

TRIGGERS BEHIND HUMAN-BUILDING INTERACTIONS FROM A USER PERSPECTIVE: RESULTS AND EFFECTIVENESS OF CAPTURING MOTIVATIONS IN REAL-TIME

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1. Introduction

Although there have been significant advancements in the field of energy-related behavioural research in buildings, gaining a more comprehensive and “multi-dimensional” understanding of drivers behind human-building interactions is still needed to better incorporate the user perspective in building operation and design practice [1]. Increasing effort is being put on studying how the combined effect of IEQ (Indoor Environmental Quality) factors may affect user perception and behaviour in occupied buildings [2]. Oftentimes, the motivations behind actions are derived solely from physical measurements of the environment, which might not always reflect the real triggers behind occupants’ actions [3]. On the other hand, requesting feedback directly from occupants might give valuable insights on the perceived triggers for actions, but might also increase the so-called *Hawthorne effect*, according to which the occupant’s knowledge of being studied affects their natural behaviour [4,5]. This paper provides early insights from a field study that precisely addresses these questions and relies on a newly developed mobile application named “OBdrive”. The aim of the study is to capture an extensive set of both subjective and objective multi-domain variables that are likely to drive building occupants’ actions on environmental controls [6].

2. Methodology

OBdrive was dedicatedly designed for the so-called eCOMBINE project (“Interaction

¹<https://www.smartlivinglab.ch/en/projects/ecombine/>

between energy use, COMfort, Behaviour and the INdoor Environment in office buildings”)¹. In this paper, we report partial results from the eCOMBINE monitoring campaign conducted for two weeks during the heating season (17-28 February 2020) in an open space office located on the fifth floor of a six-story commercial building with a mix-mode ventilation system in Geneva, Switzerland.

All desk spaces have an access to a window within less than 5 m and both windows and external shading were freely operable. The mechanical ventilation system is usually not operating during heating seasons. Thirty-one participants were asked to report the motivations behind their actions on the mobile application OBdrive installed on mobile phones positioned close to windows and blinds each time they interacted with them. The type of answers proposed by the mobile application during the pilot campaign is shown in Figure 1a. Occupants could select multiple answers in case of simultaneous motivations behind an action. The self-reporting of actions on the mobile interface was complemented with window state logging, meaning that each window was equipped with a mobile phone (subjective data) and a wireless window reed sensor (objective data). The experimental setup in the open office space is shown in Figure 1b.

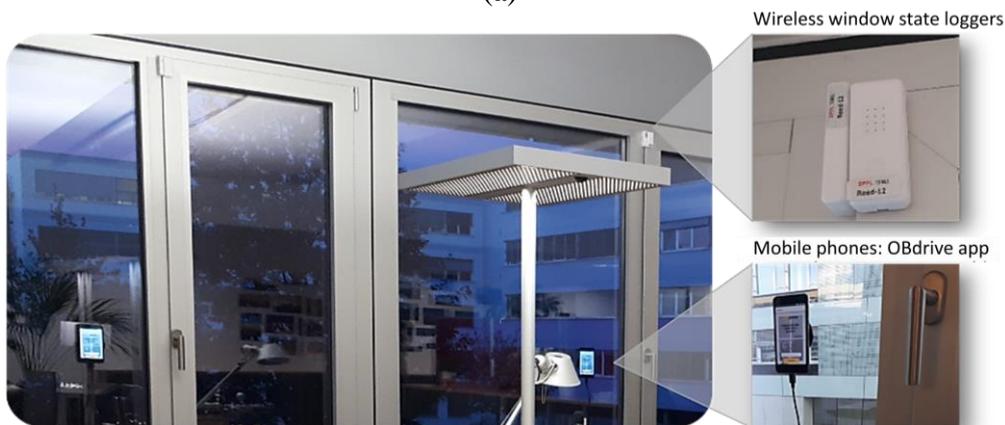
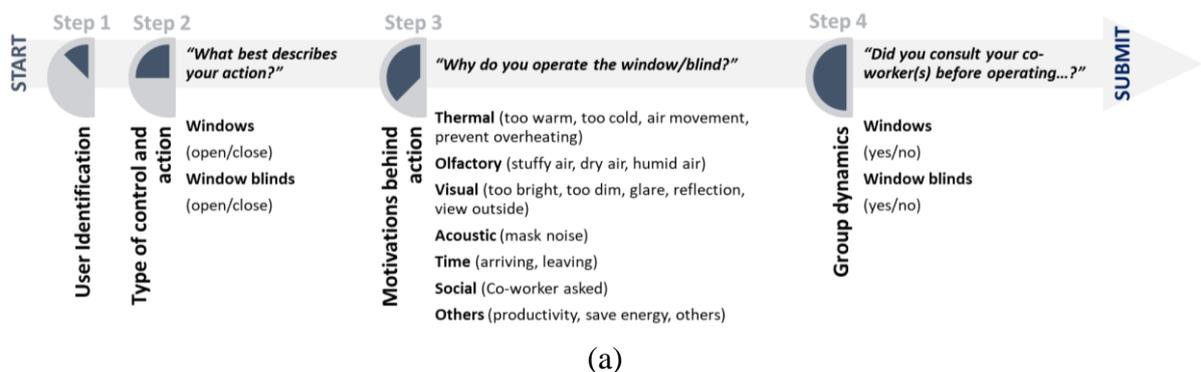


Figure 1. Experimental setup: (a) flow of information requested by OBdrive and (b) installation of phones and wireless window state loggers on the window.

3. Results and Findings

The number of self-reported opening and closings of windows and blinds is shown in Figure 2. The lower number of reported “closing” actions highlights that participants used the application more constantly during opening actions. The same figure also shows that most of the time participants did not consult co-workers before interacting with controls.

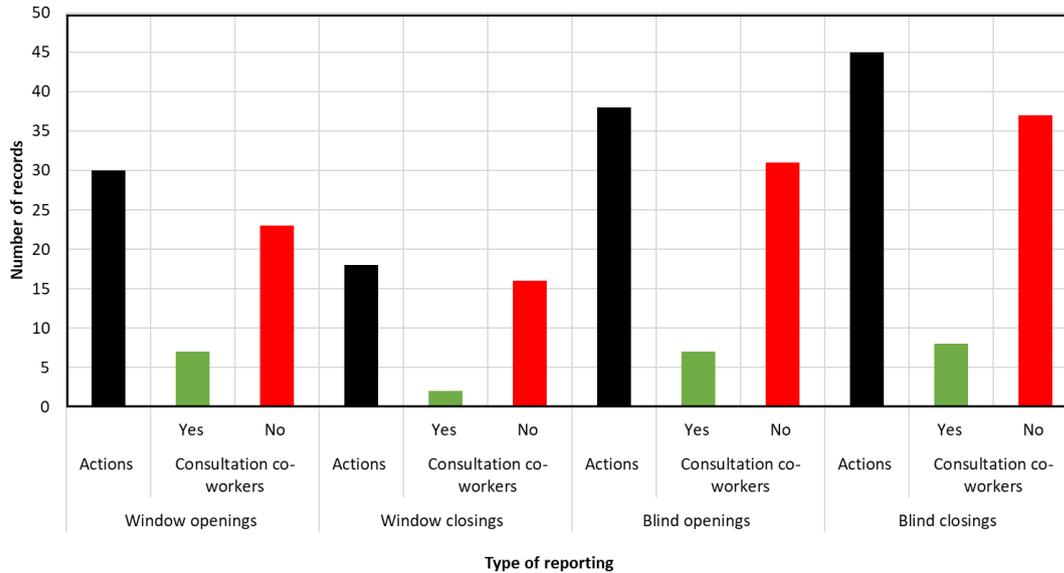


Figure 2. Reporting of actions and consultancy with co-workers before interactions.

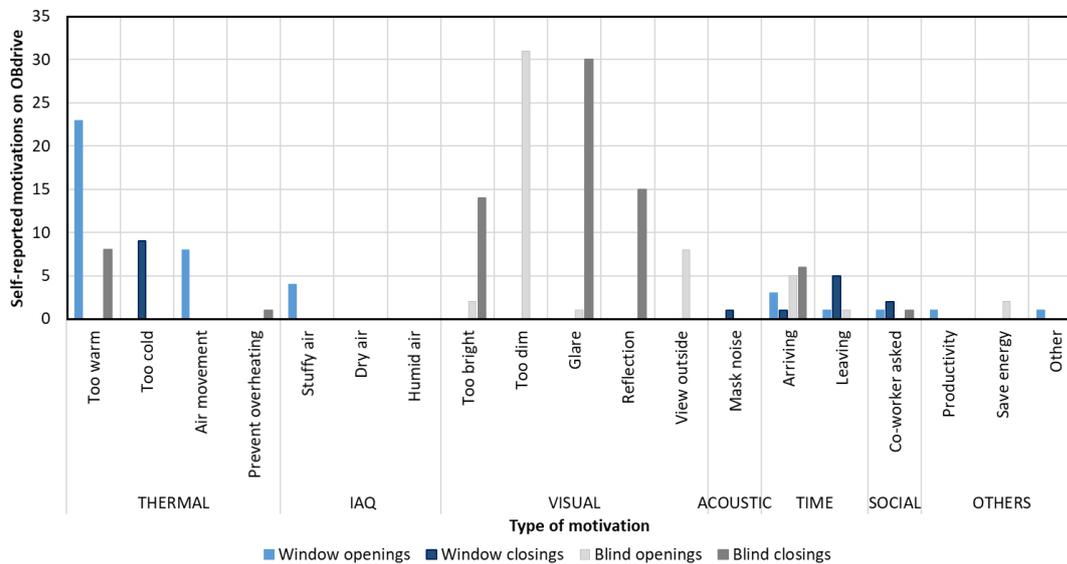


Figure 3. Self-reported motivations behind interactions with windows and blinds.

Self-reported motivations behind actions are reported in Figure 3. Window openings were mainly related to motivations related to the thermal and olfactory environment, such as “too warm”, “more air movement”, and “stuffy air”. Oftentimes (21% of all window opening actions), the options “too warm” and “air too stuffy” were selected simultaneously by the occupants, which stresses a strong relationship between these two environmental dimensions from the user perspective. Other reported motivations were “productivity”, “arriving/leaving”, and “co-worker asked”.

The most frequently reported motivations behind closing windows were linked to thermal (“too cold”) and time-related drivers (“leaving”), but also to acoustic, and social, and other drivers. Blind openings were mainly related to visual drivers (“too dim” and “view outside”). Other motivations were “save energy”, “arriving” and “prevent overheating”. The self-reported key motivations behind closings instead were related to visual (“too bright”, “glare”, “reflection”), thermal (“too warm”), and time-related drivers (“arriving”).

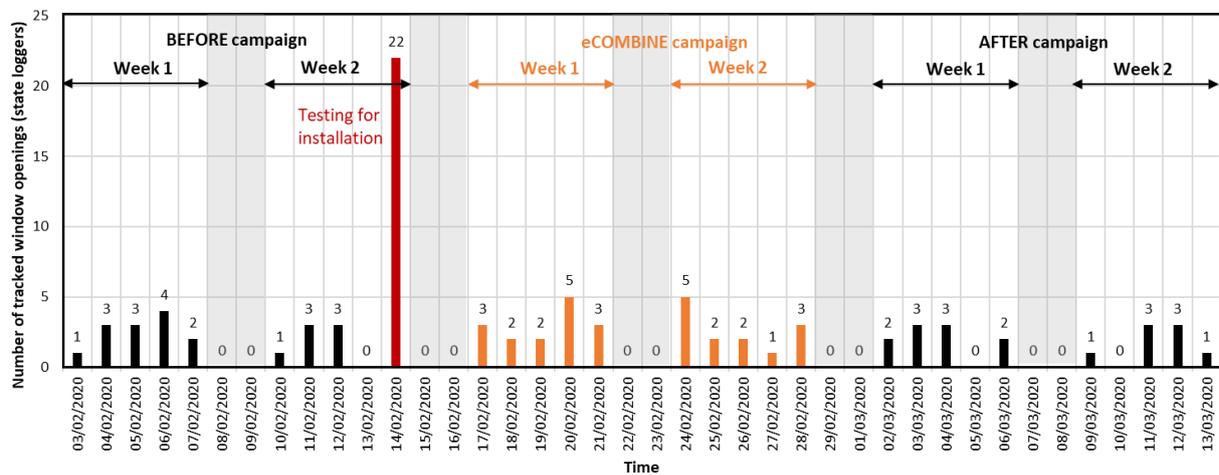


Figure 4. Logged window opening actions from wireless window state loggers before (22), during (28), and after (18) the campaign.

4. Discussions and Conclusions

The previous section highlights that the OBdrive app can be a useful tool to investigate motivations behind interactions with controls from user perspective. However, a pending question remains if the installation of visible and interactive interfaces in office spaces would influence employees to behave differently (e.g. interacting less often with controls because they might be bothered by having to self-report on the mobile application; interacting more often because they might be curious, attracted by providing input). For this reason, the frequency of logged window opening actions by the window sensors was compared to periods pre- and post- campaign (Figure 4). A slight but not significant increase of window opening actions (which could also be triggered by a wide range of other influencing factors [2]) can be

observed during the interactive monitoring phase. The peak shortly before the start of the campaign is due to testing of the correct functioning of the installed window sensors. The self-reported actions on the phones could be used to check the objective measured actions by window operation sensing solutions, and vice-versa. This allows for obtaining more precise information on window control actions when sensors fail due to connection issues to the gateway. Figure 5 highlights that 11% (3 out of 28) of the self-reported actions were not captured by the sensors. Further, in a post-campaign survey, compiled by 21 participants, nearly half of the occupants indicated that they always reported their interactions on phones installed close to controls (Figure 6). In light of these outcomes, we found the OBdrive app to be a helpful tool to investigate perceived motivations behind human-building interactions without significantly altering the behaviour of occupants. The authors would like to highlight that the outcomes of this paper are based on data collected in one eCOMBINE campaign only, which implies that this study has an explorative purpose. The results will be completed and analyzed in combination with physical measurements (e.g. environmental data) as well as data from other eCOMBINE pilot case studies.

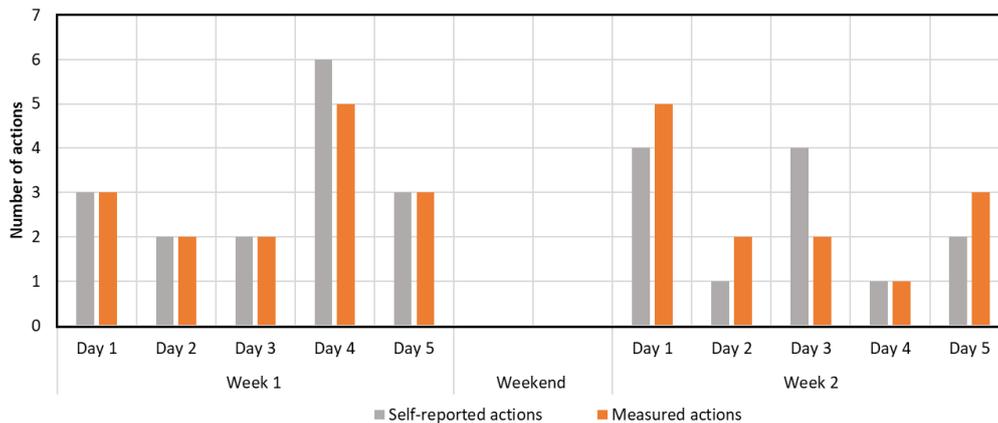


Figure 5. Measured actions vs. self-reported actions on OBdrive.

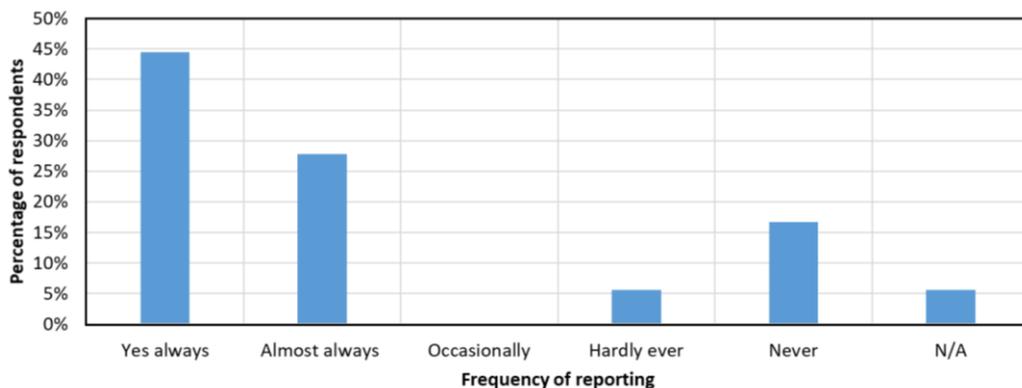


Figure 6. Frequency of reporting. Answers to the post-campaign survey question: *Over the last two weeks, how often did you report your interactions on the mobile phones installed close to windows and blinds?*

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