

Review

of the doctoral dissertation by mgr inż. arch. Mohammad Mahdi Mohammadi, entitled "The Future of Housing Buildings; Optimizing Natural Ventilation Strategies in Polish Housing: Simulation-Based Design for Thermal Comfort in a Changing Climate."

dr hab. inż. arch. Tomasz Bradecki, Professor of the Silesian University of Technology
Faculty of Architecture, Silesian University of Technology
Department of Urban Planning and Spatial Planning
Akademicka 7
44-100 Gliwice
Tomasz.bradecki@polsl.pl

1. Basis for preparing the review

The basis for preparing this review is Resolution No. 11/2025/2026 of 14 July 2026 of the Scientific Council of the Discipline of Architecture and Urban Planning at the Poznań University of Technology, and the letter of 16 July 2026 concerning the preparation of a review of the doctoral dissertation by mgr inż. arch. Mohammad Mahdi Mohammadi, supervised by dr hab. inż. arch. Maciej Janowski, Faculty of Architecture, Poznań University of Technology. The review was also prepared in accordance with the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (Journal of Laws of 2024, item 1571, as amended).

2. Assessment of the work submitted for review

3. Assessment of the work in scientific terms

The typescript comprises 193 pages.

The dissertation is divided into the following chapters:

Chapter 1 – introduction, the assumptions of the work, and research hypotheses

Chapter 2 – natural ventilation research is explored, along with its principles, mechanisms, and typologies.

Chapter 3 – investigates the specific literature and current condition of natural ventilation in Polish apartments.

Chapter 4 – the practical research framework. It explains the full methodological process of the study, including the selection of representative case studies, classification of housing typologies, development of simulation scenarios, and the modeling workflow.

Chapter 5 – Own research– the analytical phase of the research.

Chapter 6 – Synthesis (discussion beyond CFD outputs alone).

Each chapter includes conclusions. The numbering of the subchapters in Chapter 6 differs from that of the earlier chapters (continuity was not maintained). The conclusions of the final chapter relate both to the research findings presented in that chapter and to the dissertation as a whole.

The dissertation contains several dozen illustrations and 28 tables. The table of contents indicates the authorship of the photographs and tables. Most of them are the author's own work.

The dissertation contains 260 bibliographic entries, the great majority of which are printed publications, with a few online sources. All of the listed publications are closely related to the topic.

4. Assessment of the thematic scope, the aim of the work, the research method, and the theses of the work

The thematic scope should be regarded as sufficient. This allows appropriate conclusions to be drawn. In the introduction, the author sets out the aims of the work, divided into a main aim and specific aims.

The main aim of the research is:

to investigate and optimize natural ventilation strategies (cross & corner ventilation) in residential buildings under current and future climate conditions.

The author describes the research aim as follows:

The goal is to provide scientifically validated design guidelines and methodology that improve thermal comfort, reduce overheating, and support energy-efficient, real-scale practical solutions for retrofitting or designing housing in Poland.

The author further adds:

The research also seeks to bridge the gap between simulation practices that traditionally focused on engineering aspects, airflow behavior, energy performance; and architectural design needs, which prioritize spatial functionality, aesthetics, human comfort, and construction feasibility. By integrating advanced Computational Fluid Dynamics (CFD) simulations into the architectural design process and applying them to realistic, full-scale residential layouts rather than abstract or simplified models, this study provides architects with practical, evidence-based tools to make early-stage design decisions. This interdisciplinary approach enables more accurate prediction of thermal and airflow performance under real-world conditions, supporting the creation of housing that is not only efficient but also adaptive to future climate scenarios.

The main aim and the specific aims have been correctly formulated. The dissertation addresses the optimization of cross- and corner-ventilation strategies in Polish multi-family

residential buildings, using a simulation-based approach. The work draws on issues from the fields of building physics, environmental design, and housing research.

The research method comprises a literature review and case-study simulations carried out as part of the author's own research. This research involved simulation studies combining architectural analysis, climate assessment, Computational Fluid Dynamics (CFD), solar-exposure assessment, and thermal comfort modelling, in order to examine the influence of building orientation, window size, shading systems, floor level, and wind direction on airflow and thermal conditions in the interiors. Each chapter presents conclusions relating to the issue it addresses.

5. Assessment of the composition of the work

The composition of the work, based on chapters and subchapters, should be considered correct, with one reservation. In the reviewer's opinion, however, a final, more general and comprehensive summarizing chapter is missing — one that would contain the author's own architectural recommendations.

6. Assessment of the manner of presenting the material and its treatment

The author's narrative is conducted correctly. The text lacks footnotes. In a substantial part of the text, references to the numbers of illustrations and tables are missing. Although the illustrations and tables are placed within the text so as to form a coherent sequence, the lack of references means that the reader must infer some of the connections. The materials and key information are presented in the work in a clear and comprehensible manner.

7. Assessment of linguistic and stylistic correctness

The author uses correct vocabulary and employs subject-related terminology in a professional manner.

8. Assessment of the terminology, notation, and symbols used

The notation, symbols, and terminology adopted in the work should be regarded as appropriate and commonly used in research activity within the scientific discipline of architecture and urban planning.

9. Assessment of the length of the work (whether there are repetitions of information, general remarks, or insignificant details)

The work is extensive, its content presented on 193 pages of A4 format, printed double-sided. The information presented in the work is detailed, often very detailed, and in some places general remarks are lacking.

The author's own research presented in the work, relating to the simulations and the analysis of data developed for the case studies, deserves recognition.

10. Assessment of the choice of title

The title of the dissertation should be assessed as correctly chosen.

11. Assessment of the selection of illustrations and tables

The illustrations, tables, and charts have been appropriately selected. Some of the illustrations, which are visualizations of the research results in the form of plans and sections, are presented multiple times in order to show the differences between the various simulations. These illustrations are placed at the side of the page and are very small, and as a result are not always legible, both in the PDF file and in the printed version (e.g., pp. 35–36).

12. Assessment of whether the work meets the requirements set for doctoral dissertations

The work is characterized by a high cognitive value. The research and the literature review presented are conducted in an appropriate and comprehensible manner. The author's own research presented in Part Five is conducted clearly and legibly. Summaries and conclusions are provided at the end of individual chapters, within the scope of their respective topics. At the end of Chapter 6 (pp. 152–177), conclusions are presented both for that chapter and for the dissertation as a whole. The presentation of the conclusions is sufficient; however, a separate chapter is missing that would organize the whole and compile the recommendations.

The author's greatest achievement appears to be the consistent application of a research method that makes use of contemporary software, object models, and simulations. The use of CFD in research within the discipline of architecture and urban planning may be regarded as innovative.

The assignment of the dissertation to the discipline of architecture and urban planning seems debatable. 80% of the work concerns research into models of airflow in residential buildings located in Poland, with a clear emphasis on variation in air quality and temperature. Meanwhile, as regards residential architecture itself — including the discussion of the selection of the studied cases — only a very brief, synthetic description is provided (about 4 pages, pp. 65–70).

The abstract states:

The study contributes to building science by combining architecture, building physics, and computational modelling through the development of evidence-based design recommendations for residential buildings with natural ventilation.

The selected keywords are as follows: natural ventilation, cross ventilation, corner ventilation, thermal comfort, CFD, Standard Effective Temperature (SET), passive cooling, overheating, residential buildings, Poland, climate change. Thus, only in one phrase — residential buildings — do we find a direct reference to architecture. Likewise, the illustration showing the results of the keyword analysis (VOSviewer tool) in the literature (p. 31, Fig. 2-1) demonstrates that the keywords are related mainly to other disciplines. Given the subject matter undertaken, one might expect that keywords such as housing estates, residential complexes, residential design, housing design, and similar terms would also be considered. Likewise, the proposed bibliography relates almost 100% to items concerning ventilation and temperature in the built environment, the creation of models for CFD analyses, and similar topics. The reviewer found only a few items in the bibliography concerning residential architecture, and these are articles related to the developments presented in the dissertation.

The above shows that a substantial part of the dissertation and its research relates to the discipline of civil engineering and possibly other disciplines that make use of CFD or describe SET.

The selection of cases and the research sample was carried out as follows; the author states (p. 65):

To initiate the case study selection process, a comprehensive graphical analysis was conducted on over 30 residential communities constructed between 1940 and 2020 across seven major Polish cities, including Warsaw, Gdańsk, and Poznań. This initial dataset encompassed over 320 residential units, with a focus on multi-family apartment buildings, a typology that remains prevalent in urban Polish contexts. The primary aim was to explore spatial layouts, ventilation strategies, and façade organizations across different architectural periods. The graphical analysis involved comparing floor plans, window placements, and orientation patterns, aiming to identify trends or recurring design logics that could influence thermal performance and natural ventilation potential. However, this purely visual method proved to be insufficient, as it lacked the depth and clarity needed to extract quantifiable parameters relevant to the research goals, (...)

It is worth noting that the periods of construction and the locations differ, and consequently so do the conditions that determined the form of the developments mentioned (legal and technical requirements, the technical possibilities available on the market at the time, the design paradigm, purchasing power, and the expectations of residents, etc.). The author then adds, on p. 69:

Based on the analyzed data and statistical findings, although residential buildings constructed between 1945 and 1970 represent a larger portion of the housing stock, they were not prioritized for this study. Since the focus of this research is on optimizing cross ventilation, and the architectural characteristics required for effective natural ventilation, specifically cross-ventilation potential, were more prevalent in buildings constructed between 1995 and 2005.

This justification is accompanied by the citation of several floor plans of apartments from completed buildings which the author considered representative. Specifically, the author points to two, stating:

Therefore, two residential complexes from this era were selected as case studies, representing not only relevant architectural features for natural ventilation but also a practical opportunity for energy-efficient retrofitting in the current decade.

The reviewer considers this approach to be highly unusual and rarely encountered in dissertations in the discipline of architecture and urban planning — particularly since, as a result of the above assumptions, the author decides to select the rooms within apartments that he considered to meet the criteria. The decision to adopt a model-apartment approach to the research is understandable; what is not understandable, however, is the absence of a broad description and discussion of the 320 housing complexes examined (there is no list, no discussion, no information on their architecture, no appendix). The reader is left with Figures 4-9, 4-10, and 4-11, from which the scope of the case studies can only be inferred.

The research is based on 3D models reflecting the adopted functional layouts of the apartments, divided into corner apartments (ventilated at the corner) and classical apartments with daylighting and ventilation from one side of the building only. In the digital model, simplifications were adopted for the surrounding development, treated as dense, compact development with a uniform urban-layout structure (a multi-family, multi-entrance residential building adjacent to empty spaces — by default streets — and further, similar buildings; Fig. 4.20). The author states (p. 81):

To simulate the effects of a dense urban context, two rows of surrounding building blocks were also introduced into the CFD domain. These blocks were modeled at the same height as the main building and placed based on recommended spacing ratios found in validated studies [243, 244].

It might be expected that such assumptions are sufficient. It should be noted, however, that intensive residential development is very often carried out within urban blocks (kwartały), and the urban structure frequently differs from that adopted in the model. At the same time, this affects the cardinal orientation and exposure of the façades, and thus also the ventilation of the apartments — which the author identifies as one of the most important factors in shaping future development resilient to climate change, including warming. At the same time, the author himself states that contemporary development is becoming more intensive, and consequently the possibilities for ventilation are worse than under the urban-planning assumptions adopted in earlier periods.

In the conclusions, the author states:

The central ambition of this thesis has been to demonstrate that architecture, when attentive to climate, can meaningfully extend the boundaries of thermally comfortable occupancy without mechanical conditioning and without compromise to livability.

Conclusions of this kind appear self-evident in an era of changing climate. The author provides detailed data, including data showing possible future temperatures within the apartments.

The author also states, in the conclusions:

The question of thermal comfort will increasingly be answered not by the power consumption of cooling systems, but by the intelligence of architectural form.

This statement is entirely valid; however, one cannot escape the impression that the summary should not only be general but should also contain the author's own recommendations in the field of architecture. It is not obvious how the reference to "intelligent architectural forms" should be understood, without any indication of what form they should take (presumably, they are meant to help reduce indoor temperatures during the summer period). The reader is left to guess about the possibilities for implementation in newly constructed buildings, and about the challenges of implementation in existing buildings. Certainly, the analyzed and optimized size of window openings, or the use of shading devices, are important — but they are not the only possible solutions.

In summary, the dissertation has been prepared at a good technical level; however, it differs considerably from other, similar dissertations, or those related to the shaping of housing or the assessment of living conditions, within the discipline of architecture and urban planning.

13. Final conclusions

The critical remarks listed in this review are counterbalanced by: the originality of the research approach and the research tools employed, the high substantive level of the work, the reliability of the research, and the overall quality of the work.

In light of the provisions of Article 187 of the Act of 20 July 2018 – Law on Higher Education and Science (Journal of Laws of 2024, item 1571, as amended), the Author's achievement presented in the dissertation entitled "The Future of Housing Buildings; Optimizing Natural Ventilation Strategies in Polish Housing: Simulation-Based Design for Thermal Comfort in a Changing Climate" should be regarded as meeting the required criteria and as a significant contribution to the development of the discipline of architecture and urban planning.

I hereby admit the doctoral dissertation to public defense before the Scientific Council of the Discipline of Architecture and Urban Planning at the Poznań University of Technology.

A large black rectangular box redacting the signature of the reviewer.

dr hab. inż. arch. Tomasz Bradecki

