World Academy of Science, Engineering and Technology
International Journal of Architectural and Environmental Engineering
Vol:10, No:3, 2016

A Comparative Study of Afghan Traditional and Contemporary Courtyard Housing Regarding Affordable Planning and Sustainability

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Abstract**—**The purpose of this research is to upgrade a pleasing, sustainable and safe shelter in the Afghan urban community. It also aims to maintain traditional housing, which is fitted to its environment, while attempting to upgrade it with new, traditional standards. The three main objectives of this study are to upgrade the traditional courtyard house to become safe and sustainable today and tomorrow; to fit the contemporary house environmentally and culturally, and to suppress or reduce the broad gap between traditional and contemporary housing. The paper tries to exhibit and analyze the sustainably best practices available in both traditional and contemporary courtyard housing in Afghanistan. For instance, the use of thick walls and Tawa-Khana (floor heating system) shows the best sustainable practice in that context.

Keywords**—**Afghan Traditional Courtyard Housing (ATCH), Afghan Contemporary Courtyard Housing (ACCH), suitability planning, affordable and thermal comfort.

I. Introduction

AFGHAN residential architecture and lifestyle have been confronted with modern and international architecture and urbanism has transformed Afghan dwellings into unsuitable forms that clash with the Afghan culture and environment. All over the country, more than 95% of people live in courtyard housing. [1]-[4], [8]. This research analyses and compares the spatial quality of contemporary courtyard houses with traditional courtyard houses based on their comparative sustainability. The relatively static heating and cooling system used in a courtyard house can provide the basis for understanding modifications that can generate air movement by convection. In summer, air temperature drops considerably after sunset because of re-radiation to the night sky. The air is relatively free of water vapor that would reflect the heat or infrared radiation back toward the ground, as occurs in warm humid regions such as Nangarhar province. To enhance thermal comfort, this phenomenon has been used in the architectural design of houses by employing the courtyard concept [5]-[7], [9]. Quantitative methods of data analysis will be done using an analytical and sustainable model to carry out a comparative study of two types of traditional and contemporary accommodation is now day a best practice.

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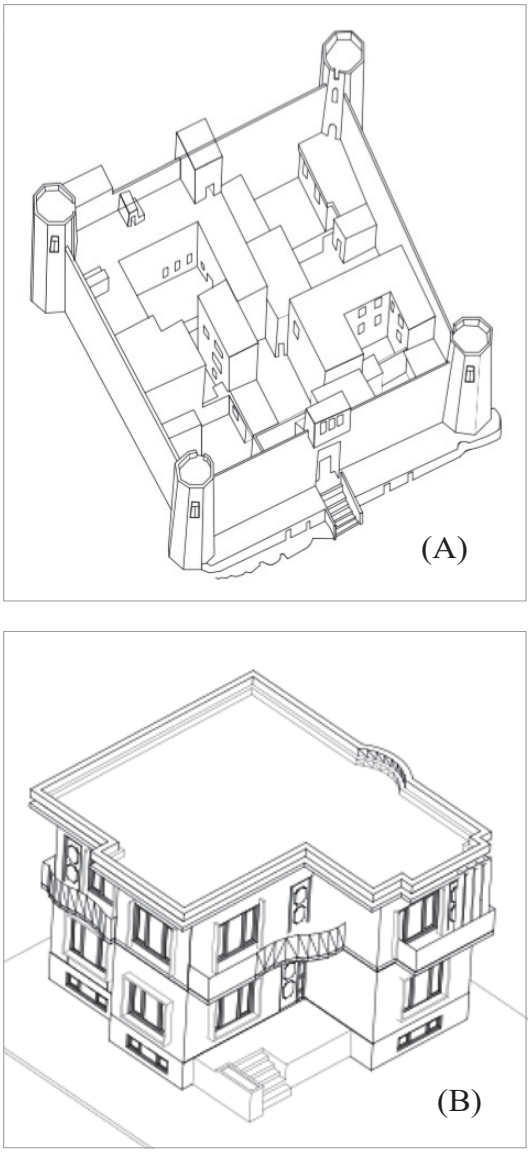

Fig. 1 (A) Afghan Traditional Courtyard House (ATCH) also call Kala and (B) Afghan Contemporary Courtyard House (ACCH) 3D Drawing

Development in contemporary housing space, environment and safety is an urgent requirement for Afghan shelter. This change, which is expanding day by day along with the dimensions of the space, is a problem that encapsulates the identity crisis of contemporary housing. This discussion can be recreated as a beginning for space to be used in contemporary

housing with comparison to its use in traditional settings [9]-[11]. The recreation of space based on the arrangements of traditional architecture was suggested through the strategy of introducing flexible elements and spaces. Based on the survey, we selected three zones for research (Kabul, Nangarhar, Kandahar and Herat).

The Afghan courtyard served three purposes. First, it serves as interior open space with full privacy and security for all family members, especially women and children. Second, the Afghan courtyard (especially the traditional one) in summer is shaded by its four walls, causing the surrounding rooms to heat slowly and remain cool until late in the day, when the sun shines directly into the courtyard, and in winter the cold wind passing above the house during the day does not enter the courtyard. Third, in both traditional and some contemporary courtyard houses, multiple families settle in one courtyard house to create in rural regions high-density living surrounded by walls for environmental protection and privacy (Table I) [1]-[4], [8].

II. Objects and Method

The methodology of this study is derived from the aim of this paper, which is to examine the level of thermal comfort and habitability of the Afghan modern courtyard house design in comparison to the level of planning sustainability of house design of Afghan traditional courtyard houses. This study applies the planning and environmental interpretative research method. The climate and cultural factors of different areas in Afghanistan are the independent variables, while different types of open spaces or courtyards and courtyard morphology are among the dependent variables in both the traditional and contemporary segments of this research. The data collection methods used include both field surveys and documentation, As we have surveyed about one hundred houses across the country, from each of those surveys we selected seven samples to represent the Afghan traditional and contemporary courtyard housing, (Fig. 1) [1]-[4], [9].

As a pattern at the local scale, the Afghan geographical location, Islamic religion and turbulent history combined to shape all major historical cities, including Kabul, Kandahar and Herat, with a courtyard shape with four thick walls and four gates following the same courtyard pattern. The new conceptual pattern for the Afghan house is mainly an upgraded version of the old Kala.

TABLE I
Changes of Life Pattern in House of ATCH and ACCH in Afghanistan

Living Activities	Changes in Space		Changes in Methods of Use
	Traditional or ATCH	Contemporary or ACCT	
Dining	Living Room	Dining Room Living Room	Establishment of a space reserved only for dining
Sleeping	Bedroom and Living	Bedroom	Partial use for living bedroom but modern cases changes most.
Family Gathering	Living room, Parent Room	Living Room and Master bed room	Courts have disappeared in housings, with its function now incorporated into the living room
Guest Reception	Living Room, Guest Room	Living Room	Spatial division along gender has been discarded
Housework	Tanwer Khana, Spacha	Kitchen Dining Room	The traditional kitchen, (Tanowr Khana) previously use as bakery and the same in Summer out side.
Ritual Ceremony	Gust room out of court or near to main gate and women inside	Living Room Basement Hall	Through modernization, ritual ceremonies, previously held inside the Gust room for men, are now served in Living Room And high-class house in Basement Hall for Men.

TABLE II
Comparison of Concepts and Parameters of Traditional and Contemporary Houses

	Courtyard Housing Type	
	Traditional	Contemporary
Plan Configuration	Afghan Spatial organization of traditional houses, itself, undertook the comfort supply by considering shadows, putting ponds for surface evaporation as well as observing energy saving elements and Existence of three types of spaces: open, semi-open and closed, with specific ratios for these three spaces proportionate to the climate.	The responsibility and plan for comfort supply of houses are not included in spatial organization of contemporary houses. Amount of participation of spatial organization in providing cold, heat and ventilation seems little. And Change in the amount of utilizing semi- open and mediating spaces (porch, etc.). Leading to decreasing and omitting them as well as changes happening in the ratio of these spaces also the space proper orientation, due the every area should adopted in local climate and sun path.
Quality of Space	Space flexibility for lifestyle dynamism, human behaviors, and their status and allocating no space for special operations.	Domination of objects in house special organization, transformation of space into a rigid material resulting from space inflexibility.
Thermal Comfort	Comfort providing elements such as wind-catcher, basement, shades, pond and courtyard in a uniform pattern were integrated inside the spatial organization and appeared in architectural displays and Convergence between residents' needs and demands with environment.	Architecture does not have any role in installing of factory packages (cooling and heating devices) in internal spatial organization. These devices are attached to the building as an accessory part. And In the spatial organization, there is no spatial response for achieving adaptation to environment and its changes and space response is replaced by technology in a divergent way.
Building Connection to Nature	House was not separated from nature, and existence of some natural representatives was mandatory in internal spatial organization of a house.	The spatial organization of a house does not consider the nature. Its facilities have not been used for providing residents' comfort, and relation of construction with nature in contemporary houses has been minimized to consumption of environment and weakening it.

III. Discussions and Result

A. General Discussion

Most Afghan modern architecture lacks conscious use of passive methods to control the indoor environment. Excessive use of modern imported materials, irrespective of their efficiency in regulating the indoor environment has often resulted in high-energy consumption during the cold winter in Kabul and the hot summer in some other cities, leading to many environmental problems. There is a close connection between the energy use in buildings and environmental damage, because of the energy-intensive solutions that are required in buildings to attain comfort conditions in terms of mechanical heating, cooling and ventilation and artificial lighting. This has caused severe depletion of non-renewable energy resources and environmental degradation [6]-[10]. The Afghan internal courtyard provided in such traditional buildings is found to play a prime role in providing the required air movement through the building. Thus, the internal courtyard of the Afghan traditional residential building provides a comfortable indoor environment, in addition to the natural airflow recorded by electronic sensors. A smoke study was conducted to analyze internal air movement, especially the air movement that is induced in the interiors of traditional buildings when there are still conditions outdoors. The outcome of the study proves the efficiency of internal courtyards in the climate-responsive design of Afghan traditional architecture (Table II) [6], [7], [10].

The basic form of a traditional Afghan residential building in Kabul consists of four walls built around an open courtyard that is generally rectangular or square in plan. The walls are in some cases part of a building, but in some others only serve as boundary walls, while the courtyard is open to the sky for letting air and light inside. There is an internal verandah around the courtyard for protection from rain and sun. A typical summer kitchen foregoes complete walls in favor of pillars, a structure that in summer effectively vents smoke.

The Afghan traditional courtyard house has better microclimatic conditions than the surrounding open areas, and is supposed to have a positive effect on the indoor comfort conditions of the enclosing building volume. In some cases, the courtyard retains a pool of cool air, as this is heavier than the surrounding warm air in hot areas such as Kandahar and Jalalabad. The top layer of air in the courtyard gets warmer in daytime and becomes lighter, causing the air to move upwards [8]. Thus, a low-pressure area develops in the courtyard, inducing air movement from outside, through the surrounding spaces. In addition to this thermal induction, the internal courtyard helps to induce air movement due to the pressure effect in the event of high-velocity, external winds that flow above the building. The wind flow reduces the pressure at the top layer of the air column, creating a suction effect above the small courtyard. This produces an upward movement in the top layer of air in the courtyard, pulling the air towards the court through the surrounding spaces, resulting in circulation of air in those spaces, especially in summer. These factors suggest many methods for planning, adopting and upgrading of an Afghan contemporary courtyard house (Table III). [14]-[18].

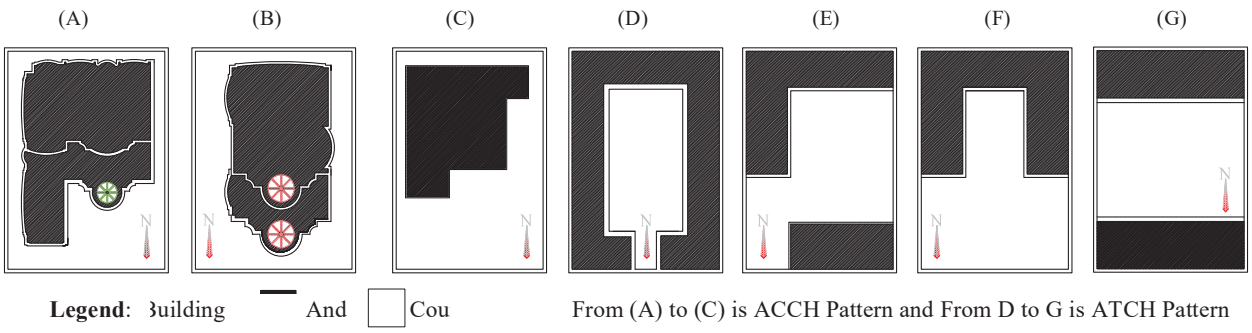

Fig. 2 More used Forms of Afghan Traditional Courtyard House (ATCH) and Afghan Contemporary Courtyard House (ACCH)

A. Envelope Thermal Properties of Housing

The value derived from steady-state calculations (U-value) is not by itself an appropriate indicator of the thermal performance of building elements, because it is possible for two walls with the same U-value to absorb and release heat at different rates [14]. Steady-state analysis is concerned only with the thermal conductivity of the material; the influence of heat capacity is ignored. Intermittent occupancy and associated heating or cooling operation combined with external diurnal variations mean that the building is more often in a state of flux and, particularly in hot summer conditions, the dynamic behavior of the whole building should be assessed in order to optimize the selection of envelope materials for greatest combined thermal comfort and energy performance. The material bulk properties of heat capacity (C), density (ρ), and thermal conductivity (λ) play an important role in the cyclic performance of the construction, which is significant when the outdoor temperature is cycling below and above the desired indoor temperature. Materials with beneficial thermal properties are either insulating materials, or materials with thermal mass [15] and the effect of thermal mass and thermal insulation, which are representatives of dynamic and steady state thermo-physical properties of materials, must be taken into account simultaneously [10]-[14].

TABLE III
THERMAL COMFORT OF COMPARATIVE ANALYSIS BETWEEN ATCH AND ACCH IN THREE DIFFERENT CLIMATICALLY ZONES

Climatically Zone Name		Kabul Central Zone (1)							Heart and Kandahar Zone (2)							Nangrahar Zone (3)						
	Groups	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
Main Two Type	Comparative Level / Category	High cost from 3 to 5 stories	High cost from 2 to 3 stories	Medium cost from 2 to 2.5 stories	Medium cost 2 stories	Medium Cost 1 Story	Low cost 2 stories	Low cost 1 Story	High cost from 3 to 5 stories	High cost from 2 to 3 stories	Medium cost from 2 to 2.5 stories	Medium cost 2 stories	Medium Cost 1 Story	Low cost 2 stories	Low cost 1 Story	High cost from 3 to 5 stories	High cost from 2 to 3 stories	Medium cost from 2 to 2.5 stories	Medium cost 2 stories	Medium Cost 1 Story	Low cost 2 stories	Low cost 1 Story
Afghan Traditional Courtyard Housing ATCH), Thermal Comfort comparative analysis	Floor			F1	F1	F2	F3	F3			F1	F1	F2	F3	F3			F1	F1	F2	F3	F3
	Wall			Wal	Wal	Wal	Wa3	Wa3			Wal	Wal	Wal	Wa3	Wa3			Wal	Wal	Wal	Wa3	Wa3
	Roof			R1	R1	R2	R3	R3			R1	R1	R2	R3	R3			R1	R1	R2	R3	R3
	Window			W1	W1	W2	W3	W3			W1	W1	W2	W3	W3			W1	W1	W2	W3	W3
	Door			D1	D1	D2	D3	D3			D1	D1	D2	D3	D3			D1	D1	D2	D3	D3
	Heating System			HS1	HS1	HS1	HS3	HS3			HS1	HS1	HS1	HS3	HS3			HS1	HS1	HS1	HS3	HS3
	Cooling System			CS1	CS1	CS2	CS3	CS3			CS1	CS1	CS2	CS3	CS3			CS1	CS1	CS2	CS3	CS3
	Night Lighting			NL1	NL1	NL1	NL2	NL2			NL1	NL1	NL1	NL2	NL2			NL1	NL1	NL1	NL2	NL2
	Day lighting			DL1	DL1	DL1	DL1	DL1			DL1	DL1	DL1	DL1	DL1			DL1	DL1	DL1	DL1	DL1
	% Of Glazing			50	45	30	25	20			50	45	30	25	20			50	45	30	20	15
	% Of Energy			50	45	35	30	30			50	45	35	30	30			50	45	35	30	30
Afghan Contemporary Courtyard Housing (ACCH), Thermal Comfort comparative analysis	Floor	F1	F1	F1	F1				F1	F1	F1	F1				F1	F1	F1	F1			
	Wall	Wa1	Wa1	Wa1	Wa1				Wa1	Wa1	Wa1	Wa1				Wa1	Wa1	Wa1	Wa1			
	Roof	R1	R1	R1	R1				R1	R1	R1	R1				R1	R1	R1	R1			
	Window	W1	W1	W1	W1				W1	W1	W1	W1				W1	W1	W1	W1			
	Door	D1	D1	D1	D1				D1	D1	D1	D1				D1	D1	D1	D1			
	Heating System	HS1	HS1	HS1	HS1				HS1	HS1	HS1	HS1				HS1	HS1	HS1	HS1			
	Cooling System	CS1	CS1	CS1	CS1				CS1	CS1	CS1	CS1				CS1	CS1	CS1	CS1			
	Night Lighting	NL1	NL1	NL1	NL1				NL1	NL1	NL1	NL1				NL1	NL1	NL1	NL1			
	Day lighting	DL1	DL1	DL1	DL1				DL1	DL1	DL1	DL1				DL1	DL1	DL1	DL1			
	% Of Glazing	50	50	45	40				50	50	45	40				50	50	45	40			
	% Of Energy	50	50	45	35				50	50	45	35				50	50	45	35			
Average Sustainably Level of ATCH				M	M	M	H	H			M	M	M	M	H			M	M	M	M	H
Average Sustainably Level of ACCH		L	L	M	M				L	L	H	H				H	H	H	H			

Abbreviation: H= High level, M= Medium level, L = Low level (According to level of Sustainability and Comfort.) Note: All other Abbreviation Explained in Table IV)

B. Sustainable Design Principles in Afghan Courtyard House

In the ACCH, siting and orientation of the building, the space between buildings, building form and optical and thermo-physical properties of the building envelope are the most important design parameters affecting indoor thermal comfort and energy conservation in building scale. [9] Among these parameters, the building envelope, because it separates the outdoor and indoor environment, is the most important parameter. All of these parameters are related to each other; the best values of each parameter should be determined depending on the values of the others and their best combination should be determined according to the climatic qualities of the region. [12] The climate of southern Afghanistan is relatively similar to a desert climate. This region is a hot and arid area with a high temperature difference between day and night. When evaluating traditional architectural patterns, it can be seen that designers were more sensitive to these climatic issues, and they presented the most suitable design and settlement examples for each climatic region.

C. Site and Orientation of the Building

Topography is a basic parameter that determines the architecture of the hot and arid region in Afghanistan. In Panshir, Nuristan and some other areas, houses are situated according to the slope of the hills of the city, and they are all oriented to the center-east, in order to maximize the sunlight that enters the house [6]-[11].

D. Space between Buildings to Provide Shady Areas

In the design of the ATCH in hot and arid areas in Afghanistan, there are several precautions taken against the hot climate. Houses are isolated from the street and surrounded by high walls. During the day, external walls of houses provide generally shady areas in narrow streets (in traditional cities) and especially in courtyards. By means of heavy, thick walls, a warm environment in winter and a cool environment in summer can be provided easily.

TABLE IV
ENERGY CONSUMPTION, BUILDING COMPONENTS INSULATION ANALYSIS AND EXPLANATION OF ABBREVIATION TABLE III

Symbol of Items	Items Full Name	Specification	Form	Insulation	Average Thickness/m	Unit	Unit Cost /U$	Standard ASHRAE Value	
								R- Value m^2 K/W	U- Value W/m2K
F1	Floor 1	Reinforcement concrete	A, B, C	Y	0.3	M2	30-50	1.5	0.66
F2	Floor 2	Plain concrete	D, E	N	0.25	M2	20-35	1.5	0.66
F3	Floor 3	Compacted earth clay	F, G	No	0.6	M2	4-8	2	1
Wa1	Wall 1	Fired Clay brick masonry	A, B, C	Yes	0.45	M2	30-50	1.3	0.76
Wa2	Wall 2	Concrete brick masonry	D, E	No	0.35	M2	25-54	1.2	0.55
Wa3	Wall 3	Clay brick masonry	F, G	No	0.45	M2	10-15	2	1
R1	Roof 1	Reinforcement concrete	A, B, C	Yes	0.3	M2	30-50	2.3	0.42
R2	Roof 2	I beam with fired brick	D, E	No	0.25	M2	20-35	1.5	0.66
R3	Roof 3	Wooden beam and clay cover	F, G	No	0.5	M2	5-10	1.9	1
W1	Window 1	Wooden	A, B, C	Yes	0.2	M2	25-40	0.35	2.7
W2	Window 2	PVC and Aluminum	D, E	Yes	0.07	M2	20-40	0.38	2.8
W3	Window 3	Steel	F, G	No	0.1	M2	15-30	0.2	2
D1	Door 1	Wooden	A, B, C	Yes	0.2	M2	25-40	0.35	2.7
D2	Door 2	PVC and Aluminum	D, E	Yes	0.07	M2	20-40	0.38	2.8
D3	Door 3	Steel	F, G	No	0.1	M2	15-30	0.2	2
HS1	Heating System 1	AC Air heating and cooling	A, B, C			Year	500-700	0	0
HS2	Heating System 2	Combined gas and Electricity	A, B, C			Year	250-420	0	0
HS3	Heating System 3	Traditional Wood stove	D, E			Year	180-200	0	0
CS1	Cooling System 1	AC Air heating and cooling	A, B, C			Year	200-300	0	0
CS2	Cooling System 2	Electrical fan	A, B, C			Year	150-200	0	0
CS3	Cooling System 3	Natural	D, E			Year	0	0	0
NL1	Night lighting 1	Electrical	A, C, D			Year	200-300	0	0
NL2	Night lighting 2	Oil light	D, E			Year	30-40	0	0
DL1	Day lighting 1	Natural from window	All			Year	0	0	0

E. Form of the Buildings

In Afghanistan, in hot and arid climate, the most preferred plan type is the courtyard house. In order to reduce the area affected by the solar radiation, compact forms are chosen. Shady areas can be obtained by arranging those forms with courtyards. In courtyards, with the help of plants and water for evaporative cooling, shady areas can be obtained, the floor temperature can be reduced by the high walls surrounding the courtyard, and the open areas can be used during the day [15] water Channels poured out from the pool are important elements for cooling (Fig. 3) [1]-[5], [7].

IV. CONCLUSION

In this short, comparative study, our main object was to introduce housing that provides energy-efficient, comfortable and restful shelter for its residents. In recent years, Afghan residential architecture and lifestyle, especially in big cities, have been confronted with modern and international architecture and urbanism that have transformed the dwellings of Afghans into unsuitable buildings that clash with Afghan culture and environment. We selected from a large survey of shelter over all major cities, including examples of both ATCH and ACCH. Most Afghans do not presently insulate their homes. Mud, straw and earth are used in traditional architecture. Rural buildings have a natural, thermal inertia adapted to the Afghan environment. Unfortunately, modern concrete buildings are becoming more and more popular in major cities because they are robust, and easily and quickly built. Genuine modern building techniques do, however, also take account of energy issues, through their design as well as the insulation material used, whereas the new concrete buildings in Afghanistan (which do not adopt energy-efficient techniques) are uncomfortable and not adapted to the Afghan climate. Their heating and cooling systems are expensive to run and they consume a lot of energy (e.g. air-conditioning systems).

Afghan traditional architecture offers more than mere symbols; it can transform the old, traditional culture into a new culture by using local, reasonable construction materials. Traditional builders in Afghanistan were using developed techniques for controlling the climate, despite their access to only limited resources, as well as their lack of modern technologies. Making use of only natural materials such as stone, earth, water, sand and plants, these builders were providing comfortable solutions. Moreover, wind and sun energy were among the resources most utilized by these builders. They built with restricted alternatives and had to understand the environmental elements and their features to make the best use of them. This current study has comparatively analyzed ATCH and ACCH regarding planning, climatic design and passive techniques used in their construction in order to understand how these ideas and techniques can provide thermal comfort for inhabitants, using

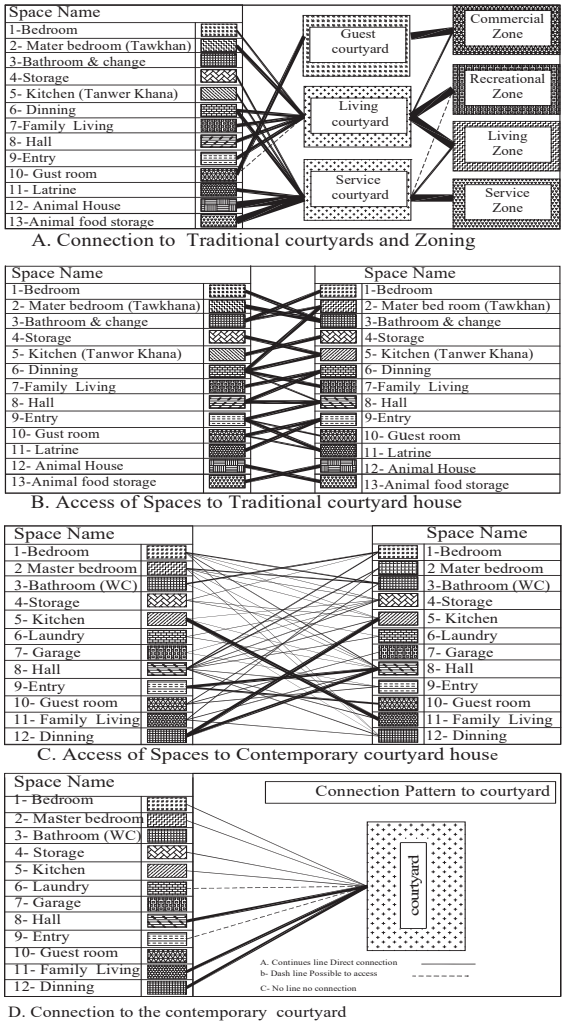

Fig. 3 Afghan Traditional Courtyard House (ATCH) and Afghan Contemporary Courtyard House (ACCH) Accesses and connection of spaces

Natural energy strategies and sustainable construction materials and methods. Understanding these issues can make suitable circumstances for making novel techniques with a natural method aiming for energy optimization in construction. Nowadays, families are not allowed to make use of all potential areas inside the houses, due to various conditions. Hence, reviving lost knowledge and techniques, planning to maximize climate consideration and flexibility, and laying out space organization based on daily needs as well as recent requirements rank among the important design issues. In the past, however, without surrendering comfort, low energy consumption levels could be reached easily. However, it should be mentioned that the purpose now is not to return to the past in the form of superficial imitation. Rather, the aim is to understand the criteria of house design based on adaptive lifestyle, leading to low energy consuming methods of living which can be achieved from the study of vernacular construction and applied in contemporary housing. Therefore, we should investigate further whether contemporary architecture has the potential to design houses in accord with indigenous architectural guidelines. The overarching theme of sustainability can be determined from the viewpoint of social, economic, environmental, and technical sustainability. This research into urban area planning and the analysis of upgrading thermal interior and exterior study aims to create comfortable Afghan courtyard housing (Fig. 3) [1]-[5], [7], [9]-[11].

ACKNOWLEDGMENT

The authors would like to thank Mr. Sean McPherson, Assistant Professor, Department of Art, Bridgewater State University, U.S.A. supports this paper as editor on English writing assistance. We all thank his cooperation.

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