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USABILITY THEORY

Adding a user-centric perspective to workplace management

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1 Background

Usability of the built environment is a concept that describes a human-centric approach to quality-in-use of physical environments with the goal of supporting users' activities and user-related outcomes. In architecture, the idea of usability has been known for centuries. Its introduction into the field of architecture is commonly attributed to Vitruvius, who postulated that buildings must be built with due reference to durability, convenience, and beauty (Vitruvius, 1914). In modern research and development, however, usability of workplaces is based on fundamental work on ergonomics in human-computer interaction (HCI). Commonly, Bennett (1979) is credited with the first publication with usability in its title. A further seminal paper by Gould and Lewis (1985) introduced the idea of early focus on users and tasks, empirical measurement, and iterative design as key principles of usability. Shackel (1991) discussed usability as a situational concept, i.e. design of tools as dependent on users, tasks, and environments. Further, he described the usability paradigm in terms of utility (i.e. whether the tool will do what is needed functionally), usability (i.e. whether the users will work it successfully), and likeability (i.e. whether the users feel it is suitable). These dimensions became the defining characteristics of the modern understanding of usability as it is defined by the International Organization for Standardization (ISO) as: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO 9241–11, 2018). While these aspects of the ISO guidance on usability were developed in the context of work with visual display terminals, the guidance is applicable to other situations where users interact with artefacts or objects to achieve certain intended objectives such as situations where people interact with different types of systems (including the built environment), products, and services (ISO 9241–11, 2018).

According to ISO 9241, usability is composed of three dimensions:

- *Effectiveness* describes usability from an output point of view. It includes the accuracy and completeness with which users achieve specified goals.
- *Efficiency* relates output to resources, i.e. describes the resources expended in relation to the accuracy and completeness with which users achieve goals.
- *Satisfaction* describes the comfort and acceptability of use.

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The three dimensions refer to output, process, and subjective assessment of the experience of interacting with a system, product, or service. Effectiveness and efficiency refer to usefulness of systems, i.e. the degree to which the interaction with the systems supports users to achieve output. Satisfaction complements usefulness of a system with a user-friendliness component (cf. Davis, 1989).

A recent extension of the usability concept in the context of user experience that may lead to new research and insights in the built environment is coolness as a characterisation of products or facet of HCI. Holtzblatt (2011) set out to find out what makes things cool (i.e. what drives the cool user experience). She found that the centre of cool is joy, and joy in life happens when products help fulfil core human needs such as accomplishment, connection, identity, and sensation. Further research on cool products shows that user experience is composed of desirability and rebelliousness (unconventional, novel aspects) besides usability (e.g. Bruun et al., 2016; Raptis et al., 2017).

2 Applicability to workplace studies

The Hawthorne studies (Roethlisberger & Dickson, 1939) disproved the deterministic-mechanistic approach of environmental influences and pointed out the importance of perceived qualities of the environment. Thus, for the behavioural relevance of a given environmental exposure, not the physically measurable quality is crucial, but its function for a person and his/her actions. Previous research shows that objective measures (i.e. measures that are independent from self-reports of users) are generally not correlated with perception-based or subjective evaluations (Hornbæk & Law, 2007; Windlinger, 2012). Thus, an approach to usability of the built environment does not require an abstraction of physical parameters but an extension of such measures with subject- and action-related terms (Schultz-Gambard & Hommel, 1987).

The usability concept was developed for the built environment by CIB Task Group (TG51) (Jensø et al., 2004) and the CIB working commission on Usability of Workplaces (W111) (Alexander, 2006, 2008; Lindahl et al., 2012).

The working commission on Usability of Workplaces (CIB W111) by the International Council for Research and Innovation in Building and Construction (CIB) conducted research on the application of usability concepts to the work environment with an international team of researchers and practitioners. The network provided new insights on the application of usability concepts and a better understanding of the user experience of different categories of environments, including workplaces. Conceptual research and case studies were to address underlying philosophical, theoretical, and methodological issues of usability of workplaces. Themes included user experience, feed-forward processes, and explorations of the links between the quality of the environment, health, well-being, and productivity in the workplace. The results of usability evaluations are used as feedback for continuous improvement processes of the workplace, facilities, and management. The main motivation for organisations to participate in usability research was the improvement of facilities with potentials to add value to their core business/user organisations.

The working commission on Usability of Workplaces (CIB W111) drew upon the ISO definition of usability from the beginning. Even though the usability concept has its roots and its most important and largest field of application in human-computer interaction, the developments of CIB W111 remained largely unconnected to usability in HCI literature and debates.

The introduction of usability in the built environment supplemented or even replaced a narrower focus on functionality of buildings and facilities that was based on technical rationalism with attributes of products that are described mainly in objectively measurable terms

(Jensen, 2010). Since usability focuses on use or interaction of people with buildings and facilities and the resulting experience, it is highly context-dependent and situational. Usability evaluations therefore must specify contextual parameters such as purpose of the environment, user groups, activities, specific locations, places, or rooms (Hansen et al., 2011).

2.1 Applying the usability perspective in workplace-related processes

Usability has been applied in different categories of environments such as workplaces (e.g. Alexander, 2005; Windlinger et al., 2016), learning environments (e.g. Alexander, 2010), and hospitals (e.g. Fronczek-Munter, 2016).

In the workplace, user reactions to the physical environment shape individual well-being, social interactions, and organisational effectiveness. Therefore, work environments should be aligned with work tasks and organisational goals and strategies in order to produce the best accommodation for a certain work style (Aronoff & Kaplan, 1995; Becker, 1990; Vischer, 1996). From this perspective, work environments are considered as a resource or tool that should be designed not primarily to reduce space (and cost), but to support the work style and business mission of the organisation (Vischer, 1996) and thus to contribute to organisational profitability. The significance of the built environment for the effective operation of an organisation is rooted in the fact that buildings and spaces are constructed for particular purposes or functions. Functional and programmatic aspects are translated into spatial forms and infrastructure. However, these aspects are very rarely evaluated (Hay et al., 2017; Li et al., 2018).

Usability as a quality-in-use approach is based on considering workplaces as a tool or resource and acknowledging that what matters most for users of an environment is their experience (and not compliance of a building or indoor quality aspect to norms, standards, or expert assessments). Therefore, usability is highly contextual, i.e. dependent on tasks, user characteristics, and properties of the physical, social, and technical environment (cf. Alonso-Ríos et al., 2010).

The usability perspective can be applied in strategic, developmental, operational, and evaluative phases of workplace projects as well as in workplace-related processes and continuous improvement. Usability is thus a general approach in workplace management which affects workplace strategies and projects as well as the day-to-day operations and continuous improvement of work environments. Key principles of usability management are:

- An early and continuous focus on users: identification of users (or user groups) and their activities and interactions with the work environment is a fundamental point of departure.
- A balanced consideration of output, process, and subjective assessment of the experience of interacting with the environment.
- A combination of objective and subjective measures: in the HCI domain, the output component of usability often contains some objective outcome measures related to performance. In the built environment domain, objective outcome measures may be partly substituted by user assessments since performance-related objective measures are rather an exception in knowledge work. Subjective measures should cover functional properties (usefulness) as well as experience (user friendliness).
- Integration of four perspectives (Bevan et al., 1991; Sauer et al., 2020): (1) product-oriented view: product-inherent attributes (e.g. ergonomics); (2) user-oriented view: users' mental effort in usage of a system, product, or service and their attitude towards it; (3) performance-oriented view: user interaction with the system, product, or service; and (4) context-oriented view: influences of differences in tasks, user characteristics, and physical, social, and technical environment.

- Taking account of changes over time: work environments may change as buildings and infrastructure move through their respective life cycles, or when regulations change. Contexts of use may change as business strategies, organisations, or technologies develop.

These principles imply that conceiving, designing, managing, and optimisation of work environments are tailored to specific contexts (and do not just follow standards). The process of achieving or increasing usability of a specific context is carried out as true interdisciplinary cooperation in and for real work settings. Interdisciplinary teams involve experts and users or participants that are as similar as possible to future user groups. Usability-focused workplace-related processes are participative in nature. Participation reaches beyond information and consultation but involves co-development of concepts and spatial/infrastructural solutions in iterations. Design of work environments is based on analyses and follows a human-centred design approach "that puts human needs, capabilities, and behaviour first, then designs to accommodate those needs, capabilities, and ways of behaving" (Norman, 2013, p. 8). This approach considers differences between different user groups and stakeholders. Eventually, usability of the built environment refers to a continuous improvement process with periodic usability evaluations. Periodic evaluations are formative in nature, i.e. they aim at improving the work environment by identifying problems in human-environment interaction (as opposed to summative evaluations that evaluate quality of the environment with the goal of comparing it against other environments or some specified standards or goals) (cf. Sauer et al., 2020).

Usability thus emerges as a fundamental approach or perspective in workplace management which includes the day-to-day operations and continuous improvement of work environments. Usability adds value to work organisations by aligning the physical work environment design to organisational operations.

2.2 Usability briefing and design

The importance of briefing to achieve usability is highlighted by the CIB W111 work commission, where usability is taken as a central concept for the workplace design and operation of facilities (Alexander, 2010). Briefing is usually known as one of the first phases of a building project, before the design activities. In practice, it involves users as data sources and results in briefing documents (the brief or the program of building requirements) (Fronczek-Munter, 2014). Considering the traditional approach in briefing, several researchers suggest that briefing should be a dynamic (Nutt, 1993; Prins et al., 2006) and a continuous process (van der Voordt & van Wegen, 2005; Jensen, 2006). Briefing in usability studies refers to a transition from being a single process in a definite initial stage resulting in a final document, to a continuous and interactive process throughout all building processes (Jensen, 2006).

Alexander (2006) emphasises that knowledge from usability evaluations should feed into briefing. Jensen et al. (2011) notice the potential implications for the briefing process when usability is taken as a contingent quality rather than as the inherent functionality of the physical environment. They introduce a usability briefing model that involves users since the concept of usability is seen as a similar approach to functionality but strongly depends on subjective views of users, context, culture, situation, and experience. Jensen (2006) identified the following reasons as the most important for involving users in the briefing process:

- Ensure that new facilities are designed in accordance with the needs and intentions of the organisation,

- Learn from good and bad experiences with existing facilities,
- Ensure acceptance and appreciation of the new facilities among managers and staff.

Jensen et al. (2011) suggest that further research should examine the effects of user involvement for different types of users, processes, and facilities while considering the role of the users in the briefing process and how to manage inclusive and continuous briefing. The follow-up research by Fronczek-Munter (2014) addresses these suggestions and proposes additional relevant characteristics for usability briefing, i.e. concerning existing or future facilities, process being continuous in all phases with focusing on usability, and the importance of co-learning and co-designing.

Compared with the characteristics of traditional briefing (Table 15.1), usability briefing is a continuous briefing process with a focus on usability, in which users are actively involved, not only in evaluations and data gathering but also in decision of workplace-related processes (Fronczek-Munter, 2014). The novelty of the usability briefing model by Fronczek-Munter (2014) consists in the combination of the four known activities of briefing (design, evaluations, user involvement, briefing documents). It organises them as well as provides a visual overview of the four activities throughout all building design phases. The model consists of main activities to be carried out with a focus on the stages and methods where usability topics are formalised (e.g. in notes, documents), discussed (in workshops, design meetings), and systematically evaluated (e.g. in design appraisals). The model combines continuous user presence, co-creation, design and evaluation with various users and stakeholders, and using creative boundary objects in workshops (Table 15.1).

Researchers emphasise that briefing is a key process to achieve usability and effective facilities (Alexander, 2008; Blakstad et al., 2010; Jensen, 2010). For instance, the case study in NCR Discovery Centre, Dundee, Scotland, investigated how to add value to the outcome by involving people, and how to avoid design errors by realising their requirements for the workspace. Different from a traditional top-down approach, where generally users are expected to adapt to what is given to them, the involvement of staff in the planning was seen as very important as stakeholders wanted a significant change to their working environment (Alexander, 2005). Another case study of a new broadcasting facility for the Danish Broadcasting Corporation in Copenhagen, Denmark, investigated evidence for relocation processes and activities that would lead to more usable workplaces. The results show that user involvement in briefing and design had a positive effect on the finished buildings and user satisfaction (Jensen, 2006).

Other usability studies investigate different aspects of the usability concept in workplaces. For instance, research by Rasila et al. (2010) claims that understanding the usability dimensions

Table 15.1 Comparison of traditional briefing and usability briefing (Fronczek-Munter, 2014, p. 270)

Traditional briefing	Usability briefing
Concerns new building/construction	Concerns all client/user needs in existing or future facilities
A definite phase at an initial stage of construction	A continuous process with changing focus in all the phases of building life cycle including occupancy
An expert-based information collection	A co-learning and dialogue process
Users mainly involved as data sources	Users actively involved as co-designers and part of a corporate change process
The result is a brief, i.e. a requirement specification	Continuous collection of visions and specification requirement specs, with changing detail and focus

end users use in assessing built environments makes it possible to improve existing environments and to create new environments that suit end-user needs better. They propose 12 different dimensions that users could use when they are assessing the usability of built environments: efficiency, flexibility, learnability, memorability, amount/tolerance/prevention of errors accessibility, navigation, functionality, atmosphere, interaction and feedback, servicescape, feeling secure, space networks. Lindahl et al. (2012) emphasise that usability evaluations should also focus on how the building impacts value creation in the user organisation. They suggest that the user organisations ask: *What do we want to achieve? What do we want the building to contribute? How can our premises create added value for the organisation?* Another usability study by Windlinger et al. (2016) aimed to capture the elements of user experience connected to usability using the distinction between usefulness and user-friendliness. Their findings show that perceived support of work activities by workspaces in relation to work tasks is the main element of usefulness. The most important aspects of user-friendliness are comfort and control. The correlations between usefulness and user-friendliness and outcomes of usable workspace design are low for self-assessed performance, moderate for job satisfaction, and high for work area satisfaction. Another recent usability study focuses on social and healthcare workplaces. The study lists the most important usability elements in these workplaces as functionality, safety/security, healthiness, orientation, interaction, and comfort (Aalto, 2019).

3 Methodology/research approach

The cases analysed by CIB W111 applied various tools and methods to provide fundamental insights on usability of the built environment and how to evaluate it. Furthermore, specific tools were developed considering their potential to contribute to the use of workplaces in various aspects, such as workplace management and design decisions. Traditional methods used in building evaluation are usually expert-based and concerned mainly with the physical aspects of the environment and do not involve user experience. One of the strong traditions has been post-occupancy evaluations (POEs). POE (Preiser et al., 1988) refers to a process of systematic collection of data after a building is in use and is strongly tied to performance. Data collection is gathered from experts and users, but convergence between users' assessments and the view of designers and facilities managers is usually low (Chigot, 2005). Researchers criticise the existing assessment methods as they focus too much on technical aspects of the buildings (e.g. van der Voordt & Van Wegen, 2005; Alexander, 2006). POE originally included the idea of a feed-forward approach (i.e. use data from POE for planning). However, this approach is rarely applied in practice. Instead, POE practices are mostly used as feedback from finished buildings, and researchers (e.g., Jensen, 2010; Alexander, 2006) suggest that usability evaluations should be part of a feed-forward approach in workplace projects. From a workplace management point of view, usability evaluations lead to improvements in both existing and new buildings. The methods and focus used for evaluation of usability of workplaces have shifted towards a more holistic, process-oriented, and user-centric approach.

Nenonen et al. (2008) investigated how to assess work environments from the user perspective, as part of user experience. They developed a methodology for user-oriented workplace management, which consists of post-occupancy evaluations, usability walk-through audits, and service process evaluations that are combined with insights from customer journeys. Considering pros and cons of different methods and tools, they deduce that POE focuses on the building as an object instead of process, while usability walkthrough can focus on qualities of different functions within a building and its attributes, and customer journey provides data about the processes and user experiences in the work environment. Even though the methods can unveil

small details that may affect the user experience in workplaces, they recognised a need for further development of the theoretical framework, methods, and tools for measuring usability from different users' perspectives.

Another usability study by the Norwegian group (Blakstad et al., 2008) aimed to evaluate the relation between building and people and organisation when evaluating usability of buildings. Considering the challenge of understanding users' actions and a long list of user types and groups, they suggest not only focusing on the individual level but also looking at the impact of the building in the organisational context, for a better understanding of the relation between people and building. They describe usability as context-dependent and related to user experiences and social relations between users and facilities. They further emphasise that the complexity of usability shows the importance of triangulation of methods (multi-methods strategies) and interdisciplinary research teams with different backgrounds and skills to perform the usability evaluations.

Future methods and research on usability of workplaces need to focus on the management of the complex issue of efficiency of facility use incorporated with the efficiency of the organisation. It is left to future research to identify and take advantage of naturally occurring situations for quasi-experimental longitudinal field studies (cf. Shadish et al., 2002) or other possibilities to demonstrate benefits of a usability approach in the built environment. Furthermore, the content dimensions of usability of the built environment are not yet developed in detail, and a framework that would relate material, ambient, and socio-spatial aspects of workplaces to efficiency, effectiveness, and satisfaction remains to be developed.

4 Limitations

Usability theory has its roots in human-computer interaction (HCI). Usability engineering may be difficult in the built environment compared to HCI since modifications, adaptations, and optimisations of workplaces and other environments follow different principles (in terms of effort, cost, dynamics, and time cycles) than software. This may be a reason why usability is not established as a process – or, at least, perspective – in practice in the built environment domain. While principally hypotheses could be derived from usability theory, rigorous experimental or field studies are missing so far. It must be acknowledged that it is very challenging to empirically demonstrate benefits of a usability approach since normally there will be no comparison to other approaches possible.

5 Theory relevance to practice

Usability of the built environment is an approach that emphasises quality in use with a strong focus on human experience. It thus extends post-occupancy evaluation and its associated continuous improvement ideas with a more user-oriented or even user-centred perspective. Usability provides valuable guidance in developing, assessing, and improving workplaces with a user-centric perspective.

5.1 Management of usability of workplaces

Taking the aforementioned into account, an extended perspective of workplace management with a focus on usability has potentials to make the workplace process more effective and usable. The usability perspective can be applied in strategic, developmental, operational, and evaluative phases of workplace projects as well as in workplace-related processes and continuous

improvement. The experiences and learnings that have resulted from usability studies empha-sise that, besides continuous user presence, a better understanding of the concept of usability is important for the application of usability in workplace projects. For instance, Blakstad and Hansen (2012) studied the adoption of different tools and methods for usability evaluations in four organisations in Norway. They found that the adoption of methods for usability evaluations can be a driver of innovation in organisations when key players have awareness and competence and when sufficient resources and adequate incentives are present.

For the application of usability in workplace management, Jensen et al. (2009) suggest con-sidering usability as a general approach which refers to a continuous briefing and commission-ing for the improvement of work environments throughout all building processes. As shown in Figure 15.1, the briefing process refers to an ongoing capturing of requirements based on experience and changing needs with continuous user presence, and it has a peak around the start of the design phase but continues during the construction and occupation of the building. The commissioning process, with an opposite intensity, refers to an ongoing optimisation of building performance during the use of existing and new buildings. It begins with ensuring and verifying the performance of the new building and intensifies during design and construction with a peak when the new building is occupied.

Considering the objectives of facilities management, which are to provide setting and ser-vices to support the effectiveness of organisations and to support user activities (e.g. work on tasks, work processes) and their outcomes (performance, productivity), the application of usabil-ity in workplace management is a complementary approach that focuses on quality-in-use. The important key for management of usability of workplaces is specifying the processes and strate-gies throughout the whole life cycle of the work environment with a focus on usability aspects. These aspects are to connect effective utilisation of the physical, environmental, and organisa-tional resources to result in positive outcomes and value creation for all users and stakeholders.

5.2 USEtool: a toolkit for usability in the built environment

A major outcome of usability in the built environment research and development is a USEtool, a common usability framework or methodology (Hansen et al., 2010; Blakstad et al., 2010). It consists of five stages and results in the drafting of an action plan for improved usability for the organisation involved. For each stage, they propose a general (preliminary) introduction, fol-lowed by a description of the goals in that stage, the methods used, and the expected results, with a focus on usability aspects related to effectiveness. They, later, published the USEtool handbook as an active tool that building owners themselves can implement by using their inter-nal resources (Hansen et al., 2011). Their objective was to develop a set of tools that are easy
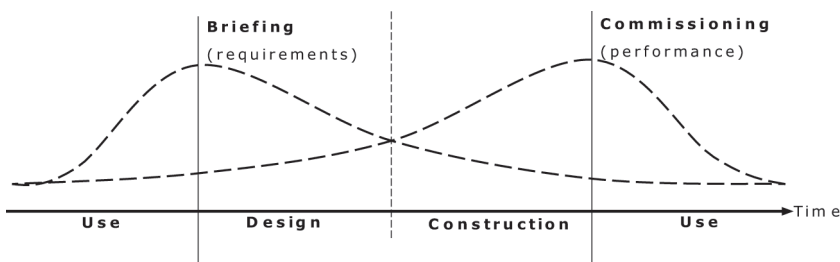

Figure 15.1   Continuous briefing and commissioning (adapted from Jensen et al., 2009, p. 7)

to use and more manageable for evaluation, as providing both an overview and more in–depth knowledge of the concept of usability. As the perspective may vary depending on whether the context is the preferences and satisfaction of individuals or the effectiveness of the organisation as a whole, they focus on who, what, where, and why questions in their tool in order to have a clear assessment (Hansen et al., 2010, 2011; Blakstad et al., 2010):

- For what? The definition of usability emphasises the fact that there are specified objectives to be achieved. To define the activities that are to take place "for what?" is multifaceted: *What objectives are to be realised? What activities are to be conducted? What work processes should be supported?*
- For whom? As the definition of usability designates specified users, it is important to define which user groups are in focus. There is a need to define both the user level (individual, group, user organisation) and the type of user (user group). Different user groups may have divergent or even conflicting views of usability.
- Where? Users' experiences should be related to space or place. This means that in usability evaluations there is a need to relate users' experiences to specific physical surroundings.
- Why? Discovering factors that enhance/inhibit effectiveness is not sufficient; the next step is to understand why. This fundamental will enable generalising and providing knowledge for the benefit of future projects or to improve existing settings.

6 Further reading

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