UC Berkeley
2017 Conference Proceedings

Title
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Permalink
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Publication Date
2017-10-15

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The role of self-reporting in heating energy efficiency

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Behavior Energy and Climate Change Conference 2017, Berkeley CA, USA

Abstract
Indoor comfort was earlier viewed as driven exclusively by the physics of the body's heat exchange with its immediate thermal environment. There is now widespread recognition that a person's thermal comfort and adaptation level, including behavioral aspects, physiological and psychological processes, including sense of control, influence comfort [1]. A stronger emphasis has been given not only to psychological parameters and their impact on satisfaction and productivity, but also to possibilities of energy saving in buildings while maintaining a high comfort standard [2]. A field study was conducted to consider the relationship between localized comfort control capabilities and self-reporting behavior. A significant effect was found for subjects' frequency of self-reporting in relation to heating control behavior.

Background
The perceived indoor environment quality (IEQ) factors in the office place are commonly measured via online questionnaires or paper based formats at fixed intervals to gain an assessment of the workplace. Factors such as perceived comfort, health symptoms, as well as individual characteristics, working conditions, and psychological and social aspects may be taken into account [3]. However, questionnaires in the office environment are typically time consuming activities and the motivation to fill in a questionnaire on a frequent basis may be low. An alternative approach to gather information relating to the perceived IEQ or is the experience sampling method (ESM). ESM is a research procedure for studying what people do, feel, and think during their daily lives, it consists in asking individuals to provide systematic self-reports at random occasions during the waking hours of a normal week [4]. Sets of self-reports from a sample of individuals are used to create an archival file of daily experience. ESM measures can be designed as digital scales in an app or as physical controllers in a device.

Information from self-reported perceived comfort in the office place can be used to:

- Provide a better match between personal preferences for indoor climate and the building environmental parameters, for example some occupants may choose to work in cooler zones, thus saving energy as the entire building does not have to heated at the same level.

- Identify problems relating to the building management system (BMS) and the building façade in relation to occupancy comfort and energy usage.

- Inform the BMS across zones. For example the average occupant vote can be used to set the temperature level.

- Improve communication between the facility manager and office occupants.

Previous pilots conducted by the authors demonstrated the challenge of motivating office occupants to self-report their comfort levels. Two different approaches were tried, in one approach a physical controller was placed on colleagues desks in a lab, the participants were not motivated to self-report as the direct benefit to them was not clear. In a second study conducted at a large commercial office building, 27 participants were instructed via a kickoff

workshop with management to self-report. In this case the response rate, being two times per day over a two-week period, via a desktop application, was 100 percent. The disadvantage of the latter approach is that management has to be directly involved and it would most likely be difficult to sustain such a mode of working over a longer period, in particular in less-hierarchical managed work organizations.

Field Study

A field study was conducted in which the experience sampling method was integrated in local heat control for the office place via a native Android and IOS app and desktop interface (Figure 1.)

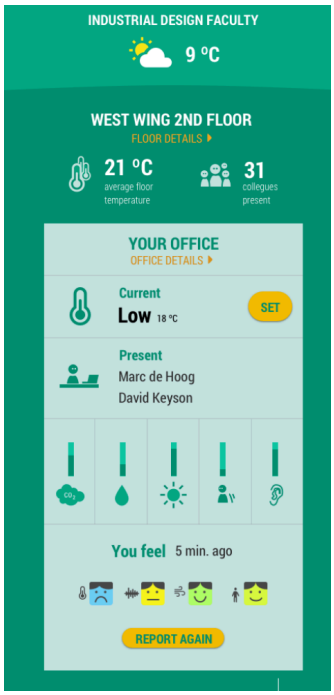

Figure 1: Integrated self reporting with localized heat control

The hypothesis tested was: users who more actively engage personal heat control would also be more likely to self-report. The study involved 26 office workers who installed the self-reporting app and desktop version. An earlier developed sensor box located on each the desk that measures temperature, humidity, noise, light, CO2, and movement [5] was modified to include communication with a wireless office radiator controller. All participants received a notification, with a maximum of three times per day, when in the office on their desktop or in the app to self-report over three one week periods spread over three months. The days remaining to self-report could be viewed in the app and desktop version. A significant main effect was found for frequency of self-reporting and local heat control $F\ (1, 25) = 4.53, p = .01$. Thus users who were more engaged in controlling their office heat were more likely to self-report. Next steps are focused on integrating local self-report information and sensor information at the desk level in a commercial BMS. The potential to provide office occupants with integrated health related feedback, such as the amount of movement during the day at work and sit/stand time, as a trigger to increase self-reporting of comfort will be also be examined. The goal here to reduce energy needs and create a better match between comfort needs and the building infrastructure, while reducing sedimentary behavior at work.

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