Methodology for the design of climate responsive houses for optimized thermal comfort in Quetta, Pakistan

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ABSTRACT

A building must be energy-efficient and provide comfortable indoor environment to the residents. The Building Energy Code of Pakistan (BECP) only focuses on commercial buildings [1]. In today's scenario a standard must include the context and climate considerations. The aim of this study is to improve indoor thermal comfort of free-running houses in Quetta, Pakistan and raise the awareness of builders about climate sensitivity.

KEYWORDS

Thermal comfort, Decision support, Energy simulation, Resource efficiency, Design strategies, Design intervention, Fuel poverty

PROBLEM

Pakistan is facing serious energy crisis. Housing sector is the largest consumer by using more than 51% of the total electricity [2]. There are diverse climatic zones in the country ranging from very cold in the north to very hot in the south. The city of Quetta has dry, semi-arid climate with substantial temperature differences between summer and winter. The urban population of Quetta is more than 1 million which increased to more than double in last 20 years [3]. The houses are poorly designed, and the residents suffer due to uncomfortable indoor environment.

OBJECTIVE/ HYPOTHESIS

- Characterization of the existing housing stock (inventory)
- Monitoring and analysis of common housing type
- Development of a representative benchmark in order to test it through parametric analysis using different comfort models
- Development of design strategies to improve the indoor thermal comfort
- Testing and application

AUDIENCE

Architects, designers, building/ construction engineers, contractors, researchers and resident builders

RESEARCH QUESTION(S)

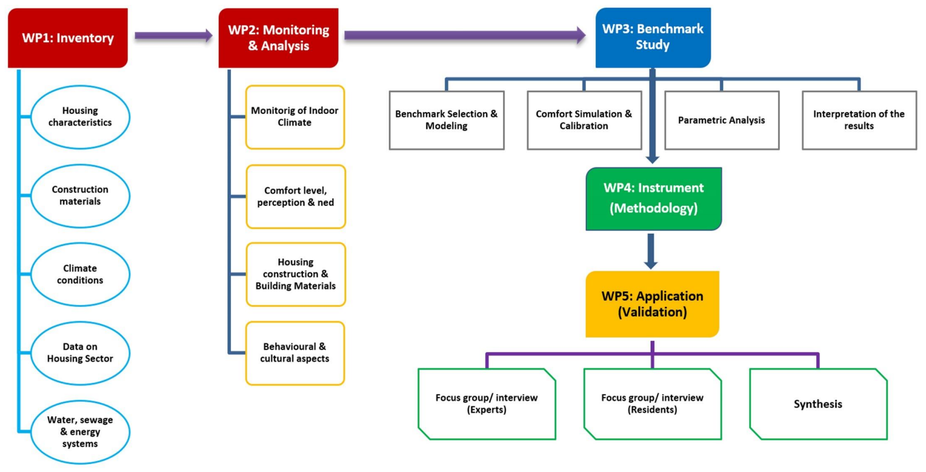
- What are the characteristics of existing houses in Quetta?
- What is the comfort situation and comfort perception of the residents?
- How design strategies can help to improve the indoor thermal comfort and construct climate responsive houses?

ORIGINALITY

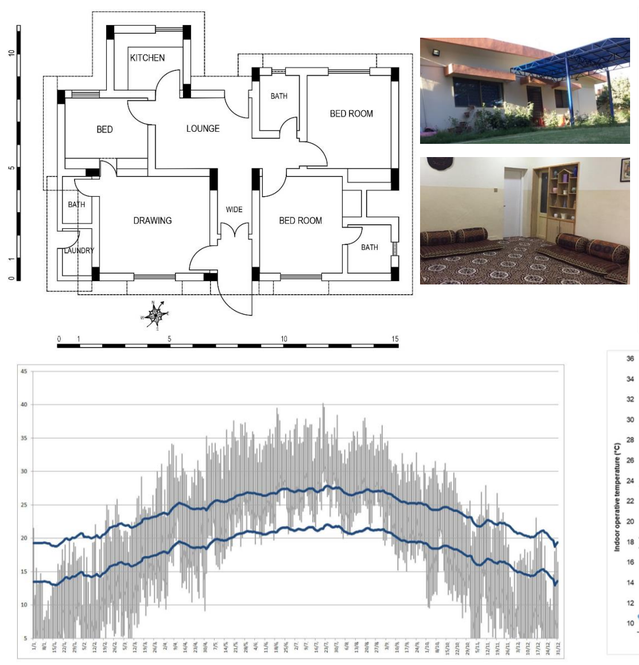
- There is wide knowledge gap on housing and thermal comfort in Pakistan
- The study will provide unique guidance towards indoor thermal comfort in housing
- Quetta has extreme weather conditions which requires context and climate based design
- The study will investigate and apply several comfort models

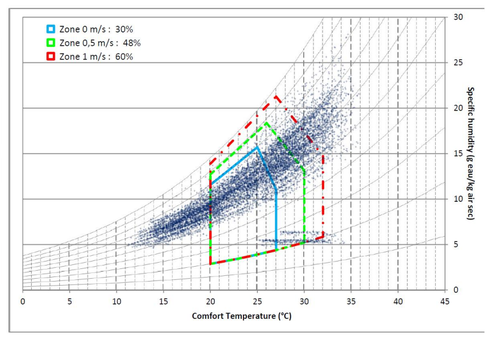
METHODOLOGY

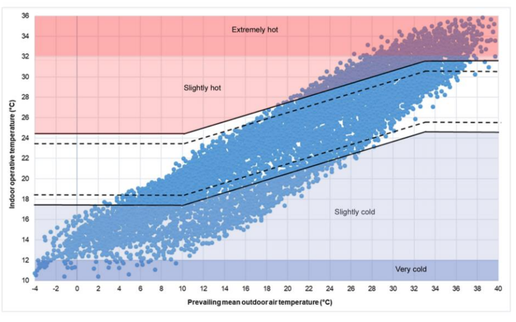
1. Housing survey for inventory and characteristics.
2. Monitoring of indoor and outdoor climate and comfort survey.
3. Benchmark selection, calibration of model and parametric analysis using simulation for optimized indoor thermal comfort
4. Conclusion based on the results of 1-3, and development of design strategies
5. Validation with experts and the future residents



RESULTS







CONCLUSION

- Housing in Quetta can be divided into 3 types, reinforced cement concrete (RCC), brick masonry and sundried brick houses. RCC is the most common housing type, i.e. 64% [4].
- Extreme indoor temperatures were recorded in both seasons which creates discomfort for the residents [5].
- Existing houses are poorly designed and don't provide optimal thermal comfort to the residents [6].
- With design interventions and application of alternative materials, indoor thermal comfort can be improved.

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