METHODOLOGY TO DETERMINE HOUSING CHARACTERISTICS IN LESS DEVELOPED AREAS IN DEVELOPING COUNTRIES: A CASE STUDY OF QUETTA, PAKISTAN

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Abstract

The province of Balochistan is one of the least developed areas of Pakistan, facing problems of energy shortage and rapid urbanization. On the other side the region has great potential for renewable energy sources and the development of sustainable housing concepts. However, a first barrier is the lack of data on the existing housing stock. This paper will discuss the methodology and results of collecting housing data in this context for Quetta city. Considering unsatisfactory law and order situation, a survey was conducted to identify safe areas for housing survey. More areas were included to make the survey more representative. In total 215 houses in 32 residential areas were then surveyed. It is found that housing in Quetta can be divided in 3 main types; i.e. R.C.C frame, brick masonry and sundried bricks and that the energy consumption is mainly determined by area of the house and household size.

Keywords: housing data, household characteristics, material use, energy consumption, developing countries

Introduction

Pakistan is 6th most populous country in the world with an estimated population of 197 million (PWD, 2017). There is a wide diversity of climatic zones, cultural identities and housing types. Moreover, there is large population growth in the country and a trend of rural-urban migration which increases the urban population and problems at the same time. According to Kugelman (2013), the urban population is increasing at an annual rate of 3% which is the fastest pace in South Asia. As per an estimation of United Nations Population Division, nearly half of the country's population will live in cities by 2025. The country is facing a serious energy crisis since the last decade which greatly affected the lives of common man. On the other hand, due to its climate the country has great potential for alternative and renewable energy (Shaikh, Ji, & Fan, 2015). The government of Pakistan is focusing on renewable energy sources and new projects have been installed to generate energy from wind and solar sources in various parts of Pakistan.

In Pakistan, the province of Balochistan is one of the most deprived and less developed areas and Quetta is the provincial capital and 9th largest city of the country (PBS, 1998). The total area of Quetta district is 2, 653 sq.km. The major ethnic groups living in Quetta are Pashtoon, Baloch, Hazara and Punjabi. Quetta is located in North-West of Balochistan near the Pakistan-Afghanistan border (figure 1) and it is trade and communication centre between the two countries. The terrain of Quetta district varies from 1390 m to 3455 m above the sea level. The city is located in an earthquake zone and approx. 60,000 people died during the earthquake of 1935. The climate of Quetta is dry, arid: mild to extreme cold in winter and hot in summer. Quetta lies out of monsoon range, but it receives snowfall

mostly in the months of December, January and February (P&D, 2011). The climate of Quetta has significant variations during winter and summer. The average recorded temperatures in summer were 31 ºC and in winter 7 ºC during 2009-2016 (Online, 2017). In recent years, law and order situation in Quetta is unsatisfactory (P&D, 2011; BBC, 2016; DAWN, 2016).

Figure 1. Location of Quetta
(Source: https://thepeopleofpakistan.files.wordpress.com/2010/02/clear_pakistan_map21.gif?w=630)

The energy crisis in Pakistan also affected the residents of Quetta. People living in urban areas face 4-6h per day load shedding (outage) of electricity in winter and 6-8h per day in summer (QESCO, 2016). One of the reasons for the energy crisis is enormous population growth from 260,000 in 1975 to 1.2 million in 2010, mostly due to migration from Afghanistan (Abdul S., Shuhab D., & Din M., 2013). However, the city and its surrounding areas have great potential for renewable energy sources (NREL, 2007a) (NREL, 2007b).

As in many other developing cities around the world, the development of sustainable housing and the maintenance of existing housing stock in liveable conditions remains an acute and intractable problem in Quetta. Housing is an important part of the human life and the urban environment and housing conditions reflect many issues including socio-economic status, health and well-being of the residents and their identity (Gibson, et al., 2011) (Alnsour, 2011). The study focuses on the improvement of energy efficiency of the most common housing type in Quetta. Therefore, the aim of this research is to develop a methodology for the development of sustainable houses in Quetta.

However, the available data on the existing housing stock of Quetta is very limited or out-dated since the Quetta Master Plan was developed in 1985 and the available census data is from 1998. The city has seen several changes and growth in the last 17 years due to the War on Terror and internal migration from various parts of Balochistan. Therefore, as a starting point for this research, the conditions, and characteristics of the existing housing stock in Quetta are analysed. The paper provide introduction to study area, methods followed to complete this research and present the results and conclusion.

The study area

Quetta city is the part of Quetta district which covers Metropolitan Area and cantonment. The available knowledge about housing and demographics of Quetta is very limited or outdated, since the last master plan report (1980s), and a complete master plan was developed in 1985 and the available census data is from 1998 (MPQ, 1980s; NESPAK, 1985; PBS, 1998). However, a recent census was

conducted during March- May 2017 and the collected information is under process. Historically, the city of Quetta went through several changes. The present city of Quetta was developed during the British period. It remained under British control during 1839-1842 and again during 1876-1947. British government developed Quetta as a garrison town (Quetta-Pishin district) due to its geographical importance and connected it via road and rail network to Afghanistan and Iran (P&D, 2011). A major earthquake in 1935 completely destroyed the city area. However, the cantonment area survived to a great extent (PESA, 2015). It remained an administrative unit of West Pakistan and later became capital of Balochistan province. The city has grown a lot especially in the last 2 decades due to internal, international migration and being the only urbanized city of the province. Quetta Development Authority (QDA) was established in 1978 by the Government of Balochistan to cater the needs of housing, planning, development and improvement of Quetta Tehsil including Quetta Municipal Corporation limits and all other units which the government may notify from time to time (QDA, 2016). Many development schemes were planned under Quetta Master Plan and nearly half of them are completed so far. Since, the city has witnessed major expansion and increase in the population there is a need of new master and development plans. Unavailability of qualified and trained staff also remained a major problem and so far, there are only 7 architects and there is no qualified town planner working in Quetta Development Authority (QDA, 2017).

Methodology

In order to find out the characteristics of the existing housing stock of Quetta, a housing survey was conducted. However, since the law and order situation in Quetta is unsatisfactory (P&D, 2011), it was essential to know more about the safety level of housing areas in order for the students and staff to be able to visit and conduct a housing survey. So, the research methodology included two steps, 1) identification of safe areas and 2) inventory of the housing stock to determine housing characteristics.

Several areas of Quetta have been affected due to terrorist attacks and activities. The opinion of local authorities and local population vary on the safety of areas and localities. It was decided to seek the opinion of local population on the safety of residential areas rather than local authorities to get opinion of diverse and large group of people. For the inventory of housing stock, both primary and secondary data sources were used to complete this study. Primary data were obtained using a structured household questionnaire which was filled during housing survey. Secondary data was collected and reviewed from literature, and information provided by Quetta Development Authority (QDA), Water & Power Development Authority (WAPDA), Quetta Electric Supply Company (QESCO), and Water & Sewerage Authority (WASA).

Safety questionnaire

The city of Quetta was divided in 11 areas with reference to the familiarity of the local population with the major roads and links (Figure 2). It was then confirmed with the map provided by Quetta Development Authority (QDA) which shows the distribution of areas with the connection of road networks. Areas with less and scattered population were not included in this survey. Quetta Cantonment areas were also not included since it is difficult to get permission for visit and cantonment authority does not follow the bylaws and regulations of Quetta city. The selected 11 areas were further divided into several sub-areas based on the major neighbourhood and housing located in each area. A safety questionnaire was developed and distributed online via email and social apps, i.e. Facebook, WhatsApp. It was possible to fill the questionnaire using computer, mobile phone or tablet. The survey period was 2 weeks from 19/9/2016 to 4/10/2016. In total 497 emails were sent to people from various walks of life including academicians, medical professionals, lawyers, media persons, civil servants, students, social workers, traders and businessman etc. In total, 242 people started the survey and 221 completed it. The 21 partly filled questionnaires were not included in the results. The questionnaire includes questions on demographic information of the respondent, and his/her familiarity with specific areas and sub-areas of Quetta city. Once the respondents consider any area familiar, then a question

about sub-areas appears to select familiar sub-areas. After the selection of sub-area(s), the respondent had to mark sub-area(s) "safe", "unsafe" or "I don't know".
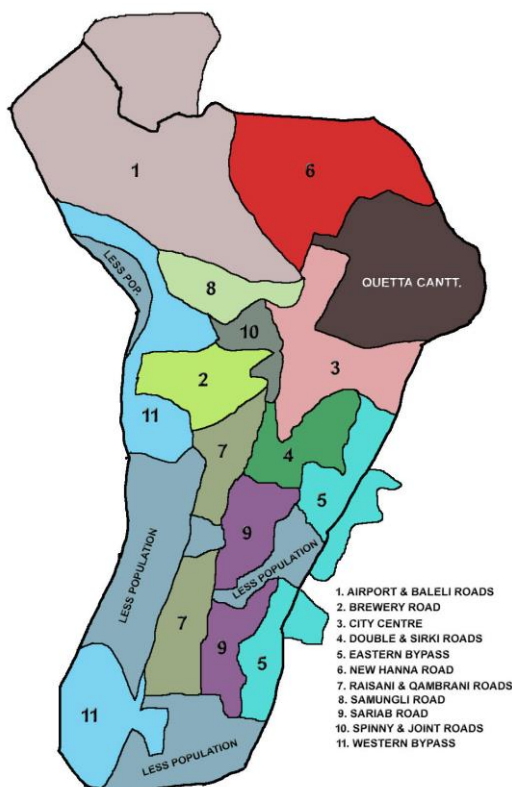

Figure 2. Map of Quetta city with the classification of areas for safety questionnaire

Housing stock survey

The residential areas which were more familiar and marked safe by most the respondents who live and visited those areas were considered safe. For housing stock survey, initially, 12 out of 14 (safely marked) areas were selected. However, in order to get a more representative sample of Quetta, 18 additional housing areas were also included to represent various housing typologies (public, slum, real estate etc.), old and new housing developments, and various ethnic, religious and income groups.

The classification of residential areas in some studies was done based on rent and amenity value (Kanton, 2007) (TAMA, 2003). In the case of Quetta it was not possible to classify housing based on rent, amenity value or income level due to lack of available information. Two Master Plans prepared for Quetta identified slums, informal settlements, old neighbourhood and proposed future developments in the city (MPQ, 1980s) (NESPAK, 1985). The details of new and planned developments are also discussed in a report by AlHasan systems private limited (PESA, 2015). Based on that information additional areas were selected and classified in order to focus on variety of housing types including slums, informal settlements, planned schemes, real-estate developments, old neighbourhoods, and public and private housing areas. The classification of all 32 residential areas selected for housing survey is given in Table 1.

Table 1. Classification of residential areas for housing survey

S. No.	Reason/ Housing type	No. of areas
1.	Safe areas	12
2.	Public housing	3
3.	Real estate developments	3
4.	Slums and squatter settlements	4
5.	Old neighbourhoods	3
6.	New developments	2
7.	Middle-high income areas	3
8.	Low income areas	2
Total		**32**

Initially, the survey was conducted in 5 residential areas by students who live in the same area as a test/ pilot study to see the response of the residents and if there is any need to change/ skip any question in the questionnaire. The response was good, and no change was needed in the questionnaire. Later on, the survey was conducted in remaining 27 residential areas.

Multiple criteria were used for the selection of houses within a specific area. Clear instructions were given to the survey team and verified after the survey. In public or planned housing schemes every 5th house on each side from a selected landmark was surveyed (Yakubu, Akaateba, & Akanbang, 2014); in case of more than one sector or residential block, a representative number of houses from each sector/ block were selected; if the residents were not willing to participate, then the next house or household willing to participate in the survey from the same street/ area was selected; in areas with mixed or multiple construction types, a representative number of houses in terms of architectural layout/ construction type (Tuncoku, İnceköse, Akış, & Yalçın, 2016) were selected, and finally the representation of major ethnic, religious and income groups was also one of the selection criteria.

A structured survey questionnaire was designed with reference to the English housing survey and a housing inventory used in a PhD research conducted in Pakistan (Naeem, 2009) (DoCLG, 2016). The questionnaire was further modified after discussion with experts from architecture, economics, and social sciences background.

The wealth index is usually used as a proxy indicator to know more about household level wealth and key assets (WFP, 2008). For Demographic and Health surveys (DHS), USAID developed wealth indices for many countries including Pakistan. Wealth index was also used in scientific studies to assess the household physical assets and endowments (Tripple, Korboe, & Garrod, 1997) (Yakubu, Akaateba, & Akanbang, 2014). Since questions on household income are always delicate and might result in inaccurate answers, the household wealth was also validated through the availability of assets besides asking the question on household income. The purpose was to find out the availability of various utility and luxury items and appliances being used by the residents. Initially, 31 assets/ items were enlisted which were then modified after discussion with experts and, finally, 22 assets were selected. These assets were then divided based on their importance and usage (what assets/ service people would prefer to buy/ get when they can afford) into Need and Luxury assets or items (Table 2). However, the assets mentioned in the wealth level were given no score because it is hard to define a price or value of the items in the context of Quetta; for example, there are also markets in Quetta where people can buy used products and cars which are brought into the country through informal ways.

Table 2. Wealth level assets for Quetta

S. No.	Assets	
	NEED	**LUXURY**
1	Electricity	Charpai (local bed)
2	Natural gas	Bed
3	Fan/ Air Cooler	Dining table
4	Press Iron	Sofa
5	Room heater	Microwave oven
6	Mobile phone	Vacuum cleaner
7	Television	Air-conditioner
8	Washing machine	Computer
9	Water geyser/ boiler	Internet connection
10	Refrigerator	Car
11	Motorcycle or scooter	Domestic servant in household

As mentioned by Barry & Rüther (2005), employing literate members of the community for socioeconomic data collection is effective to register more people. Therefore, the survey was conducted with the help of local contact persons who also possess specific knowledge about housing and construction and who can speak local language(s) for easy communication with the residents. This includes 3rd year onward students of architecture department, staff member(s) of civil engineering and architecture of Balochistan University of Information Technology, Engineering & Management Sciences (BUITEMS) Quetta, practicing architects and non-government organizations (NGOs). The number of houses surveyed per survey team can be seen in Table 3.

Table 3. Details of the survey team

S. No.	Survey done by	No. of houses
1.	Students	125
2.	Architects	33
3.	University staff	27
4.	NGOs	30
Total		215

In total, 224 questionnaires returned and after sorting 215 questionnaires were included for the result of this survey. The excluded 9 questionnaires were either partly filled or several questions were skipped or left blank which provided incomplete information.

Results and discussion

Safety questionnaire

The majority of the respondents of safety questionnaire were male (82%) and their ages were between 21 to 30y (76%). During a survey conducted in Pakistan, it was observed that internet is more popular among the people between the ages of 18-35y and male internet users are higher (87%) than female (13%) (The Express Tribune, 2013). 61% respondents possess a bachelor degree and 52% of them were employed. The familiarity of areas varies from higher in the North of Quetta and the city centre to lower in the South, East and West of Quetta city. In total, 14 residential areas were found safe.

Housing survey

The results of housing survey are categorised as 1) characteristics of households (socio-demographic information, household size etc.), 2) general housing characteristics (plot size, construction year), 3) construction type and main construction materials, 4) housing characteristics of the most common housing types and 5) socio-demographic profile and energy consumption of R.C.C houses.

Characteristics of households

In the data collected from 215 houses, common ethnic groups found are Pathan (34%), Baloch (16%), Punjabi (15%), Hazara (13%), and Muhajir (12%). The average household size was 9.9 persons per house. In terms of qualification of head of the family 33% possess a bachelor, 21% completed a master, 7% of them were uneducated while rest of them have lower education level than a bachelor degree. Majority of the heads of family were employed and salaried (Figure and 4).
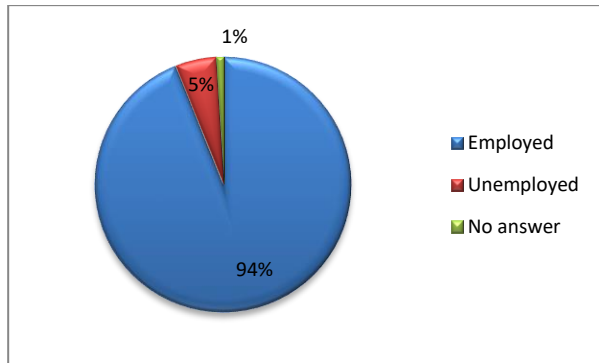

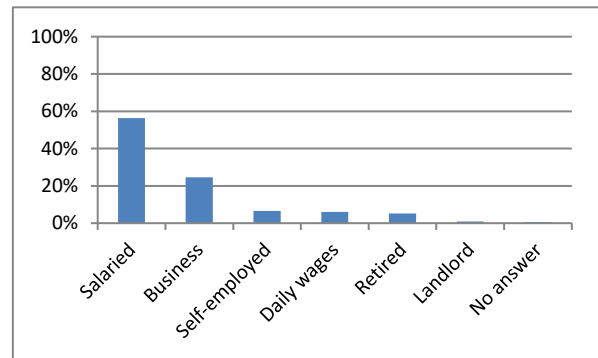Figure 3. Employment status of head of the family [N=215]

Figure 4. Nature of job for head of the family [N=215]

For household income there were 6 income ranges given and respondents had to select the average income level rather than providing exact income since many people do not feel comfortable about income related questions. The result shows that 30% of the households earn between €143-402 (PKR 15,000-PKR 45,000) per month (Figure) and 27% of households earn between €411-€715 (PKR 46,000-PKR 80,000) per month while 6% of the households earn less than €134 (PKR 15,000) which is the minimum salary per month defined by the federal government of Pakistan (Note: considering 1EUR= 111.92 PKR).
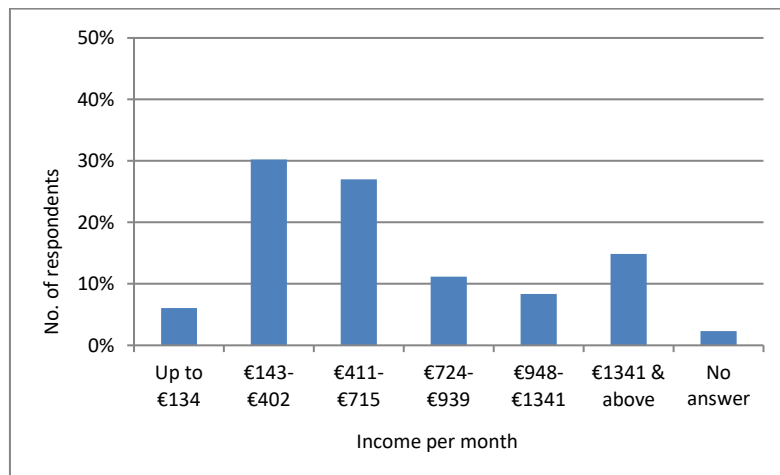

Figure 5. Household income per month [N=215]

All 215 (100%) houses had electricity connection while 210 (98%) houses were connected with gas line (Figure). According to Pakistan Bureau of Statistics in 1998, 94% of houses in Quetta had an electricity connection (PBS, 1998). Results also show that 98% of the households have fan and mobile phone. Television was available in 93% households. More houses have computer 80% than the internet connection 72% (Figure). Sofa/ couch are available in 50% houses but dining table in only 32% houses. It is a tradition in Quetta that people take their meals while sitting on the floor and do not prefer a dining table.
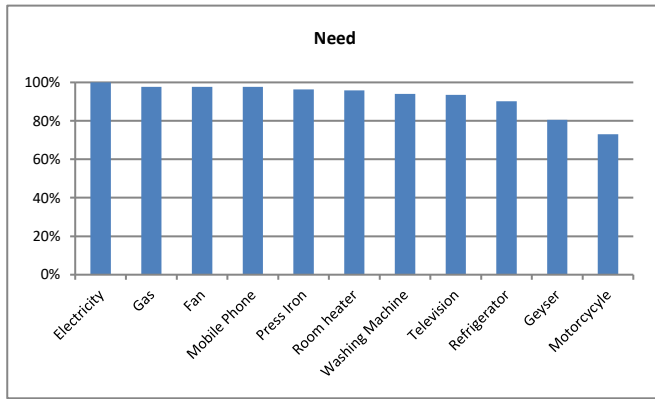
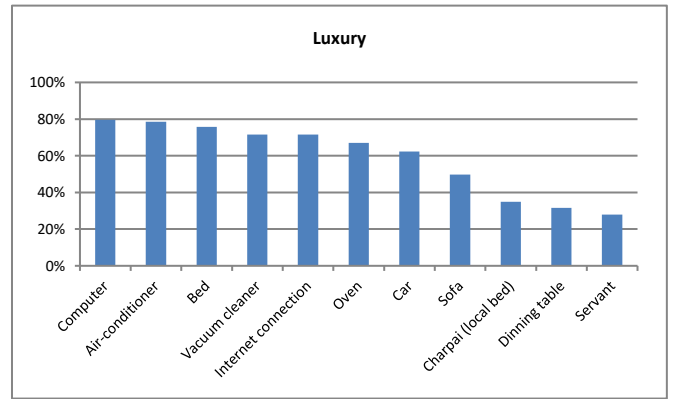Figure 6. Availability of need assets in a household

Figure7. Availability of luxury assets in a household

Housing characteristics

In Pakistan, plot size or area of a house is usually measured in square feet (sq. ft.). The average area of a house in the housing survey was 423 m^2 (4555 sq. ft.). Most of the houses were constructed during the last 40 years (**Error! Reference source not found.**) from them maximum were even built in the last 2 decades: 37% houses were built during 1997-2006, and 26% houses were constructed during 2007-2016. This could be related to the fact that many refugees moved to Quetta due to War in Afghanistan (2001-2014), and that during the last 2 decades new housing schemes were developed in the northern part of Quetta city.
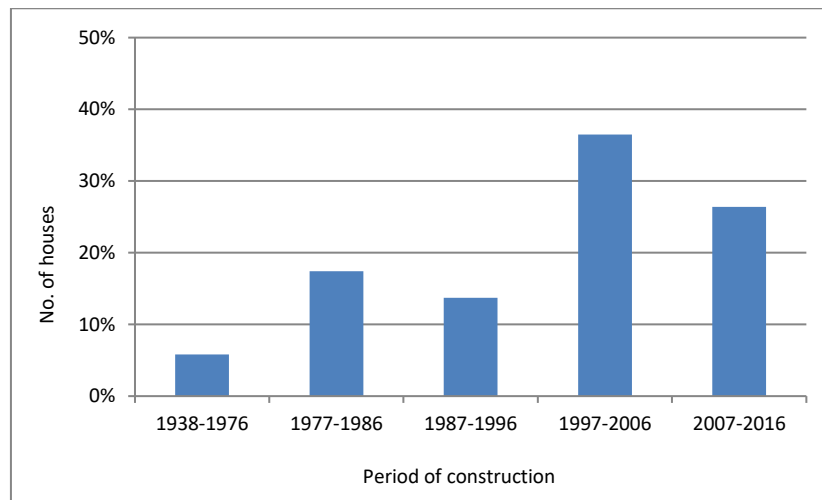

Figure 8. Period of construction of houses in the housing survey [N=189]

Most of the houses only consisted of a ground floor (48%), 36% of the houses had ground floor and first floor whereas 12% had more than two floors. Average room occupancy was 2.18 persons per bedroom which is slightly higher than the tolerably crowding level proposed by the United Nation; 1.4 to 2.0 persons per habitable room (Haq, 2011). Majority of the houses (64%) were constructed of R.C.C (reinforced cement concrete) structure, 31% of brick masonry construction and 5% of sundried bricks. According to 1998 census, 44,249 (50.81%) houses out of 87,091 in Quetta were Pucca houses (PBS, 1998). The word Pucca means 'solid' and 'permanent'. This term is applied to housing in South Asia built of substantial material such as stone, brick, cement, concrete, or timber (Qadeer, 2006).

Construction type and main construction materials

The housing in Quetta can be divided in three main construction types; i.e. R.C.C frame houses, brick masonry houses and sundried brick houses. The materials composition for all these three structural types is stated in

Table **4**. In R.C.C houses walls were constructed of baked bricks (98%) and concrete blocks (2%), with cemented floor (96%) and R.C.C roof (100%). Many houses (68%) used single glazed windows and 32% houses had double glazed windows. In brick masonry houses, the walls were filled with baked bricks (97%) and concrete blocks (3%), floor was mainly cemented (85%), roofs found in 4 different compositions and 81% of the houses had single glazed windows. In sundried brick houses walls were built of sundried bricks (73%) and rammed earth (27%), floors were earthen (45%), bricks (36%) and cemented (19%) as well. Roofs were girder/t-iron (46%), wooden beams with bamboos (45%) and wooden beams with girders (9%).

Table 4. Material composition of housing units in housing survey

Building part/ material	R.C.C frame (%)	Brick masonry (%)	Sundried brick (%)
Construction of walls			
Baked brick	98	97	
Concrete blocks	2	3	
Sundried brick			73
Rammed earth			27
Flooring material			
Cement	96	85	19
Baked brick	1	5	36
Earth/ sand/ mud	2	10	45
Wood	1		
Roofing material			
RCC roof	100	52	
Girder/ T-iron		31	46
Wooden beams with bamboos		9	45
Wooden beams with girder		8	9
Insulation			
Walls	4	7	
Floor	2	3	
Roof	3	4	
Windows glazing			
Single glazed	68	81	82
Double glazed	32	19	18

Housing characteristics of the most common housing types

R.C.C and brick masonry houses were mainly built during last 4 decades with more units have been constructed during 1997-2006. Plot size (average) of houses varies from larger in R.C.C houses (434 m^2) to smaller (205 m^2) in houses constructed with sundried bricks. R.C.C houses also had more number of bedrooms where 21 houses with 6 bedrooms; in brick masonry houses 13 houses had 4 bedrooms while 3 houses had 2-3 bedroom in sundried brick houses. Direct heating system was most common in all types of housing and less houses use central heating system (Table 5).

Table 5. Housing characteristics of common housing types in housing survey

Housing characteristics	R.C.C frame (units)	Brick masonry (units)	Sundried brick (units)
Year of construction			
1938-1976	5	7	
1977-1986	22	9	1
1987-1996	14	9	1
1997-2006	43	21	6
2007-2016	39	11	
Bedrooms			
1		1	1
2	26	12	3
3	28	10	3
4	23	13	2
5	19	11	1
6	21	7	
7	5	5	1
8	9	1	
above 8	7	7	
	R.C.C frame	Brick masonry	Sundried
Plot size (mean)	434 m^2	344 m^2	205 m^2
Heating system			
Direct heating (%)	90	97	100
Central heating (%)	10	3	

Socio-demographic profile for RCC houses

There are five major ethnic groups found in the survey; i.e. Pathans, Baloch, Hazara, Punjabi and Muhajir. A large number of Pathans (37%) live in R.C.C houses whereas 14% of each Baloch, Hazara and Muhajirs live in such houses whilst only 12% of Punjabis; and 5% of the households living in such houses did not mentioned their ethnicity (Table 6). The average household size of the families living in R.C.C houses is 14.3 persons per house and 91.3% of the head of household are employed.

Table 6. Ethnicity of households living in R.C.C houses

Ethnicity	R.C.C houses	
	Frequency	Percentage (%)
Pathan	51	36.7%
Baloch	20	14.4%
Hazara	20	14.4%
Muhajir	19	13.7%
Punjabi	16	11.5%
Others	6	4.3%
No answer	7	5%
Total	139	100%

Majority of the residents living in R.C.C houses (Table 7) were salaried (60.4%) or doing business (24.5%). The qualification of head of households varies from uneducated (3.5%) to bachelor (36.6%), master (23%). It shows that most of the people prefer to obtain bachelor and master qualification.

Table 7. Nature of job, qualification, and employment status of the head of household living in R.C.C houses

Characteristics of household	R.C.C houses	
	Frequency	Percentage (%)
Nature of job	84	60.4%
Salaried	34	24.5%
Business	10	7.2%
Retired	9	6.5%
Self-employed	2	1.4%
Education		
Uneducated	5	3.5%
Primary	3	2.1%
Middle	7	5%
Matriculation	15	10.7%
Intermediate	13	9.3%
Bachelor	51	36.6%
Master	32	23%
PhD or above	4	2.8%
No answer	10	7%
Employment		
Employed	127	91.3%
Unemployed	10	7.1%

Only 2 households with low income €134 (PKR 15,000) lived in R.C.C houses while the most common income groups found were: people who earn between €143-€402 (31%), and €411-€715 (28%) while 16% of the households earn more than €1341 (Table 8). The household wealth level of residents living in R.C.C houses was also higher than of brick masonry houses or sundried brick houses. The frequency and percentage of wealth level assets of households living in R.C.C houses is presented in Table 9.

Table 8. Monthly incomes of the households living in R.C.C houses

Monthly income of the household	R.C.C houses	
	Frequency	Percentage (%)
Up to €134 (PKR 15k)	2	1.4%
€143-€402 (PKR16k-45k)	43	31%
€411-€715 (PKR 46k-80k)	39	28%
€724-€939 (PKR 81k-105k)	15	10.8%
€948-€1341 (PKR 105k-150k)	13	9.4%
above €1341 (PKR 150k)	23	16.6%
No answer	4	2.8%
Total	139	100%

Table 9. Household wealth level

Wealth level (Assets)	R.C.C houses	
	Frequency	Percentage (%)
Need items		
Electricity	139	100%
Natural gas	139	100%
Fan	138	99%
Press iron	137	99%
Mobile phone	136	98%
Room heater	136	98%
Television	136	98%
Washing machine	138	99%
Water geyser	128	92%
Refrigerator	132	95%
Motorcycle	102	73%
Luxury items		
Charpai (local bed)	46	33%
Bed	119	86%
Dining table	49	35%
Sofa	83	59%
Microwave oven	107	77%
Vacuum cleaner	108	78%
Air-conditioner	54	39%
Computer	121	87%
Internet connection	113	81%
Car	95	68%
Servant	42	30%

Energy consumption of R.C.C houses

Natural gas is the major source of heating (98%) for the households living in R.C.C houses. Direct heating (90%) by using gas heaters is the most common way to heat rooms and indoor spaces and only 10% houses use central heating system. Electricity consumption in summer is higher due to use of cooling devices whereas consumption of gas is higher in winter due to heating of spaces, water, and cooking (Fig. 9-12). According to 1998 census, 77.53% houses in Quetta were using natural gas for cooking (PBS, 1998).
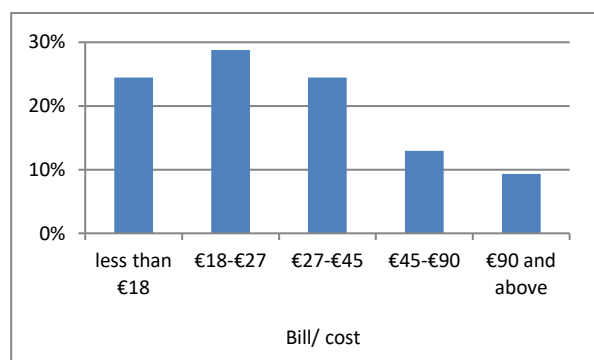

Figure 9. Electricity bill per month in summer
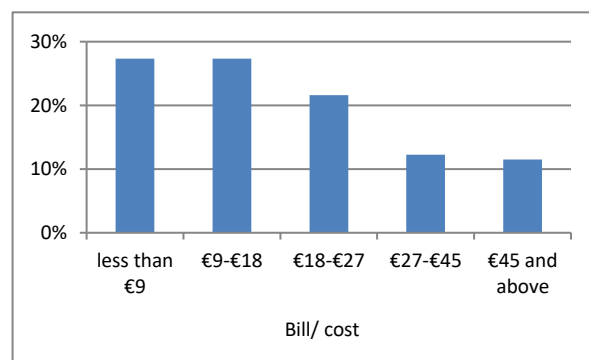

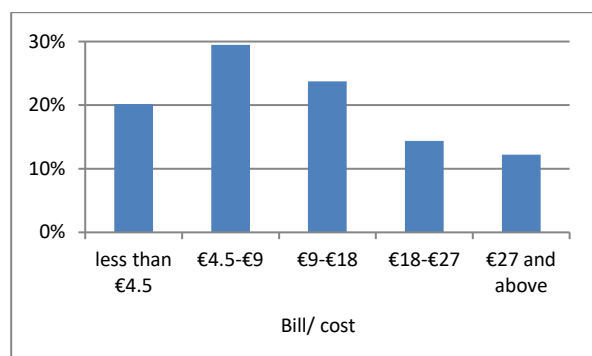Figure 30. Electricity bill per month in winter
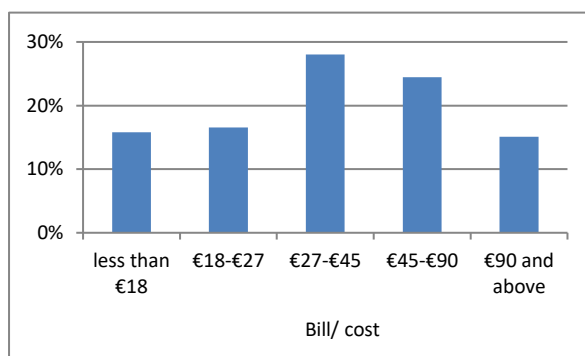
Figure 11. Gas bill per month in summer

Figure 12. Gas bill per month in winter

There is no strong relation between the total usage of electricity and the availability of household appliances which mainly use electricity, such as electric fan, press iron, washing machine, refrigerator, air-conditioner, vacuum cleaner and microwave oven, whereas, the houses using gas geysers for water heating pay more during winter as water heating increase the total usage of gas.

Houses with more energy consumption have large plot size (area) and more number of bedrooms. The comparison of increased consumption, plot size (mean) and bedrooms (mean) is given in Table 10.

Table 10 Comparison between energy consumption, plot size and number of bedrooms

Bill	Plot size (mean)	Bedrooms (mean)
Monthly electricity bill in summer		
Less than €18	229 m²	4.7
€18- €27	298 m²	4.7
€27-€45	319 m²	5.3
€45-€90	538 m²	5.7
above €90	696 m²	9.9
Monthly electricity bill in winter		
Less than €9	224 m²	4.6
€9- €18	282 m²	5.5
€18- €27	343 m²	5.2
€27-€45	432 m²	5.5
above €45	819 m²	9.1
Monthly gas bill in summer		
Less than €4.5	220 m²	5
€4.5- €9	246 m²	4
€9- €18	335 m²	5.6
€18- €27	577 m²	6.2
above €27	610 m²	8.3
Monthly gas bill in winter		
Less than €18	224 m²	3.7
€18- €27	238 m²	5.7
€27-€45	341 m²	5.6
€45-€90	397 m²	5.6
above €90	551 m²	8.4

Conclusion

The study has provided valuable insights of the existing housing stock in Quetta. The housing can be divided into 3 types, R.C.C frame structure houses, brick masonry houses and sundried brick houses whereas R.C.C houses is the most common housing type. The use of reinforced cement concrete is maybe more common considering the fact, that Quetta is located in earthquake zone. The majority of the head of the households are employed; salaried or doing business and mainly hold a bachelor or a master degree. There are two common income groups, households earn between €143-€402 and €411-€715 per month.

The houses in Quetta city are mainly constructed during last 4 decades and most of them were built during 1997-2006. The households with more wealth level assets live in R.C.C houses while the households living in brick masonry and sundried brick houses possess less household assets. The construction materials also differ for each housing type where R.C.C houses use more durable materials for the construction of walls, roofs, and floors. Insulation is rarely used, and single glazed windows are commonly used in the houses. Natural gas is commonly used for heating and rooms are directly heated by using gas heaters. The consumption of electricity was noticeably higher in summer while the consumption of gas was higher in winter. The houses with larger area and more number of bedrooms consume more energy.

The results provide an overview of the housing stock and characteristics of housing in Quetta, Pakistan. Since, R.C.C houses is the most common housing typology in Quetta and these houses are wide spreading in the city, it is important to study this type of houses in detail to improve their energy performance and provide optimal indoor thermal comfort for the residents.

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Bibliography

Abdul S., K., Shuhab D., K., & Din M., K. (2013). Land subsidence and declining water sources in Quetta Valley, Pakistan. *Environmental Earth Sciences, Vol. 70*(Issue. 6), 2719-2727.

Alnsour, J. A. (2011). Illegal housing in Jordan. *Jordan Journal of Social Sciences, Vol. 4*(Issue. 3), 339-354.

Barry, M., & Rüther, H. (2005). Data collection techniques for informal settlement upgrades in Cape Town, South Africa. *Journal of the Urban and Regional Information Systems Association (URISA), Vol. 17*(Issue. 1), 43-52.

BBC. (2016, August 8th). Retrieved May 13th, 2017, from http://www.bbc.com/news/world-asia-37007661

DAWN. (2016, October 25th). Retrieved June 13th, 2017, from https://www.dawn.com/news/1291999

DHS. (2015). *Demographic and Health Surveys by USAID*. Retrieved from http://dhsprogram.com/topics/wealth-index/Wealth-Index-Construction.cfm

DoCLG. (2016, February 18th). (Department of Communities & Local Government) Retrieved from English Housing Survey: https://www.gov.uk/government/publications/english-housing-survey-2014-to-2015-questionnaire-and-physical-survey-form

Gibson, M., Petticrew, M., Bambra, C., Sowden, A., Wright, K., & Whitehead, M. (2011). Housing and health ineaulities: a sysnthesis of systematic reviews of interventions aimed at different pathwayslinking housing and health. *Health & Place, Vol. 17*(Issue. 1), 175-84.

Haq, R. (2011). *Quality and Quantity of Housing Conditions. Population of Pakistan: An analysis of National Socio-Eeconomic Registry.* Pakistan Institute of Development Economics (PIDE) Islamabad together with Benazir Income Support Program (BISP) and UNICEF.

Kanton, O. (2007). *Household environment and health in the Tamale metropolitan area. Unpublished PhD thesis.* Department of Geography & Resource Studies, University of Ghana.

Kugelman, M. (2013). *Urbanisation in Pakistan: causes and consequences.* Norwegian Peacebuilding Resource Centre. Retrieved May 13th, 2017, from https://www.files.ethz.ch/isn/159296/4c5b5fa0ebc5684da2b9f244090593bc.pdf

MET, P. (2015). *Pakistan Meteorological Department, Govt. of Pakistan*. Retrieved June 15th, 2017, from Regional Meteorological Center, Quetta, Balochistan: http://rmcbalochistan.pmd.gov.pk/historical-events.html

MPQ. (1980s). *Master Plan for Quetta.* Design Directorate, City & Regional Planning Group, University of Engineering & Technology, Lahore, Pakistan.

Naeem, A. (2009). *Recognizing historic significance using inventories: A case of historic town in Sindh Pakistan (PhD Thesis).* Oxford Brookes University, Oxford, UK.

NESPAK. (1985). *Quetta Master Plan.* Quetta: Quetta Development Authority together with National Engineering Services, Pakistan.

NREL. (2007a, February). Retrieved April 19th, 2017, from National Renewable Energy Laboratory: http://www.nrel.gov/international/images/pak_10km_dni_ann.jpg

NREL. (2007b, May). Retrieved April 19th, 2017, from National Renewable Energy Laboratory: http://www.nrel.gov/international/pdfs/pak_wind.pdf

Online, W. (2017, July 19th). Retrieved from World Weather online: https://www.worldweatheronline.com/quetta-weather-averages/balochistan/pk.aspx

P&D. (2011). *Quetta: District Development Profile.* Planning & Development Department. Planning & Development (P&D) Department, Government of Balochistan. Retrieved April 7th, 2017, from http://balochistan.gov.pk/DistrictProfile/DDP%20Final%202012/Quetta/Quetta.pdf

PBS. (1998). Retrieved April 19th, 2017, from Pakistan Bureau of Statistics: http://www.pbs.gov.pk/sites/default/files//tables/District%20at%20a%20glance%20Quetta.pdf

PBS. (1998). Population & Housing Census 1998. Pakistan Bureau of Statistics (PBS), Government of Pakistan.

PESA. (2015). *Pakistan Emergency Situation Analysis: District Quetta.* AlHasan Systems Private Limited, Islamabad, Pakistan.

PWD. (2017, May 13). Retrieved from Population Welfare Department, Govt. of Punjab: http://www.pwd.punjab.gov.pk/

Qadeer, M. A. (2006). *Pakistan: Social and Cultural Transformations in a Muslim Nation.* Routledge, Taylor & Francis Group.

QDA. (2016). Retrieved June 20th, 2017, from Quetta Development Authority, Government of Balochistan: http://www.balochistan.gov.pk/index.php?option=com_content&view=category&layout=blog &id=47&Itemid=552

QDA. (2017). Quetta Development Authority, Government of Balochistan.

QESCO. (2016). Management Information System (MIS) department, Quetta Electric Supply Company, Quetta, Pakistan.

Shaikh, F., Ji, Q., & Fan, Y. (2015). The diagnosis of an electricity crisis and alternative energy development in Pakistan. *Renewable & Sustainable Energy Reviews, Vol. 52*, 1172-1185.

TAMA. (2003). *Medium term development plan 2003-06. prepared under the medium term development policy framework.* Accra: Ministry of Local Government & Rural Development.

The Express Tribune. (2013). *Pakistan Internet Use Survey.* Retrieved April 5, 2017, from https://www.scribd.com/document/161598355/Pakistan-Internet-Use-Survey-2013

Tripple, A. G., Korboe, D., & Garrod, G. (1997). Income and wealth in house ownership studies in urban Ghana. *Housing studies, 12*(1), 111-126.

Tuncoku, S. S., İnceköse, Ü., Akış, T., & Yalçın, M. A. (2016). Assessment of construction techniques and material usage in Izmir rural houses. *International Journal of Architectural Heritage, Vol. 9*(Issue. 8), 1005-1022.

WFP. (2008). *Wealth Index:Food Security Analysis.* World Food Program. Retrieved from https://resources.vam.wfp.org/

Yakubu, I., Akaateba, M. A., & Akanbang, B. A. (2014). A study of housing conditions and characteristics in the Tamale Metropolitan Area, Ghana. *Habitat International, Vol. 44*, 394-402.