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Can we make our office buildings more responsive? Energy-efficiency and behaviour in the post-pandemic office

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1. Introduction

The Covid-19 pandemic has accelerated the switch between traditional office-working and flexible working solutions. In 2017, The European Commission published that around 10% of people were working from home [1], while in June 2020 between the 30% and the 65% were working from home full-time [2]. The urgency of meeting climate targets by 2050 requires to cut by 40% the energy consumption in buildings [3]. In the post-pandemic world, even if office-working will return to be more relevant, flexible hybrid solutions are likely to stay [4]. The design and operation of office buildings will have then to adapt to new working habits, while becoming more energy-efficient, given the stricter climate targets that the post-pandemic world is facing.

Automation plays a key role in creating flexible design and achieving energy-efficiency whilst maintaining adequate levels of occupant comfort and well-being, which includes also the minimisation of contagion risk [5]. However, the disruptive advent of the pandemic and extreme climate events has shown that the design of office buildings is not enough responsive and automated. For instance, during the first wave several buildings were still consuming large amount of energy despite the low level of occupancy. In addition, office buildings will have to re-adapt in short time-scales to an even more variable occupancy than before the pandemic.

This paper presents data from occupant satisfaction in office environments with and without automated controls before and after the Covid-19 pandemic in order to give evidence of the importance of occupant-centred building controls and indoor environmental quality in the post-pandemic office. Offices in post-pandemic world will need to devise an optimal occupancy distribution for both controlling Covid-19 infection risk and energy consumption

whilst maximising occupant satisfaction. Flexibility, responsive design and the use of occupant-centred automated building technologies will need to become a core design principle in order to achieve occupant health and carbon neutrality [6].

2. Methods

Data on occupant perception of the working environment is compared at a distance of one year before and after the COVID-19 outbreak in two different office environments, one with automated controls of the building envelope and one with manual controls. The offices were located in Central London, both had automated environmental services for heating, lighting and ventilation.

Linear Mixed models and repeated measures are used to analyse the data. Environmental data is collected by a novel Internet of Things (IoT) toolkit before, during and after the pandemic. The toolkit was designed in order to capture high-resolution data on the visual, thermal, air quality and acoustic environment. In addition, includes interfaces for gathering occupant response in terms of occupant discomfort and environmental satisfaction. Occupancy and energy consumption are also monitored by the Building Management systems.

3. Results and Findings

Volunteers had in average a statistically significant higher satisfaction with daylight, the thermal environment, the level of personal control and acoustic environment when working from home in comparison by pre-pandemic working conditions. In addition, they also felt generally more productive than in the office environment. Improved levels of personal control and flexibility were considered by the volunteers a main factor in their higher levels of satisfaction with their workload, despite being working for longer hours than in pre-pandemic time.

Occupancy in the building showed already a large variability before the pandemic, highlighting the potential for better occupancy regulation that could increase occupant satisfaction whilst decreasing energy and space usage. After the first lockdown, occupancy levels were extremely low, but energy consumption of the buildings was only 50% less than in pre-pandemic times. Despite the abrupt decrease in occupancy, energy consumption decreased gradually throughout the first month of lockdown, showing an inertial response to the change in occupancy of the automated environmental services.

In the office with automated controls of the building envelope, occupants experienced two scenarios upon their return to the office space. In the first scenario, the building envelope was manually controlled, while in the second scenario a hybrid solution was adopted, where the envelope was controlled by automated and manual strategies. In the hybrid scenario, occupants were more satisfied upon their return to the office environment in comparison to the office with the manual controls since they perceived a larger indoor environmental

quality, due to improved levels of daylight and view.

4. Discussion and Conclusions

Automated occupant-centred control of occupancy regulation, building envelope and artificial services can play a key role in re-defining office environment in the post-pandemic world. Office environments will have to offer spaces that can enhance occupant well-being and productivity, promoting social interactions and minimise the risk of infections. The post-pandemic office presents an opportunity to accelerate the use of smart building technology, which will ensure workplaces are designed in flexible and personalised way, while minimising resource-consumption by increasing the level of responsive behaviour of buildings. This will be also important to support optimization of space use, workspace allocation, and physical distancing. Interfaces for a better Human-building interaction will also be crucial to empower occupants, increasing their levels of perceived personal control in a safe manner, for instance with the use of touch-free interfaces. A shift from compliance to performance-based design will be therefore required to support responsive building design.

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