Methodology For The Design & Development Of A Sustainable House Concept For Quetta, Pakistan

Waqas Ahmed Mahar, Griet Verbeeck, Elke Knapen

Research Information

Keywords
Sustainability, Energy, Material, Water, Renewable energy

Introduction / Context
Quetta, the capital of Balochistan province, Pakistan, is facing problems due to increasing population and shortage of energy and water [1]. On the other hand, there is a great potential for renewable energy [2] and the usage of solar and wind energy is wide spreading in the city and its neighbouring areas.

Question / Goal
Objective

The objective of this PhD is to develop a methodology for the design of sustainable houses in Quetta, taking into account the best possible solutions for the energy and water shortage and maximizing the use of local materials. In the first phase of the PhD, insights in the existing housing stock are needed. This poster focusses on the results of the first phase.

Research Question of Phase I
What are the main characteristics of the existing housing stock in Quetta?

Hypothesis / Methodology of Phase I
To make an inventory of the existing housing stock, a housing survey was conducted.

- Safety questionnaire: Due to the unsatisfactory law and order situation in Quetta [3], first a safety questionnaire was distributed online to identify the safe areas where it is possible to conduct the housing survey. The areas identified as safe were complemented with areas in which university students and staff, who helped with the housing stock survey, live. In this way, data of different ethnic and religious groups, types of housing contract (public, slum, owner occupied), housing density, old and new housing developments etc. are collected.
- Housing stock survey: To get insights in and identify the main characteristics of the existing housing stock, a survey on demographics, material use, construction type, source and usage of electricity, gas and water, household income and wealth was conducted. 215 houses were surveyed in 32 residential areas of Quetta by filling in the questionnaire, taking pictures and drawing sketches.

Results of Phase I
The results of the housing survey can be summarized as follows:

- Demographic information: Most of the occupants are salaried (56%) and business class (25%), and a large number of households fall under 2 income brackets, i.e. €143-€402 (PKR 16k-45k) and €411-€715 (PKR 46k-80k) per month. Household size varies from 2-40 persons with an average size of 9.9 persons per house and a room occupancy of 2.1 persons per room.
- Electricity consumption and water systems [Fig. 1]: The electricity consumption is higher in summer due to the usage of cooling devices. Common heating system is direct heating using gas heaters. Main source of water is piped water but still a good number of households needs water tankers to fulfil their water consumption demand.
- Construction types and material use [Fig. 2]: Most houses are built on ground floor and there are 3 common structural systems; R.C.C frame, brick/ stone masonry and sundried bricks.

Conclusion of Phase I
The most common housing type is R.C.C frame structure for all income groups, with a plot size depending on household size and income. In phase-II, this type of houses will be further analyzed in detail for their energy performance, environmental impact, construction patterns, water and energy consumption and the household characteristics. In phase-III, a sustainable house concept has to be developed taking into account all the information collected in phase-I & II. It will be further validated by simulations of energy, comfort and water performance and discussion with experts and future occupants.

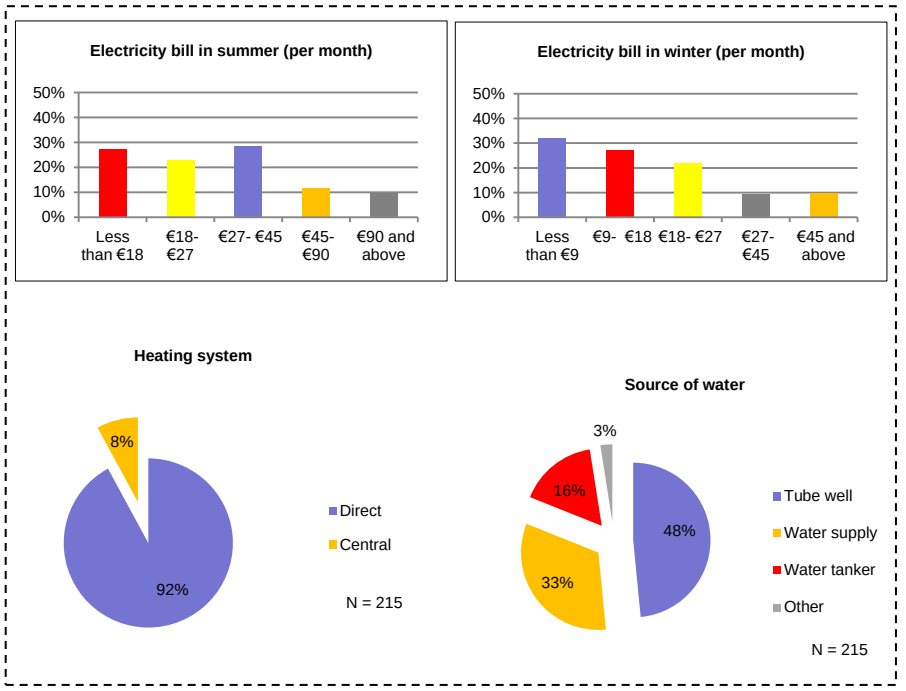
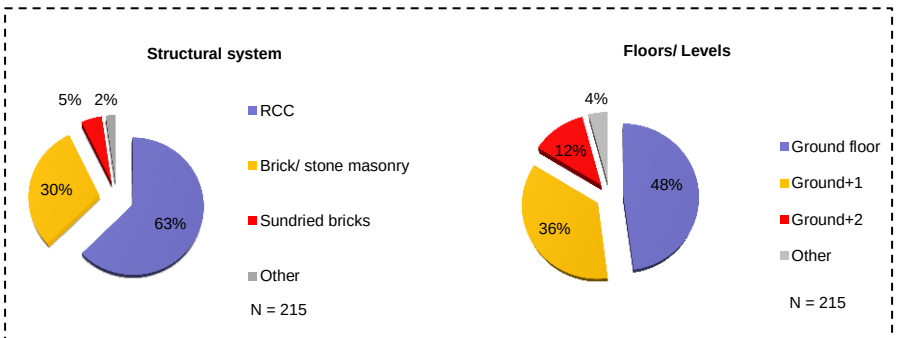


Fig. 1: Electricity consumption, heating and water system



Building part/ finish	R.C.C Frame	Brick masonry	Sundried bricks
Exterior walls	Baked brick with cement mortar (61%), baked bricks (19%), RCC walls (17%)	Baked brick with cement mortar (60%), baked bricks (21%)	Sundried brick (73%), rammed earth (27%)
Finish of exterior walls	Paint (60%), cement plaster (49%)	Paint (31%), cement plaster (43%), mud plaster (12%)	Mud plaster (73%), Paint (18%)
Finish of interior walls	Paint (78%), cement plaster (53%)	Paint (60%), cement plaster (54%), mud plaster (13%)	Mud plaster (55%), Paint (45%)
Material of floor	PCC (96%)	PCC (85%), earth/sand/mud (12%), Brick (4%)	Earth/sand/mud (45%), Brick (36%), PCC (18%)
Floor finish	PCC (53%), carpet/ mat (45%), marble (20%), ceramic tile (13%), chip/terrazzo (9%)	Carpet/ mat (52%), PCC (39%), chip/terrazzo (15%), marble (9%), brick (6%),	Earth/sand/mud (45%), brick (36%), carpet/ mat (9%), PCC (9%)
Roof framing	RCC beams (99%)	RCC beams (52%), Girder/T-iron (31%)	Girder/T-iron (45%), wooden beams with bamboos (45%)
Roof covering	RCC slab (98%)	RCC slab (51%), burnt brick/ roof tile (36%)	Thatch/palm/bamboo (55%), burnt brick/ roof tile (45%),
False ceiling	Gypsum (9%), card board sheets (7%), wooden sheets (6%), PVC (4%)	Gypsum (19%), wooden sheets (12%), card board sheets (6%),	Mud (27%), wooden sheets (9%),
Window glazing	Single glazed (67%), double glazed (32%)	Single glazed (81%), double glazed (15%)	Single glazed (82%), double glazed (18%)

R.C.C Frame | Brick masonry | Sundried bricks

* The percentages in the table represent the share of houses that have the mentioned materials as main material in that building part/finish. Multiple answers were possible.

Fig. 2: Construction types and material use

References

1. Khan, Abdul S. et. al (2013). *Land subsidence and declining water resources in Quetta Valley, Pakistan.* Environmental earth sciences, V. 70, Issue 6, pp. 2719-2727
2. Khalid, Anjum and Haroon, Junaidi (2013). *Study of economic viability of photovoltaic electric power for Quetta-Pakistan.* Renewable energy, V. 50, pp. 253-258
3. Planning & Development Department, Government of Balochistan. *District Development Profile 2011.* Retrieved from http://balochistan.gov.pk/DistrictProfile/DDP%20Final%202012/Quetta/Quetta.pdf

Note: Pictures are taken during Housing survey.

Contact
Ar. Waqas Ahmed Mahar
Email: waqasahmed.mahar@uhasselt.be
Tel: +32(0) 11 29 21 69

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