Usability Mapping Tool

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Abstract

A building’s true purpose is to support and shelter its users, while they are performing their activities and living their lives. Buildings are means to an end. Depending on how well they support their users’ activities, our physical surroundings contribute to efficiency, effectiveness and satisfaction in the user organizations. This is what we call the usability of buildings.

This paper reflects on methods for evaluation of buildings in use, and on their applicability for usability assessment. The main contribution is, however, our operationalised perspectives on usability, and a description of the evaluation process and methods as it is described in the handbook for our usability mapping tool, the USEtool.

The research is based on a development process and case studies from three large Norwegian organizations. Previous studies have shown that in order to assess usability, one has to focus on the effect of the building on the user organization’s fulfilment of goals, as well as the end users’ satisfaction and experience. In this project, we were faced with expectations from our business partners to develop a toolbox, with tools they can use themselves in order to assess the usability of their portfolio of buildings. The objective has been to develop a set of tools that are easy to use, but that yield both an overview and more in-depth knowledge, with an emphasis on aspects of usability related to effectiveness. This has governed the choice of methods and measurement parameters. This approach has also highlighted the need for a more operationalised perspective on usability, as the evaluations should be carried out by Facilities Managers and not by researchers.

The operationalization of usability is developed around the use of questions: For what, for whom, where, and why. The USEtool and the evaluation process is described in a handbook, which guides the evaluators through a series of stages (1-5), including an introductory identification stage (investigation of organizational objectives and relevant user groups), and a systematic general
usability mapping and a walkthrough with more in-depth qualitative studies of specific usability topics. The last stages of the process includes comparing findings with objectives, and developing recommendations for improvements in existing buildings or briefing of new facilities.

**Keywords:** usability, buildings in use, evaluation methods, post occupancy evaluation, facilities management

1. **Introduction**

Buildings are seldom an end in themselves. They are, rather, tools that support the activities taking place within them. Depending on how well they support the users’ activities, our physical surroundings contribute to efficiency, effectiveness and satisfaction in the user organization. This is what we call the usability of buildings. Usability is defined as “the extent to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO 9241-11).

This paper describes a set of tools that has been developed in a research and development project with 3 partners. All of them have large portfolios of buildings, which they manage and develop on behalf of their user organization. The project has aimed at developing a tool that can be used by the Facilities Managers of these organizations in order to evaluate usability of their buildings. A key product of the research project is a process description, detailing how building owners and Facilities Managers can gather user experiences from existing buildings as a basis for improving existing buildings, as input when planning new buildings, or as a reference when choosing new premises. Our project partners wished to collect experiences from their user organizations in cooperation with selected user representatives. We have focused on the development of methods and tools that the project partners themselves can employ. The objective has been to develop a set of tools that are easy to use, but that yield both an overview and more in-depth knowledge, with an emphasis on aspects of usability related to effectiveness. This has governed the choice of methods and measurement parameters. This approach has also highlighted the need for a more operationalised perspective on usability, as the evaluations should be carried out by Facilities Managers and not by researchers. It has also been both an academic and a pedagogical challenge to present the methods and the concept of usability in a way that is both usable and interesting for the evaluators as well as for the user organizations.

Usability depends both on the physical environment and how the environment is used. Any evaluation of usability will thus depend on context. For our partners, the main objective has been to improve usability within their premises. This means that improvements may be related both to use and to the properties of the building.

In this paper, we start with presenting the research projects development process and methods, as well as some theoretical perspectives on evaluation of usability. The main contribution is, however, our operationalised perspectives on usability, and a description of the evaluation process and methods, as described in the USEtool handbook.
2. Research methods and process

In this section of the paper, we present the methodological discussion related to the process of developing and testing the usability mapping tool. Later, in relation to the description of USEtool, we reflect on the choice of methods in the toolbox and their applicability to usability evaluation.

This research and development project has been conducted during a two-year period from 2007 to 2009 on commission of 3 partners, all of them companies that develop and manage facilities on behalf of large user organizations. The usability mapping tool has been developed in close collaboration with the project partners. The researchers and the project partners have been engaged in participatory workshops to develop the project’s aims and approach to evaluation, the usability indicator, and an appropriate evaluation process, as well as to reflect on the results of various tests. Each project partner has provided a case that has been used for testing and developing the methods and tools. The cases were workplaces (offices), a highschool and a university college.

All methods described in the USEtool handbook have been tested in the cases. The aim of the testing has not been to evaluate the actual workplaces or educational spaces, but to gain experience with use of the methods, tools and indicators as they were developed and refined. Each test has concluded with a discussion together with the user representatives on how the methods and parameters worked. After testing, findings from each test have been summed up and presented in different workshops with partners. Some methods and tools were seen to work well, and only needed smaller adjustments, while others were rejected, or were in need of major redevelopment due to the results of the test. The following methods have been tested in cases and are part of the USEtool handbook: interviews, document analysis, structured group interviews, walk-throughs, and workshops. As a part of the development process, also questionnaires such as ASTM and DQI have been tested. Questionnaires are, however, not part of the final set of methods in the toolbox.

This project was developed and commissioned as applied research. This positions our work as a “real world enquiry” with the limitations, challenges and focus on practice that this implies (Robson 2002). This means that there was a set of clear expectations from our partners that had to be met: The tools should focus on effectiveness and fulfillment of organizational objectives. The tools should not require the use of questionnaires for all end users in the building, but should use input from a small number of users. The results should be useful both for improvements in existing buildings, as well as for input to briefing. And finally, representatives from FM or the user organization should be able to perform the evaluation without involving external consultants or researchers.

The USEtool handbook explains each stage and step in an evaluation process, enabling trained FM or user representatives to carry out evaluations of Usability. Supporting tools follow each stage to provide support to the evaluator.
3. Theoretical framework

By definition, *ex post* means after the fact, as opposed to *ex ante*, meaning beforehand. In relation to buildings, *ex post* evaluation means an assessment of a new or rebuilt building after it has been completed. *Ex ante* evaluations are analyses and estimations made in advance of project start-up. In this context, an evaluation is defined as a ‘Systematic and objective assessment of an ongoing or completed project, program or policy, its design, implementation and results’ (OECD, 2002). In general, we can distinguish between different approaches in *ex post* evaluations:

1. Socio-economic evaluations, usually *ex post* recalculations of *ex ante* analyses.
2. Business value evaluations, based on principles of corporate finance.
3. Holistic evaluations based on a diverse set of approaches and indicators.
4. Performance measurement evaluations utilising selected key parameters.

All four approaches can be applied to buildings. Property investors typically apply the second approach, the business perspective, which can be supported by approach 4, performance measurement (Andersen & Fagerhaug 2001, Olsson et al 2007). Government agencies and municipalities often are expected to apply the first approach, the socio-economic perspective, where benefits and costs are being monetarised to as great extent as can be defended scientifically (Sager 1991, Small 1999). Evaluators, especially those who aim at including a user perspective, typically prefer approach 3, holistic evaluations (OECD 2000). The literature shows a number of combinations of qualitative and quantitative evaluation techniques in use, including the logical framework, as described by Samset (2003). This paper is focused on this type of evaluations, in a usability perspective.

3.1 Post-occupancy evaluation

According to Preiser et al. (1988) a post-occupancy evaluation (POE) is: “... the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time”. A POE focuses on the users and their needs, and may include both physical, technical and psychosocial aspects and evaluations.

A number of POE methods focus on building evaluations and take users perspectives into consideration. Examples of this are DQI (e.g. Gann et al. 2003, Markus 2003, Prasad 2004), ASTM (2000) and Buildings Use Studies (Leaman and Bordass 2001). Others are concerned with evaluation of the direct use of buildings (data of occupancy etc.). However, in practice, we have seen that most POE methods focus on technical aspects, and less on the building’s relation to the users, as many methods for POE define functional and technical requirements against which the results are measured. Blakstad et al (2007) describe how different methods and tools were explored and tested according to their relevance and validity for Usability in several Norwegian cases. One of the main findings was that very few of the available methods aim directly at evaluation of usability, related to organizational objectives and effectiveness, but that many traditional research and evaluation methods had potential to be developed for the purpose of usability evaluation.
Alexander (2008) points out that in an organizational context, buildings usually are part of a portfolio of buildings, and are evaluated in terms of their asset value (as approach 2 above). He argues that the tools and metrics for considering the use value of buildings are less well understood and developed. The use value, or usability, is not only an attribute of the building, but also concerns the user’s experiences, use and satisfaction. Most POEs or building assessments focus on the building’s functional attributes. Functionality refers to what the building can do, to evaluate functionality is to assess to which degree the building works according to specifications. Usability has a broader scope, and therefore evaluations of usability have to focus on how people utilise the functions to meet their needs, and their experiences from doing so.

Granath and Gilleard (2008) voice a critique of traditional POEs, stating that performance measurements and POEs tend to treat the buildings statically, ignoring the dynamic nature of businesses and organizations that inhabit the buildings’ space. They also argue that “… unlike POE or other existing methods to measure performance, usability cannot be evaluated simply on the product alone but also with respect to how the product is perceived by and interacts with the user”. The National Research Council (2002) recommends to link assessments of physical conditions with user comfort in order to link facility design with business goals.

Usability is context dependent, and related to user experiences and social relations between users and facilities (as artefacts). Fenker (2008) argues that usability is a process, and can only be understood as a social construction. Fenker argues that: “… given that they are designed for one or more activities, the artefacts are bearers of a set of possibilities and constraints as well as, most importantly, activity and social practices models.”

As we have seen, usability may in many ways been seen as a “wicked problem”. Wicked problems have no definitive formulation of solutions, and they are open to multiple interpretations (Rittel and Webber 1973). Exploring “wicked problems” will usually require multi-method strategies. Blakstad et al (2007) argue for a triangulation of methods and evaluations with multiple perspectives: “… the complex nature of Usability highlights the importance of triangulation of methods (multi-method strategies) and research teams with different backgrounds and skills.”

All this implies that usability evaluations are complex, and that there is a need for simplification, and for the evaluator to possess both theoretical and practical knowledge and skills (Baird et al 1996). This means that it is challenging to develop a mapping tool for usability which can be used by evaluators with only limited training in performance assessments, and possibly no knowledge of research methods and skills. In order to develop the mapping tool, the challenge has been to operationalise usability, define which indicators one should consider, as well as provide methods that are focused, participatory and robust, as well as easy to use.

### 3.2 Operationalising the concept of usability

How can we understand the concept of usability in a way that makes it manageable for assessment and evaluation? In this project, where the objective has been to develop a methodology for assessing
usability in context, we have seen the need to operationalise the concept of usability. The definition of usability focuses on:

- **specified users** who use a product (the building) to achieve **specified goals**
- the importance of **context** – in other words, the relationship between building and users
- the **efficiency**, **value creation** and **user satisfaction** that contribute to achieving the specified goals

A building’s usability is never depending on the building alone. Its usability must be seen in light of the relationship between building and user. This is essential for understanding the concept of usability. The users have their own history, experiences, and perceptions in relation to the building and the activities that take place there. Further, the way they perceive the building will always be influenced by both individual and psychosocial considerations that have little to do with the building itself.

While working on the evaluation of usability, we have focused on the following questions: **What** do we want to achieve, and for **whom**? This is inspired by the research in universal design and quality and use of space, see e.g. Wågø et al. (2006) and Kirkeby (2006). In office buildings, the user organization often formulates objectives related to learning, branding, shared premises for units that should cooperate more, etc. In addition, there are different user groups that will often have different user perspectives. In a day-care centre, it may be desirable to have chairs and other furniture of a height that is suitable for the children, but this does not mean an optimal working position for the adults who work there. Moreover, the perspective may vary, depending on whether the context is the preferences and satisfaction of individuals or the effectiveness of the organization as a whole. For instance, an increased focus on knowledge sharing may require individuals to share their knowledge with others in the organization, which many employees may find demanding. In order to communicate this more clearly, we have focused on the following questions: who, what, where and why.

**For what?**

The definition of usability emphasises the fact that there are specified objectives to be achieved. Further, we have seen that there is a need to define the activities that are to take place. Thus the question “For what?” is multifaceted:

- What **objectives** are to be realised?
- What **activities** are to be conducted?
- What **work processes** should be supported?

When evaluating usability, it is essential to consider what factors enhance or inhibit effectiveness or the conducting of various activities.

**For whom?**

The next question is: Whose objectives should be met? The objectives of different individuals, of certain user groups, or of the user organization as a whole? We have focused on the need to define
both the user level (individual – group – user organization) and the type of user (user group). As the definition of usability designates specified users, it is important to define which user groups are being focused on. Are we evaluating usability from the perspective of a teacher, a pupil or a school librarian? In some cases, and for certain aspects of usability, different user groups may have divergent or even conflicting views of usability. Thus we have been intent on understanding how usability is evaluated by different user groups.

**Where?**

In order to obtain useful knowledge about a building’s usability, the users’ experiences must be related to space or place. Some places or rooms are well-suited for defined users and activities, while others are not. What functions well in one place for some people, need not function equally well for others in another place. Thus there will always be a connection between activities, different user groups and the physical surroundings. This means that in usability evaluations, there is a need to relate the user experience to specific physical surroundings; this influences the choice of methods for such evaluations.

**Why?**

Discovering factors that enhance/inhibit effectiveness is not sufficient; the next step is to understand why. As there will always be circumstances related to the building, the user organization, the individual user, or the way the building is used, that influence user experiences, it is beneficial to discuss the circumstances that influence the evaluation of usability. Why is this group room for students experienced as good to work in? Why does this office solution inhibit collaboration? By conducting discussions of this type, it is often possible to conclude that the reason a room works/does not work well is not necessarily a function of the room itself, but of other circumstances - such as the way the room is used - that do not match with the activities to be conducted there. This is essential when the knowledge acquired is to be applied in order to generalise and learn for later projects, or to improve the existing solution.

### 4. The USEtool: a 5-stage process

This paper presents a toolbox for evaluating usability, called the USEtool. In the toolbox, we have included a combination of different methods needed for gathering information and evaluating usability. The methods are intended as tools with which organizations or property owners themselves can conduct evaluations of usability using internal resources.

![Diagram of the USEtool process](image)

Figure 1: The evaluation process, USEtool
The methodology is presented as a process with 5 clearly defined stages and steps along the way (see figure 1). The steps are described in a handbook with specific and practical guidelines and tools, which provides the evaluator with computerised tools made available as templates and recommendations. The handbook, with active tools and guidelines, will be available in printed version in spring 2010.

**Stage 1 – Defining the evaluation**

In stage 1, the objective of the evaluation is defined, and a plan for the evaluation process is developed. When the focus is on usability, the effectiveness of the building is of primary importance. In the initial phase, representatives for the administration of the user organization are interviewed, in order to ascertain what visions, goals and strategies they have for the organization, the principles of organization, whether they have particular areas of focus in relation to how the building can boost effectiveness, and what their general impressions are, based on their use of the building. During this stage, the planning and implementation of the evaluation must be clarified.

In this stage we have chosen interviews and document studies, in order to establish a total picture of the situation at hand. Since the input comes from interviews, the quality of the results from this stage depends on choosing the right people to interview, as well as the availability of the informants.

**Stage 2 - Mapping**

We recommend conducting a general mapping process in stage 2. The objective at this stage is to establish an overall picture of the usability of the entire building or certain parts of it, based on a set of predefined parameters. This is done by holding a structured group interview, and by collecting already available information. During the group interview, questions should be asked about how the building supports activities, adaptability, universal design, architecture and floor plan, image, the indoor climate and the building’s support functions, see table 1.

**Table 1: Questions used in group interview, stage 2.**

<table>
<thead>
<tr>
<th>How strongly do you agree with the following statements:</th>
</tr>
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<tbody>
<tr>
<td>(on a scale from 1 to 6, where 1 = not at all, and 6 = to a high degree)</td>
</tr>
<tr>
<td><strong>WORK PROCESS SUPPORT</strong></td>
</tr>
<tr>
<td>1. Our premises support our activities</td>
</tr>
<tr>
<td>2. Our premises help us to work efficiently</td>
</tr>
<tr>
<td>3. Our premises help us to have a good work environment</td>
</tr>
<tr>
<td>4. Our premises facilitate cooperation within our own unit</td>
</tr>
<tr>
<td>5. Our premises facilitate cooperation with customers and collaborative partners</td>
</tr>
<tr>
<td>6. Our premises help me learn from others (support knowledge sharing)</td>
</tr>
<tr>
<td>7. Our premises support the development of knowledge</td>
</tr>
<tr>
<td>FLOOR PLAN/DESIGN</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>8. We have ready access to the rooms we need</td>
</tr>
<tr>
<td>9. The rooms are suitably designed</td>
</tr>
<tr>
<td>10. Our units/departments are suitably located in relation to each other</td>
</tr>
<tr>
<td>11. The building is well laid out and easy to find your way around in</td>
</tr>
<tr>
<td>12. We can easily adapt the building as our needs change</td>
</tr>
<tr>
<td>13. Our premises are accessible and easy for all user groups to use (e.g. the motor impaired, visually impaired, hearing impaired, orientation impaired and environmentally disabled)</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>INDOOR CLIMATE</th>
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<tbody>
<tr>
<td>14. We have a good indoor climate (lighting, sound level, air quality, temperature)</td>
</tr>
<tr>
<td>15. It is easy to keep our premises orderly</td>
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</tbody>
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<table>
<thead>
<tr>
<th>IMAGE/IMPRESSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. The building profiles our company in a good way</td>
</tr>
<tr>
<td>17. Our premises have an attractive design</td>
</tr>
<tr>
<td>18. Our premises give a feeling of belonging</td>
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<table>
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<tr>
<th>SUPPORT FUNCTIONS</th>
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<tbody>
<tr>
<td>19. I am satisfied with the canteen and the coffee stations</td>
</tr>
<tr>
<td>20. We have access to help quickly if there is a problem with the building or equipment</td>
</tr>
<tr>
<td>21. Our premises are kept clean</td>
</tr>
<tr>
<td>22. We have good systems for reserving rooms and equipment</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>EQUIPMENT</th>
</tr>
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<tbody>
<tr>
<td>23. We have ready access to the equipment we need</td>
</tr>
<tr>
<td>24. ICT (information and communication technology) supports our activities</td>
</tr>
<tr>
<td>25. Furniture and furnishings are satisfactory</td>
</tr>
<tr>
<td>26. We have access to adequate storage facilities</td>
</tr>
</tbody>
</table>

All questions are sent beforehand to the participants in the group interview. During the interview, the evaluator reads the questions, and the participants are encouraged to discuss the question, before giving individual scores (from 1-6) as well as a comment or an explanation of their score. The scores from each individual are not summarised, but the scores for each group of users are represented in a spider-web diagram, and the comments saved for later. The goal is not generalization or statistical analysis of the data. During the development of USEtool, a questionnaire was considered for use in this stage, but this was omitted because the partners wanted to avoid a large-scale survey, involving many users. This made the reliability of such a survey questionable, and we rejected quantitative methods and settled for a qualitative interview with a limited selection of users (6 to 10 persons) instead. Conducting the group interview is one of the most challenging tasks for the evaluator, and a detailed set of instructions is developed as part of the toolbox.
If the objective of the evaluation is to examine specific topics/problems, the structured group interview in stage 2 can be omitted, and stage 3 (the walkthrough) is initiated as soon as the information has been collected.

**Stage 3 - Walkthrough**

The general mapping process yields an overview of different usability parameters, but it does not provide any in-depth information. The objective of stage 3 is to gather user experiences related to selected topics from stage 2, and to attain a better understanding of why solutions function well or poorly. The mapping process will generate a picture of “where the shoe pinches”, or particular topics that it may be useful to gather in-depth information about. These topics can be explored using a walkthrough (stage 3). A walkthrough is conducted as an inspection tour of the building (with designated stops) with selected users in order to gather their experience in relation to the relevant topic. In some cases, there will be several topics you wish to gather in-depth information about. In that event, you may need to conduct several walkthroughs, with different topics, different stops and different participants.

In most studies of usability, some kind of walkthrough methodology has been used. Walkthroughs are valuable for usability evaluations, due to the fact that they may provide perspectives and experiences from multiple informants with different perspectives, spending a limited amount of resources. They provide contextual data, which can be directly related to place (where), activity (what?) and actor (whom?). Again, this is a qualitative method. The use of the walkthrough in USEtool is described as a separate paper (Hansen et al, forthcoming).

In some cases there will be no need for more in-depth information, if the necessary answers were provided by the mapping process. In that event, the handbook recommends proceeding directly to stage 4 (the workshop).

**Stage 4 - Workshop**

In stage 4, the results from the mapping process and the inspection tour are summarised and discussed in a workshop with the user organization, in order to evaluate usability in relation to the goals that the organization has formulated. This is the time to explore how physical solutions are experienced in relation to the chosen objectives, and why this is the case. The question “why” is important in order to determine what knowledge can be applied on other buildings, and what knowledge is linked to the interaction between user and building in each concrete instance.

At this stage it is important to always relate the discussions to the objectives. According to Blakstad et al (2007), assessments from users are more based on their personal experiences than on the fulfillment of organizational objectives. This is why the methodology stresses that the discussion always should be about objectives, at this stage. Since most data gathered during the evaluation is qualitative, the discussion also provides opportunities to calibrate and understand the data to enhance the reliability and validity of the assessments.
Another important issue in the workshop is attribution. We are interested in to what extent observed development is related to the physical environment. Attribution is a key issue in ex post evaluation (Samset, 2003). In this connection, attribution is defined by OECD (2000) as: "The ascription of a causal link between observed (or expected to be observed) changes and a specific intervention."

When analysing whether a building project has met its objectives, one must keep in mind that other factors may have an impact, in addition to the building studied. Low attribution means that it is difficult to isolate the impact of the project studied. User perception of the actual building, including light, space availability, and in-door climate, is usually relatively directly related to the building itself. When evaluating the effect of the building on the core activity, such as learning in a school, service production in an office building, e.g., attribution becomes an important issue.

Stage 5 – Action plan/Final report

Stage 5 consists of drawing up an action plan or communicating the results of the investigation by other means. The way these results are reported will depend on the objective defined in stage 1. The results can be used to improve solutions, in the planning of new buildings, and to increase our knowledge about the relationship between a building and its users.

5. Concluding discussion

In this paper we have presented our work on operationalisation of usability for the purpose of usability mapping and evaluation. We have also given a brief description of the proposed evaluation process, methods and tools as well as some reflections on the choice of methods. Based on theoretical and empirical work with usability over many years, our aim is that the proposed process, methods and tools will provide us with better foundations for future work with usability of buildings. The process description in USEtool contains a gathering of known, qualitative methods; such as interviews, structured group interviews, walkthroughs, and workshops. We think that the main contribution is the way these methods are combined in a structured framework with process descriptions and easy-to-use guidelines, as well as the operationalised relation to effectiveness and usability.

The methods in USEtool have been tested as part of a development process. There is still a need for further testing of the entire process (step 1-5), as well as of all the tools as they are described in the final handbook. Further testing carried out by our project partners will reveal the method’s usefulness, simplicity, and the necessary amount of resources to carry out evaluations. From what we have seen in the cases and tests, the described methods and tools really assess usability within the given context, with special focus on the effectiveness of the facilities and their ability to support value creation in the user organization. We acknowledge the fact that one cannot generalize directly from the results of highly context dependent evaluations such as USEtool. In fact, the Usability concept is context-dependent in nature. One may argue that the contextual knowledge that may be gained from applying the USEtool is as important as the generic results for building performance. Further work is needed to address this. The purpose of this project has been to provide building owners, users and Facility Managers with knowledge of usability in order to support continuous improvements. In order to take
this work to the next step; more generic evaluation of usability, we need further tests and validations
to ensure that we really target the most important aspects of usability applying USEtool.

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