Developing a Usability Framework to Support Online Rapid Urban Information Discovery and Interrogation

Dr John E. Barton
john.barton@unimelb.edu.au

A/Prof Christopher Pettit
cpettit@unimelb.edu.au

Australian Urban Research Infrastructure Network
University of Melbourne 3010

Abstract

One of the significant challenges facing the development of web portals is optimising the usability of such e-infrastructures for diverse, yet specialised uses. This paper presents a usability framework for supporting the iterative testing and development of the Australian Urban Research Infrastructure Network (AURIN). The AURIN portal serves as a securitised environment for data sharing, and as a repository of open-source analytical routines to support urban decision-making. Harmonisation, security, accessibility and discoverability are critical concerns at the data level as many different kinds of federated data are being referenced by the system. Furthermore, urban researchers are accessing this infrastructure framework across Australia. A broad spectrum of digital data relevant to human settlements needs to be not only discoverable, but also comprehensible and usable by non-experts in the area. Managing the complexity across many areas and supporting a spectrum of naïve to expert users are significant challenges. In this research we introduce a usability framework, which elicits feedback from naïve users through to domain experts. This feedback is captured through hands-on workshops with participants and one-on-one user testing sessions. In this paper we report some of the preliminary findings from early workshops with end-users and some of the one on one testing sessions. We analyse this feedback to understand the current strengths and weaknesses of the system. The end-user feedback provides a dual purpose. Firstly, it is fed-back to the technical development team as part of a cycle of continuous improvement. Secondly, the workshops also provide a vehicle for engaging end-users and raising awareness of the AURIN data search, interrogation and visualisation capabilities. We conclude the paper by discussing the next steps in developing and implementing the usability framework in relation to the AURIN portal.

1 Introduction

User-centric design is of critical importance to design of web-based portals and to ensure success as indicated by the end-users returning (Tatnall 2005). The AURIN portal provides access to data and tools to support

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evidence-based decision-making in the context of urban settlements in Australia. In concert these data and analytical tools provide the backbone to sophisticated Spatial Decision Support System (SDSS) capability. SDSS are essentially iterative, computer based systems designed to support decision-makers in solving semi-structured *spatial* problems (Sprague Jr and Carlson 1982).
An identifying feature of a Decision Support System (DSS) is the employment of information systems to process data into a form that assists knowledge sharing and communication between experts and non-experts, informing a community of users (decision-makers) focussed on solving a common problem (Stock, Bishop et al. 2008, Geertman and Stillwell 2009). Negotiating solutions requires a degree of flexibility as many different stakeholders negotiate potential approaches to the problem based on consensus between many different disciplines. Thus there exists the challenge in providing a SDSS that is usable for researchers across disciplines and with varying levels of expertise to address semi-structured spatial problems, such as determining the walkability of particular new development or the land suitability for a new industrial estate (Butterworth, Giles-Corti et al. 2013).
Spatial Decision Support Systems add a geospatial component to the information that is presented to decision-makers. This is an essential component when dealing with complex urban coverages, helping identify patterns in spatial composition, clustering, change or the predicted impacts of an intervention on the urban environment (Getis 2010, Barthélemy 2011).
Typically embedded within SDSS are expert tools and models, which aim to be effective in processing data into information that is comprehensible by non-experts in a particular domain. For example, urban planning is a field where researchers, planners, policy-makers and communities need to be involved in the decision-making process. When this information is combined, a better understanding of the structure of the problem and potential solutions is attainable. The effectiveness of these tools can be compromised by discipline-specific approaches that only highlight one aspect of the greater challenge. As such, SDSSs that support multi-disciplinary collaborative approaches to solving urban issues need to be designed with accessibility in mind across a range of experience and expertise to best allow diverse (and often divergent) approaches to be combined as seamlessly as possible.
The usability of such a system's front-end is of pivotal importance in determining the uptake and effective deployment of a SDSS. This paper examines the reiterative testing and development cycle of an online SDSS known as the AURIN portal, which is being developed to support researchers focused on solving problems pertaining to the urban settlements across Australia. The AURIN portal provides a gateway to 100s of geospatial datasets and a suite of analytical and visualisation tools to support this broad user community. Areas of endeavour span across social demographics, housing supply and demand, transport, population health and well-being and innovative urban design applications. These discipline-specific clusters are referred to as 'AURIN lenses' as they conceptually focus on a particular area of national significance and provide an interface between the technical development, the expert community and end-user engagement (Pettit, Tomko et al. 2013). Each particular lens group have identified priority data, analytical tools, models and visualisation routines that are being built into an open source portal e-infrastructure to support the broad end-user community. The fundamental challenge is that each of these resources needs to be easily discoverable and useable in such a way that the respective users goals are met sufficiently to enable rapid goal-seeking behaviour free of heuristic barriers.

2 Background

The challenges presented by urban areas increasing in both size and density, coupled with greater demands on infrastructure, socio-economic policy and sustainable design and planning have given rise to many innovative solutions internationally as to how to best manage these areas. Many groups have formed around the concept of 'smart cities' (Gibson, Kometsky et al. 1992, Schaffers, Komninos et al. 2011) and continued development has seen the emergence of high-fidelity systems primarily developed for urban areas; common instruments being employed include multi-disciplinary information sharing (Fonseca, Egenhofer et al. 2000), web-based portals (Maguire and Longley 2005) and use of three-dimensional visualisation as tools for information delivery (Zlatanova and Gruber 1998, Döllner and Hagedorn 2007).
There is a general direction for governments internationally to move toward an open data sharing model (Shah, Abraham et al. 2012, Tinati, Carr et al. 2012, Fitzgerald, Hooper et al. 2013). One example of note is the Infrastructure for Spatial Information in Europe (INSPIRE); a long-running initiative bringing geospatial information together across Europe (Annoni, Bernard et al. 2004). In the Australian context, the Government has been progressively embracing opening access to data and the employment of open source software (Missingham 2008). Increased levels of access to urban data on a non-commercial basis is progressively a easing a traditional supply-side blockage to the use (and re-use) of geospatial urban data (Vonk, Geertman et al. 2005).

AURIN provides the links to existing datasets federated as closely to their respective custodians as possible (Sinnott, Galang et al. 2011). An additional layer of tools and workflows facilitate urban information to be accessed, analysed, simulated and interrogated (Tomko, Bayliss et al. 2012). This collaborative data-sharing platform, combined with the analytical layers, forms a SDSS that many diverse users will be accessing. This makes usability issues paramount to the uptake, effective use and longevity of the system (Shneiderman and Plaisant 2003).

Typically SDSS are designed by experts for experts; for instance, Planning Support Systems (PSS) aim in engaging an end-user community (in this case planners) in the use of computer assisted decision support tools (Geertman, Toppen et al. 2013, Pettit, Nino-Ruiz et al. 2014). Vonk, Geertman et al. (2005) created a theoretical framework and have identified a number of bottlenecks of widespread adoption of these tools in the planning community (see Figure 1). Key factors include: Intention to use (78%), Awareness (66%), Organisational Facilitators (including training) (61%), Personal Adopter Characteristics, (61%), Ease of Use (58%), and Usefulness (51%). Such factors as relevant to PSS adoptions are considered to be applicable to the use of SDSS tool contained with the AURIN portal which are design to support end-users which includes researchers in the field of urban planning, urban design, geography, and policy and decision makers.

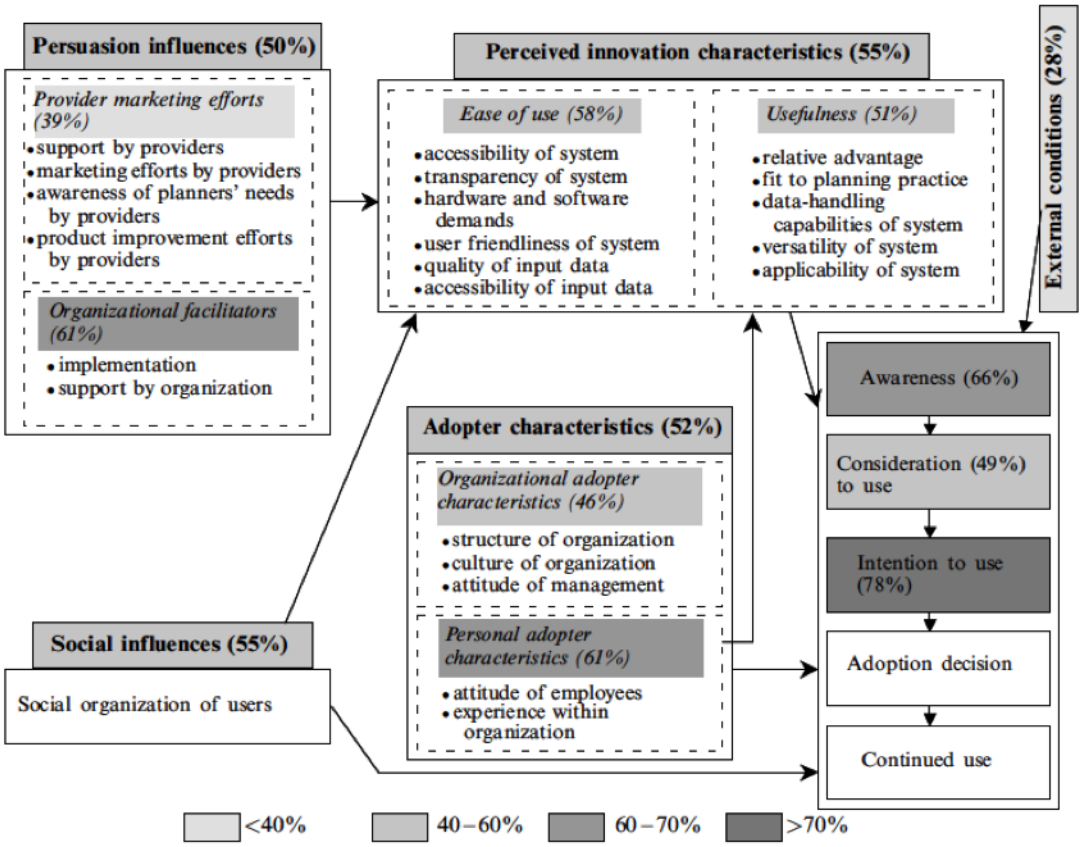

Figure 1: Bottlenecks blocking wide spread usage and adoption of PSS with importance scores (Vonk, Geertman et al. 2005).

After an initial period of technical development, AURIN has begun a series of workshops, user surveys and interviews to introduce the system to end-users from a range of urban disciplines. As part of this engagement process, detailed user testing is being undertaken by a small group of typical end-users. This is to achieve a better understanding of how people are interacting with the system and, importantly, to provide feedback to the technical development team to address usability and functionality issues identified by the group. The AURIN development process follows the agile method (Schwaber 2004). This iterative model successively refines each prototype at incremental beta phases (Huo, Verner et al. 2004). The agile method maintains a close link between developers and the client, where feedback is taken on board the development process in regular

increments. Small teams of developers discuss this feedback face-to-face and maintain a focus on satisfying client needs with working software. The agile method does not focus heavily on verbose documentation, contractually defined scope or rigid long-term planning (Conforto and Amaral 2010, Dingsøyr, Nerur et al. 2012). This development methodology has been adopted by AURIN as it best facilitates the interaction between many clients/stakeholders to prioritise optimally engineered software solutions for complex and evolving projects. The next section will describe formalised workshop sessions designed to expose the software to end-users during the beta phases of development. In turn, the feedback from these workshops is delivered back to the development team and progressively addressed. Pacing the technical development process with user feedback aligns strongly with the concept of SDSS for urban problem-solving and stakeholder community engagement (Andersen and Jger 1999, Batty, Chapman et al. 2000, Balsamo, Di Marco et al. 2004).

3 Usability Framework

3.1 Who were the respondents?

Respondents were predominantly involved in urban research at a university level. Half of the respondents were University Academic (Teaching and/or Research) and a third were University Post-graduate students (PhD or Masters). The remainder were involved in Local Government. A factored gap analysis of the self-assessed level of expertise showed the user groups to rank themselves as more adept in urban issue than technical skills, with one-third of users classifying themselves as 'expert-level' and another third as 'inexperienced'. This is to be expected as the workshops were run in-conjunction with two conferences the State of Australian Cities (SOAC) (2 workshops) and The Australia New Zealand Regional Science Association International (ANZRSAI) (1 workshop) and attracted a participants interested in urban issues and ranging from student-level to senior academics.

Between beta releases, it is important to gather as much information as possible to identify usability issues and feed these back into the development process. AURIN is using several ongoing instruments to gauge the performance of the system as a whole:

1. End-user Workshops
2. User Advisory Group (UAG) Sessions
3. Monitoring and Evaluation

Figure 2 illustrates the temporal framework of the user testing process. Beta 3 was the first public release inviting user feedback, the system having been developed internally only for the first two beta releases. Preceding each subsequent beta release is a User Advisory Group (UAG) session followed by a series of workshops. The process employs screen capture software and an unguided speak-out-loud interview process when conducted in a usability lab. Feedback received by these instruments is fed-back into the development process via the existing bug reporting and feature request framework.

Workshops are conducted between beta releases to give participants hands-on experience in a collaborative environment. These typically last 3 hours. At the conclusion of these workshops, participants are surveyed to gauge usability, confidence, focus areas/scales, self-assessed discipline and technical experience (via Likert scales) and open-ended questions prompting good points, bad points and suggestions for future development.[1]

The UAG has been established to test pre-release functions and provide feedback on the usability and functionality of the system at each beta phase of the portals development. The UAG comprises of professional users from the urban research community, which spans the disciplines encompassed through the AURIN Lenses to form a small group of invited participants for each beta testing phase. The membership of this group may change depending on the functionality associated with a particular Beta release.

Individual sessions have been undertaken with an individual users and at least one AURIN member to take notes and help in session facilitation. Each session lasts 1.5-2 hours. The sessions are tailored to specifically address the new functionality planned for a particular Beta release. Each user session consists of five components:

1. Blue sky: Users would convey their understanding of what the AURIN portal is and what it potentially could provide.

[1] See: https://docs.aurin.org.au/wp-content/uploads/2013/12/131201_survey.pdf

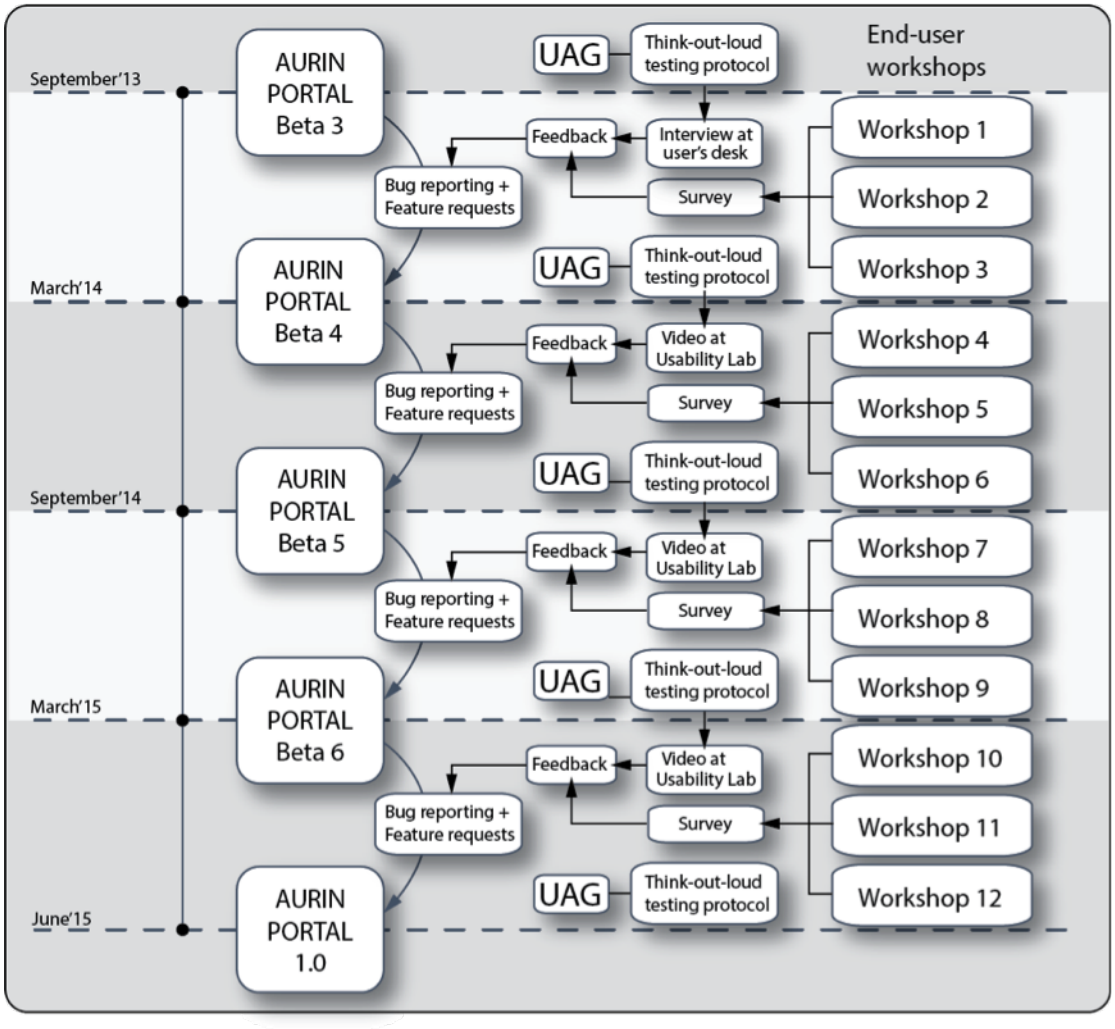

Figure 2: AURIN usability framework.

2. Unguided test: Without any assistance, participants are asked to log into the AURIN portal and a simple exercise such as preparing a chart.

3. Guided test: Any difficulties encountered in pt.2 would be addressed and the user guided through a more difficult task with the support of user manual and tutorial documentation where available.

4. Collaborative brainstorming of features and functionality: discussing user stories describing what/how a user might use data/tool/visualisation resources with basic interaction flows and desired outputs.

5. Debriefing: Finishing this process the user will be given the survey with additional questions focussing on issues of access, interface and task based interactions.

AURIN has undertaken a parallel survey as part of a Monitoring and Evaluation process harmonised with the beta releases to gauge the perceptions of the broader user community, particularly stakeholders that are involved in the broader project who have not had any specific training in the operation of the system.

4 Results

4.1 Workshops

In December 2013, three workshops were facilitated by AURIN introducing a total of 24 participants to the AURIN portal. Participants were invited to fill out a paper survey on completion of each workshop. In total 15

responses were collected.

4.1.1 What were respondents interested in?

Respondents indicated an interest in all scales of urban research ranging from an individual to a National level. Predominantly, 60% of respondents indicated and interest in the precinct/neighbourhood level, with 43% indicating interest in cities and towns, and 30% indicating interest at building scale. 70% of respondents were interested in Urban Housing, and nearly 60% interested in Urban Transport, although no responses were indicated for Urban Logistics.

4.1.2 What were the perceptions of the AURIN portal?

Respondents indicated their main interest was in data download (4.36 on the Likert scale) and Data search and discovery (4.31) while Analytical tools indicated the weakest demand (3.67). This result could confirm that the portal is primarily seen as a data acquisition tool, however still registering a demand for more specialised analytical routines. Only 4 respondents (26%) indicated that they were already familiar with the Australian Urban Research Infrastructure network (AURIN) project prior to using the AURIN portal, however, respondents strongly agreed that the information on the AURIN portal is valuable and that they were likely to visit the AURIN portal in the future. A score of only 3 was registered by respondents indicating that they were neutral as to being able to find what they need quickly on the AURIN portal. This points towards issues associated with usability of the portal that need to be considered.

4.2 User Advisory Group

Over the period of a month concluding mid-September 2013, Six (6) individuals were interviewed, the first two interviews used the Beta2 release and the subsequent four used Beta3. Participants were from academia (3) and Local Government (2) and State Government (1). This initial series of interviews was aimed at gleaning detailed user feedback from a small number of users in order to identify common issues at an early stage. It is important to note that each of the participants had been to an introductory AURIN workshop, or had been recommended by someone who had attended. Consequently, these users had a professional interest in retrieving, analysing and presenting urban information. The interviews were conducted at participants desks in order to identify any access issues via firewalls, software, hardware or bandwidth constraints. Participants were asked to 'Think out loud' to register their perceptions as two AURIN representatives notated responses.
The unguided testing phase replicated the experience of a user logging into the AURIN portal, navigating the interface, loading data and creating a choropleth map without any guidance beyond what was accessible online. Testing revealed that the users all had specific field of interest and were motivated to retrieve data specific from their respective fields- these broadly covered statistical demography, urban planning/conflict issues, urban transport analysis and well-being/social development issues. Once successfully logged in, each of the users were able to explore, find and retrieve relevant data and all were able to create a choropleth map within 30 minutes.

Common issues in unguided tests were revealed:

- at the log-on phase when users needed to correctly enter user names and passwords. If a password had been forgotten, a lengthy process of retrieval and resetting ensued- in one case up to 54 minutes before successful login. This poses a significant barrier to accessing the system with ease;

- at the interface interaction stage of trying to decipher the portal-specific iconography and workflow. Often users saw the system as being analogous to similar systems they had had experience with, however most were reluctant to refer to manuals or help documentation, preferring to intuitively navigate through the system;

- when users followed what appeared to be an intuitive workflow, goals were only revealed when the entire process was carried out (for example, interactive brushing), or if an incorrect path was followed, error messages were not revealed until several steps into the process. Users could not modify input parameters after loading; this was identified as an important part of refining a trial-and-error process.

During the collaborative brainstorming and de-briefing stage, users volunteered techniques to remedy problems or improve effective use of the portal including:

- refining the front end for intuitive interaction for first-time users, or with an interpretive layer to guide the user;
- avoiding custodian-specific acronyms, codes or jargon in preference of verbose, human readable script, with subsequent opportunities for revealing specific detail;
- pre-built use-cases, parameterised queries and industry-standard reports accessible via themes grouped around discipline;
- programmatic access for query and retrieval to bypass the portal.

Users trusted/had no concerns over the curation or reliability of data, and recognized the federated data structure to be a timesaving and trust-worthy feature of the portal. Users liked the fact that federated data was straight from the source, and not derived or static. This also created perceived opportunities for participating in forming and adding to the data network itself.
Diverging opinions were revealed between users- some saw it mostly as a data discovery and retrieval tools, while others saw value in the ability generate a visualisation layer over existing datasets. This is a usability issue that warrants further investigation.

4.3 Monitoring and evaluation

During October 2013, a series of surveys were conducted from a total sample of 106 AURIN stakeholders as part of an ongoing Monitoring and Evaluation process. Stakeholders are represented by the project's community-developers, project leaders, senior researchers and collaborators. Table 1 shows the responses to open-ended questions prompting respondents for three good points ('good'), three bad points ('bad') and three points for improvement ('todo'). These were clustered around common key themes.

Table 1: Clustered results from open-ended survey questions.

	GOOD	BAD	TODO	
Interface	67	42	34	143
Data	52	21	24	97
Feature Requests	7	21	27	55
Bug Reporting	1	30	11	42
Metadata	4	21	16	41
Speed/Performance	23	11	5	39
	154	146	117	417

Respondents primarily focussed on the user interface, both for positive and negative feedback. Respondents also identified the data handling capabilities of the portal as a major strength.

5 Conclusions

The first round of user testing has been an important step in empirically identifying and developing a profile of the system's users. Broadly, users are interested in urban research; this group are mostly members of the academic research community, and the government sector. Their skills range from naïve to expert. This suggests a focus on developing the user experience aspects of the portal to accommodate first-time users, as well as offering guides to more advanced features.
The usability framework and approach will be extended for progressive beta releases to focus in more fidelity on the details of user interaction using a dedicated usability lab where usability testing can be undertaken with a triangulation of approaches including Speak-out-loud, video recording and pre/post questionnaires. Usability inspection through Nielsens (1994) Ten Usability Heuristics are also being considered to be included in the usability framework to identify usability problems in the AURIN user interface design.
Subsequent User Advisory Groups will invite a larger sample of participants, first to confirm and elaborate on established personas, and secondly, to continue identifying issues encountered in the user experience. The cycle of testing at the beta phases enables newly implemented features to be tested, and further related feature requests to be registered. The final UAG meeting and testing will represent an end point to gauge the project's progress

and best ensure the continuity of the project into another phase of development.
The usability of portals and advanced SDSS tools has been identified as a major barrier for the use of such tools (Vonk, Geertman et al. 2005). Our research aims to address this issue by developing and applying a usability framework through-out the development cycle of the AURIN portal and implemented it at critical points in time to align with Beta releases. Future research will report on the refinement of this usability framework and subsequent longitudinal end-user testing results.
Overall, the response from the feedback acquired through the usability framework has been positive, with end-users generally citing AURIN as a valuable initiative filling a gap. Whilst AURIN is currently at the Beta3 phase, more work is required to 'harden' the portal. This will in turn enable a viable comparative analysis to similar portal products that will further assist in positioning and improving this online SDSS. Accessibility, ease of use, functional robustness and an outcome-based focus are crucial factors to the overall usability of the AURIN portal and ultimately its success.

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