Reflection

Graduation process

1. *What is the relation between your graduation project topic, your master track (Ar), and your master programme (MSc)?*

The thesis under discussion encompasses three research domains, primarily focusing on building environmental performance and computational intelligence. These fields form the core of the research, while the field of sustainable structures provides valuable supplementary information to enhance the background knowledge of resilience. Consequently, this research involves the collaboration of two chairs within the Building Technology track: Structural Design and Design Informatics. The thesis is guided by Simona Bianchi and Charalampos Andriotis. Within the chair of Structural Design, the research investigates the resilience of buildings in the face of climate change. Meanwhile, within the chair of Design Informatics, the exploration revolves around implementing resilience quantification in practical applications during the early design stage.

2. *How did your research influence your design/recommendations and how did the design/recommendations influence your research?*

The research initially established a strong theoretical foundation in resilience quantification, uncertainty quantification, and dynamic building simulation. This theoretical knowledge was subsequently applied in the practical implementation phase to bridge theory and practice. This integration of theory formed the basis of the computational workflow and early design support. Simultaneously, the practical implementation yielded valuable insights and information specifically related to the research's main focus on thermal resilience against overheating stresses. The research successfully clarified the significant building, design, and system parameters, and the visualization of simulation results facilitated the comparison of various design alternatives by designers. As a result, the study outcomes contribute to the advancement of research in the field of thermal resilience in buildings.

3. *How did the research approach work out (and why or why not)? And did it lead to the results you*

aimed for? (SWOT of the method).

The research encompassed several essential areas crucial for achieving the desired outcome. The primary objective of this research was to investigate the feasibility of implementing a computational workflow for quantifying thermal resilience against extreme heat events in practical applications. Consequently, a comprehensive analysis was undertaken, exploring five key areas throughout the project. These areas include resilience quantification in the built environment, weather data sets, uncertainty quantification, dynamic environmental building simulation, and statistical modeling. Each area presented its own challenges and complexities, but all were integral to the overarching goal of sustainable structures with computational tools, making each area a crucial component of this thesis project. While each area provided valuable insights, they also revealed numerous avenues for further research, some of which were simplified due to time constraints. The desired outcomes were successfully achieved, resulting in an improved understanding of the impact of extreme heatwaves on buildings. This research also lays the groundwork for enhancing the computational workflow by implementing more efficient tasks and expanding the scope of thermal resilience assessment to a larger scale.

Societal impact

1. *What is the impact of your project on sustainability (people, planet, profit/prosperity)?*

Sustainability was the key parameter that initiated this project's exploration. The topic addresses the problem of building performance during disruptive events posed by climate change. It explores the possibilities to design resilient and sustainable buildings to mitigate the vulnerability of the built environment. The research explores evaluation frameworks and assessment methodologies in order to develop more robust methods and tools to support the development of resilient and sustainable structures at the building level. Following this goal, this project investigates the climate adaptability of buildings through uncertainty-based risk analysis.

2. *What is the socio-cultural and ethical impact?*

The quantification of thermal resilience against extreme heat stresses in buildings has a direct relation to the wider social context. Here are a few key aspects of this relationship:

Human Health and Well-being: Extreme heat events can have severe consequences for human health, leading to heat-related illnesses and even fatalities. By quantifying thermal resilience, building designs can be enhanced to provide improved indoor comfort and mitigate the negative impact of extreme heat on occupants' health and well-being. This directly contributes to the social objective of safeguarding public health.

Climate Change Adaptation and Mitigation: Thermal resilience quantification aligns with the broader societal need for climate change adaptation and mitigation. By designing buildings that can withstand and adapt to extreme heat stresses, communities are better prepared for the changing climate. Additionally, resilient buildings with lower energy demands contribute to reducing greenhouse gas emissions and advancing sustainability goals.

3. *How does the project affect architecture / the built environment?*

Thermal resilience quantification against extreme heat stresses in buildings, utilizing a computational workflow of dynamic environmental building simulations, has several effects on architecture and the built environment:

Design Optimization: The computational workflow allows architects and designers to evaluate various design alternatives and optimize building designs for thermal resilience. By simulating the thermal performance of different architectural configurations, materials, and systems, the workflow enables the identification of design strategies that enhance thermal comfort and mitigate the impact of extreme heat events. This leads to the creation of buildings that are better adapted to the local climate conditions.

Performance Prediction: The computational simulations provide insights into the thermal behaviour of buildings under extreme heat conditions. This helps architects and engineers understand how different design choices affect thermal performance and resilience. By accurately predicting the indoor temperatures, energy consumption, and thermal comfort levels, the simulations enable informed decision-making and facilitate the development of more effective design strategies.

Risk Mitigation: The simulations allow for the assessment of potential risks associated with extreme heat stresses. By quantifying the thermal resilience, the computational workflow helps identify areas of vulnerability within the building design. This information can be used to implement risk mitigation measures such as improved insulation, shading devices, natural ventilation strategies, or the integration of passive cooling techniques. These measures enhance the building's ability to withstand extreme heat events and protect the occupants.

Sustainability Integration: By incorporating thermal resilience quantification into the design process, the computational workflow promotes the integration of sustainability principles. Design choices that enhance thermal resilience often align with energy efficiency, reduced environmental impact, and enhanced occupant comfort. The workflow allows for the optimization of energy consumption and the development of environmentally responsible building solutions.