A BREATH OF FRESH AIR: TOWARDS OPTIMAL INDOOR AIR QUALITY

INVESTIGATING INTERVENTION STRATEGIES FOR ENHANCING OCCUPANTS AWARENESS, COMFORT AND HEALTH

DANNY DE VRIES
14495643

MASTER INFORMATION STUDIES
INFORMATION SYSTEMS
FACULTY OF SCIENCE
UNIVERSITY OF AMSTERDAM

	UvA Supervisor
Title, Name	Dr. H. (Hamed) Seiied Alavi PhD
Affiliation	University of Amsterdam
Email	h.alavi@uva.nl

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ABSTRACT

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KEYWORDS

Human-Building interaction, Indoor air quality, Living Lab, Data physicalization, Smart buildings, User-centered design.

1 INTRODUCTION

Globally, it is estimated that people spend approximately 90% of their time indoors [3, 5] and breath 11.000 liters of air per day [1]. Suboptimal indoor air quality (IAQ) conditions affect building occupants' experiences of comfort and insufficient ventilation in indoor spaces is proven to play significant roles in occupants' well-being, health and cognitive functions [2, 7].

The research into the influence of Indoor Environmental Quality (IEQ) [4] on occupants', including acoustic, thermal and visual conditions, is gaining more attention espicialy the field of indoor ventilation. One core aspect of air quality is its invisibility to occupants [6], polluted air is not easily detected by smell or sight. Additionally, mechanical ventilation systems in buildings operate discreetly, contributing to occupants' perceived lack of control since these systems are typically automated and cannot be directly regulated or controlled by occupants themselves.

This thesis focuses on understanding occupants' needs through in-the-wild studies measuring indoor air quality in specific spaces (e.g. meeting rooms) and arprototyping various persuasive technologies and data physicalization devices to visualize indoor air quality and evaluating their effectiveness with the overall goal of gathering insights into occupants' comfort levels and helping them to take preventive action against poor indoor air quality. This creates an interplay between occupants' health and comfort, architecture and built environments, and computing technologies.

Researching occupants' subjective needs, experiences, and behavior, coupled with a human-centric design approach, has the potential to improve occupants' well-being and create indoor environments with good indoor air quality. Furthermore, it provides valuable insights to faculty staff in making decisions in setting

up ventilation systems, arranging indoor spaces, and informing architecture and interior design studios on making decisions about structuring spaces and integrating computing technologies within built environments.

While research on defining comfort within indoor buildings, gathering and analyzing sensory indoor climate data, and the effects of poor air quality are prevalent, there is a gap in understanding occupants' behavior and their subjective needs, along with limited research on how design solutions visualize environmental data and computing installations can empower occupants, particularly within the field of physically visualizing data to convey IAQ to building occupants in real-time.
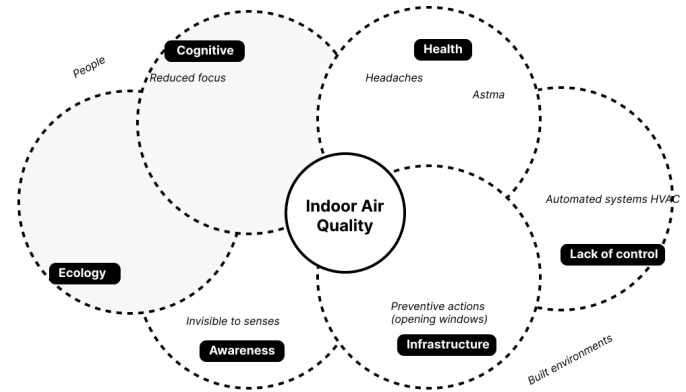

Figure 1: Complexity diagram providing an overview of the effects of Indoor Air Quality and needs of occupants

1.1 Research questions

In order to research intervention strategies for improving indoor air quality, the following main research question is formulated:

RQ: How can real-time sensory measurements and future predictions of air quality be physically visualised in specific indoor spaces integrating both environmental information and elements that increase awareness among occupants facilitating their adoption of preventive measures against poor air quality?

To effectively answer this main research question, this research is guided by the following supporting sub-questions that also serve as objectives to delineate the necessary knowledge:

- **SRQ1:** *How can environmental information related to air quality, such as pollutant concentrations and ventilation rates, be incorporated into the visual representations?*
- **SRQ2:** *How do different types of physical visualizations impact occupants' understanding of air quality and their willingness to adopt preventive measures?*
- **SRQ3:** *How do occupants' perceptions and behaviors regarding indoor air quality change over time, from pre to post-installation of the physical representation of poor air quality?*

2 RELATED WORK

Write about your related work here. Make clear to which key papers you will compare your eventual results. This can be done from the perspective of methods used, the task at hand and the addressed domain.

3 METHODOLOGY

Write about your methodology here. Focus on your own contribution. Indicate exactly how you will assess your work in terms of evaluation.

4 RESULTS

Write about your results here. Good captions to tables and/or figures are key.

5 DISCUSSION

Write your discussion here. Do not forget to use sub-sections. Normally, the discussion starts with comparing your results to other studies as precisely as possible. The limitations should be reflected upon in terms such as reproducibility, scalability, generalizability, reliability and validity. It is also important to mention ethical concerns.

6 CONCLUSION

Write your conclusion here. Be sure that the relation between the research gap and your contribution is clear. Be honest about how limitations in the study qualify the answer on the research question.

REFERENCES

[1] R. V. Corlan, R. M. Balogh, I. Ionel, and St Kilyeny. 2021. The importance of indoor air quality (IAC) monitoring. *Journal of Physics: Conference Series* 1781, 1 (Feb. 2021), 012062. https://doi.org/10.1088/1742-6596/1781/1/012062 Publisher: IOP Publishing.

[2] Jimin Kim, Taehoon Hong, Minhyun Lee, and Kwangbok Jeong. 2019. Analyzing the real-time indoor environmental quality factors considering the influence of the building occupants' behaviors and the ventilation. *Building and Environment* 156 (June 2019), 99–109. https://doi.org/10.1016/j.buildenv.2019.04.003

[3] Neil E. Klepeis, William C. Nelson, Wayne R. Ott, John P. Robinson, Andy M. Tsang, Paul Switzer, Joseph V. Behar, Stephen C. Hern, and William H. Engelmann. 2001. The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. *Journal of Exposure Science & Environmental Epidemiology* 11, 3 (July 2001), 231–252. https://doi.org/10.1038/sj.jea.7500165 Publisher: Nature Publishing Group.

[4] Priyanka Kulshreshtha, Sumanth Chinthala, Prashant Kumar, and Barun Aggarwal (Eds.). 2024. *Indoor Environmental Quality: Select Proceedings of ACIEQ 2023.* Lecture Notes in Civil Engineering, Vol. 380. Springer Nature, Singapore. https://doi.org/10.1007/978-981-99-4681-5

[5] Christian Schweizer, Rufus David Edwards, Lucy Bayer-Oglesby, William James Gauderman, Vito Ilacqua, Matti Juhani Jantunen, Hak Kan Lai, Mark Nieuwenhuijsen, and Nino Künzli. 2007. Indoor time-microenvironment-activity patterns in seven regions of Europe. *Journal of Exposure Science & Environmental Epidemiology* 17, 2 (March 2007), 170–181. https://doi.org/10.1038/sj.jes.7500490

[6] Young Joo Son, Zachary C. Pope, and Jovan Pantelic. 2023. Perceived air quality and satisfaction during implementation of an automated indoor air quality monitoring and control system. *Building and Environment* 243 (Sept. 2023), 110713. https://doi.org/10.1016/j.buildenv.2023.110713

[7] Chao Wang, Fan Zhang, Julian Wang, James K. Doyle, Peter A. Hancock, Cheuk Ming Mak, and Shichao Liu. 2021. How indoor environmental quality affects occupants' cognitive functions: A systematic review. *Building and Environment* 193 (April 2021), 107647. https://doi.org/10.1016/j.buildenv.2021.107647

Appendix A   FIRST APPENDIX

Put your appendices here.