results, with the difference in the two distributions being not significant. Further investigations on data segmented both with respect to week day and location distance (Fig. 2, right) have highlighted an overall general preponderance of visitors accessing the system while being within the geographical area covered by the mobile guide, i.e., within a radius of aprox 50km from the city of Biella (the chi-square test is significant with $\alpha = 0,001$ for the total number of visits of the whole week and for the days of Saturday and Sunday, and significant with $\alpha = 0,05$ for Monday and Thursday). Overall, these data reveal that there is a concentration of accesses to Biella Mobile by users (i) within the considered area and (ii) during the weekend. These findings provide some first evidence in support to hypothesis H1.

4.2 Influence of Context on Product Category Search

To further investigate the type of information that is most looked for by mobile users, and under which contextual conditions, we extracted from the logs the number of users who entered into thematic POI sections (e.g. list of hotels, list of restaurants, events,..) and we segmented those data for POI category, week day and user location.
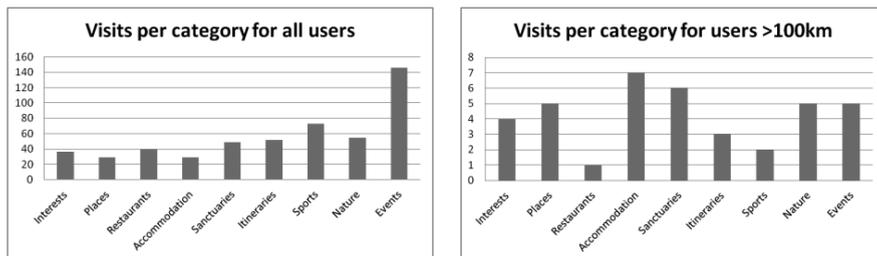
Fig. 3. Total number of visitors who entered a certain POI category (left) and segment of data for users whose distance is more than 100km (right)

The chi-square test (with $\alpha = 0,001$) computed over the distribution of visits per POI category (Fig. 3, left) shows that there is a significant difference in the interest expressed by users, with events being the most inspected type of product. The test was repeated over the distributions of each week day: for Tuesday, Friday, Saturday and Sunday there is a confirmation that events are searched significantly more than the other types of POIs (with an $\alpha = 0,001$ of significance threshold). The same is true for users who access the mobile services in a range of 0-50km from Biella. For users whose current distance from Biella is within the two ranges of 51-100km and >100km (Fig. 3, right), data reveal instead that users' interest is more equally distributed over the various categories, with far-away users less interested to restaurants and more to hotels, but in this case the differences are not statistically significant.

H1 receives confirmation by these results for the fact that the weekend, for onsite users, is particularly characterized by events search, suggesting that an automatic news/events alert service would be particularly compatible with these contextual conditions. Unfortunately, data about returning visitors whose position is known are too scarce to provide statistical evidence to the hypothesis that there is a recognizable group of frequent users, resident in the area, that access regularly to the list of events. This part of research hypothesis H1 is not confirmed and the investigation should be repeated over data collected in a longer time frame.

4.3 Patterns of Usage Depending on Product Category

To better understand whether there are varied search and decision-making patterns for specific product categories or interaction conditions, we additionally analyzed the propensity of users to visualize details pages for POIs starting from the links provided in the results list.

	Click for details	No click for details	total	% of details visualization
Interests + Sanctuaries	67	243	310	21,6
Places + Nature	73	97	170	42,9
Restaurants	83	34	117	70,9
Accommodation	32	30	62	51,6
Itineraries	96	65	161	59,6
Sports	80	58	138	58,0
Events	226	148	374	60,4
total	657	675	1332	

Fig. 4. Number of requests for details pages segmented per POI category

The table in Fig. 4 summarizes the number of times users selected (vs. did not select) a link to request details for POIs of a certain category (e.g., the number of times the user clicked on a link in a list similar to the one shown in Fig. 1.b above). The chi-square test over the click vs. no-click distributions (to also take into account the fact that some categories have been looked at more frequently) confirms that there is a significant difference (with $\alpha = 0,001$) in the amount of details visualized for the various product categories. In particular, data seem to suggest that for the "Interests" category users ask for additional details for the single POIs rarely, possibly just after a first decision-making phase is performed at the list level. Whereas for restaurants, the visualization of details seem to be integral part of the selection process. This preliminarily supports research hypothesis H3.

To further investigate the product decision-making process, we have counted for each session log how many alternative POIs for each category were inspected in detail by users. Indeed, in average, users tend to visualize more details for alternative restaurants in a session than for the other categories (average is 4, with variance 55,1). The "Interests" category is the least visualized (average is 2, with variance 3,4). However, the ANOVA test on these data does not confirm the statistical significance of these differences.

4.4 The Use of Maps

Map-based interfaces may be particularly effective for the mobile tourism scenario because they may allow the intuitive display of relevant features for the search/recommendation results (Burigat and Chittaro, 2008), e.g.: level of concentration of items (e.g. to decide which is the most promising area to take into account for further investigation); relative geographical position of items (e.g., to compare at a glance the convenience to reach the various items); possibility of graphically convey also other information (e.g. icons shape and/or colour to convey the level of recommendation; information about traffic jams; location of friends,…). The interaction with maps (especially on smartphones) allows to easily and intuitively enlarge or reduce the relevant geographical area for recommendations, and clustering techniques can be fruitfully used to solve visualization problems when many POIs have to be displayed on the same map area (Kriegel et al., 2011; Ilango and Moan, 2010). However, still remains to be investigated, from the functional point of view, whether maps are actually used and useful in the same way for all categories of searched products.

In the first version of the Biella Mobile system considered for the present study, advanced map-based search functionalities were not integrated yet, and map use is very simplified: search results are displayed in a list mode, the user can access a details page for POIs she identifies as interesting and from that page a map view is accessible to geographically localize the POI (as shown in the snapshot in Fig. 1.c). This simplified information architecture certainly imposes some effort to the user to access maps and it is expected that this impacts on usability. Indeed, only 4,37% of the visualized details pages are followed by the visualization of the corresponding map, therefore research hypothesis H2 is not confirmed, possibly due to a major usability issue. However, at a deeper consideration, log data still reveal some interesting phenomena on maps usage. We measured the propensity of users at displaying the maps –despite being the maps so down in the navigation tree– by additionally segmenting the data for POI category.

	Click for map	No-click for map	details pages	% of map visualization
Accommodation	4	32	36	11,1
Restaurants	1	83	84	1,2
Events	1	226	227	0,4
Interests + Sanctuaries	5	67	72	6,9
Itineraries	6	96	102	5,9
Places + Nature	3	73	76	3,9
Sports	10	80	90	11,1
total	30	657	687	

Fig. 5. Number of requests for map visualization segmented per POI category

By comparing frequencies of map vs. non-map visualizations from details pages (Fig. 5), we observe that different product categories have significantly different propensities at map display (chi-square test significant with $\alpha = 0,001$), as stated in hypothesis H3. We attempted an interpretation for this result by also considering the findings presented in the previous section 4.3.

Events. For events, the use of the map is practically irrelevant (only 0,4% of details pages visualization is followed by a map visualization). This phenomenon may be due to the fact that events are mostly searched by users who already know the area and are looking for entertainment activities during the weekend. This hypothesis is partly confirmed by the results of the analysis of the most searched POI categories, segmented by current location of the user and week day (described in previous section 4.2). These considerations suggest that search results for events can be effectively displayed in a list view, ordered by date, with short product descriptions for each list items (e.g., when, where, what). Indeed, in list views, by accurately selecting the features that are mentioned in the short texts it is possible to highlight those product characteristics that may be more relevant and interesting for the user or the differences between the suggested items (Jones et al., 2004).

Accommodation, Sports, Itineraries. For the POI categories of accommodation, sports and itineraries, by considering the higher propensity to visit details pages and maps, we can hypothesize that the most effective modality to display search results would be a map view that shows at a glance the position of each POI with some

graphical/iconic solution that conveys additional essential information on the POI, e.g. type of accommodation, type of sport, route of the itinerary.

Restaurants. The search for restaurants is characterized by a high percentage of details visualization, as well as by the higher average number of alternative POIs inspected. On the contrary, maps are seldom used. It is highly probable that this interaction behaviour is due to the fact that the decision-making process for selecting a restaurant involves a more careful evaluation of different aspects: type of cuisine, price, closing days,... System functionalities for easily comparing POIs or for filtering/recommending POIs according to product features (as are typically available in classical, web-based e-tourism portals) might be a desirable add-on also for mobile guides.

4.5 Usability Issues

The major usability issues that emerged in the study are related to:

- the scarce visibility of the map functionality, that is currently accessible just from the lower levels of the navigation tree.
- the length of the navigation paths that is often unnecessarily lengthened by the need to climb back the navigation tree to go back to the home page for changing product category.
- the internal text-based search filters that do not work as users expected. A qualitative analysis of repeated attempts of users to get the results list filtered by text, reveal that they assume in the internal search filters the same powerful behaviour of search engines like google and yahoo.
- the fixed entry landing page, that may explain a percentage of immediate bounces out of the system higher than that observed in the main non-mobile portal. A qualitative analysis of the referrals that brought to interactions with an immediate bounce shows the following unsatisfactory interaction chain: the user searched for a specific event or POI name with a general-purpose search engine (e.g., google); the engine correctly returned a link to the corresponding POI page indexed in the Biella main portal; the user gets disappointed to be redirected to the generic home page of Biella Mobile and not to the specific product page, and leaves the site without any further exploration.

5 Discussion and Conclusion

The evaluation study presented in this paper provides evidence to the fact that context-based analysis of session logs can be fruitfully exploited to discover functional requirements and usability problems in mobile tourism guides. Indeed, in the case of the Biella Mobile system, the asynchronous remote evaluation of free usage provided many fruitful results, despite the well known difficulties of interpreting not-controlled tasks. Apart from specific usability issues related to the simplified information architecture of the first release of Biella Mobile, we found some confirmation to research hypothesis that might be helpful for the design of any mobile tourism information system. The amount and type of information needs clearly depend on the week day and the position of the user (hypothesis H1). This

result suggests that forms of adaptivity in the interaction interface that make certain categories of information more accessible according to the interaction context might improve the usability and perceived usefulness of the system. For example, our data suggest that upcoming events should deserve a foreground position for onsite users, especially during the weekend, possibly in a recommendation, push-mode. We have not found confirmation to the hypothesis that maps are in general essential in a mobile setting (H2). Instead, we found that alternative search methods should be supported by mobile tourism information systems, as different product categories are characterized by different search and decision-making processes (hypothesis H3). This result calls for forms of adaptivity in the interface that adjust the available functionalities and interaction modalities according to the product category. For example, our data suggest that also in a mobile scenario, comparison functionalities may be of help for restaurants, whereas displaying many results on a map may be of particular help for hotels, itineraries and sports.

The functional requirements and usability issues emerged from the study will be used to guide the implementation of the second release of Biella Mobile and to improve the services offered to users. As a future work, to consolidate the general validity of the findings, for the most interesting interaction phenomena we plan to conduct a series of asynchronous remote evaluation experiments on controlled tasks with small samples of users willing to also provide feedback with a usability questionnaire.

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7   Acknowledgements

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