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Conception of open spaces- A Case of Delhi Courtyard Houses

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Abstract: *Concerns for the future of our environment, with regards to climate change, scarcity of resources, population growth, and globalization are growing, we need alternative solutions as to how can we reduce the negative impact of all the above on the planet while catering the needs of the mass. Only recently has there been debates if or not vernacular and traditional aspects of architecture can be the key to the required change. Courtyards and open spaces are one of the attributes of vernacular architecture that needs to be discussed in the above context. The importance of these spaces had already been proven for different climatic conditions. However, there is a need to justify this kind of open space typology in the lights of contemporary architecture of a metropolitan city like Delhi which is having a diverse urban fabric, a high rate of influx, and also cultural diversification. Given that the most common and relatable architectural typology is the dwelling, and it is subjected to a rapid transformation concerning its built as well as use. The following case takes into consideration the residential open spaces of Delhi through a comparative study of residential courtyard spaces of Delhi hence, the paper tries to form a conception of open spaces in the residential typology of Delhi post-independence and hence, tries to study the dwellings of the same time dating from the 1950s till date it also provides the reader an insight to the reasoning of flattening of built forms that have emerged in today's era, despite the heterogeneity of people and what are the possible solutions to this through the understanding of courtyard spaces and use its functional benefits like comfort and a sense of belongingness.*

Keywords*: Residential, Vernacular, Courtyards, Open spaces, Urban setting, Conception of spaces*

I. Introduction

The research started as an attempt to understand whether or not open spaces are required in today's urban plan and if yes how the conception of these open spaces manifests in spatial expressions that are peculiar to a piece of the urban fabric. Despite of numerous external factors the entire spatial conception of a region responds to its culture, social character and urban system. Some architects are able to correspond to these peculiarities while some fail to. The paper tries to study these peculiarities in spatial organization and spatial character of courtyards in Delhi through its contemporary residences and hence would try to provide recommendations that could be used in constructing residences of the same nature.

The aim of the study is to prove the relevance of courtyard form in today's residential architecture and hence study and analyse its characteristics to provide recommendations for today's built.

II. Material And Methods

The purpose of the study is to identify, analyse and understand the evolution of courtyard spaces and their adaptability in contemporary times based on tangible and intangible elements taking Delhi as the primary area of study.

2.1 Study Location: Residential building within the territorial boundary of Delhi
2.2 Study Duration: February 2020 to June 2020.

2.3 Subjects & selection method:
8 Residential buildings were chosen in order to understand the conception of courtyard spaces with respect to todays urban fabric of Delhi.

2.4 Inclusion criteria:

1. The paper will analyze buildings which are already constructed and are within the geological limits of Delhi.
2. The buildings considered for case studies are post- independence (1950- 2020) and are of same nature in terms of area, context and user for a better comparative analysis.
3. All the drawings will be collected from secondary sources and no on-site documentation will be done.
4. Detailed analysis of considered case studies will be done on the basis of derived parameters from the following literature study.

2.5 Exclusion criteria:

1. Only 8 case studies were done as for the lack of time and sources.
2. Out of eight – 4 case studies were the modern case studies dating between 1950s to 2000s. and rest were from 2000s till date.

2.6 Procedure methodology

STEP 1: A literature review

The dissertation was initiated as a consequence of thorough readings based on the topic of residential open spaces. Literature in the form of dissertations was sourced from the net. Even, though studies similar to the one presented in this literature have already been taken place in different forms, still this dissertation is unique. The dissertation focuses strictly on post-independence contemporary courtyard dwellings of Delhi and their evolution through time.

STEP 2: Selection of study area

Due to lack of time and sources site was chosen such that most of the data can be secured through secondary sources. Also, if the needed site should be accessible. For the same reasons Delhi was chosen as it is politically and culturally quite diverse and also was near to the author's college.

STEP 3: Selection of sample and sample size

To undertake information from secondary sources due to shortage of time dwellings with similar physical characteristics were taken. The case studies were taken such that their areas are almost the same, users are the same, all belong to dense fabric of the city distributed at a different part of the cities. Minimum 4 case studies were allowed so considering that 4 modern and 4 post-independence dwellings were chosen.

STEP 4: Analysis and Inferences

There are many studies related to dwellings already been done so identifying the gap and providing some new results was necessary for that typically new construction was taken and analysed based on its tangible and intangible elements including site, plan, form, material, user, context and enclosures. All these parameters will be explained and then will be used

2.7 Relevance of Study

Courtyards spaces have been present through ages, its form and attributes got modified although its basic function remained the same. These spaces are particular to specific climate, location, and user, and with the degrading climate, the urge to re-think and redo these spaces have emerged. There have been a lot of studies on courtyards but those concerning dwellings of a composite climate in a metropolitan city like Delhi have not been done. Also, there is a need to study the conceptual attributes of spaces along with climate is very necessary for the holistic development of this kind of architecture. These facts suggest the relevance of the study.[1].

2.8 Problem statement

Unbuilt spaces are an important part of built spaces and vice-versa. Both go hand- in-hand but often these unbuilt spaces are neglected and treated as leftover spaces. Today with increasing population and decreasing land area we tend to build maximum livable space but we confuse these livable spaces strictly with built spaces which

had resulted in monotonous flat architecture with almost no cultural identity. The attributes and function of open spaces need to be utilized to its full potential. Also, there is no particular visible language in today's construction of Delhi and buildings are a mere repetition of each other with not so improvise western notion. This has two major impacts- first is the degrading lifestyle of the user and the second is climate degradation on a larger level. Everyone is talking about sustainable design, green design contemporary design but very few are fully aware of whats going on and hence they fail to correspond to the context and climate. There's solely a fraction of architects, designers talking about sensible, community-driven architecture that may bring a change in this kind of practice of architecture.

With the passage of your time, attributes of culture, people, situation, society, necessities have modified, therefore there is a need to understand this trend and correspond to it. Building while not considering the past evidence is not a solution we have to reasonably study past evidence and work on their possible adaptation.

2.9 Background

A courtyard can be defined as an open space present within a building. It is a place within the premises where people are a part of its built as well as unbuilt nature by the means of his routine activities. Or in other words, it can be considered as an extension to several different activities that are performed. Every dwelling is an expression of its user's lifestyle, economic status, and social influence. Hence the dwelling is planned to satisfy all the needs of its user in terms of its spatial requirements. [2].

Traditional dwellings are an appropriate example of the above-stated text. They were not necessarily built by an architect but still, there every single part was given a thought. Each space was having multiple uses and users. This led to an efficient design. These buildings are a benchmark for today's architects as they are very closely knitted to the society as well as had a very good interaction within. They were planned such that that they were complete as an individual unit as well as can act as a collective unit when required. The spaces were flexible.

Courtyards were one of the most prominent features of these kinds of dwellings. Numerous scholars have already proven that these spaces are very important for the overall comfort of residents. Research on these kinds of houses has proved their efficiency in terms of contextual response, climatic needs, and spatial requirements of people. Urbanization has caused a decline in these kinds of individual residences with common open spaces. Over the years the transition is witnessed in design reflecting changing needs, cultural shifts, change in-laws, and expectations of people. The actual meaning of courtyard spaces is lost in today's construction. Therefore, the study tries to understand and analyse the significance of the courtyard form in the contemporary area and its possible modern adaptation.

The courtyard function depends upon its location, size, scale, proportion, and user. So, all these parameters must be studied along with its physical features to define certain parameters on which courtyards can be designed today.

2.10 Focus of study

The study aims at understanding Delhi's residential open spaces through its adjacent built form. An in-depth study of spaces at a micro and macro level was performed by analyzing project drawings obtained through secondary sources. This analysis was performed to ascertain suitable correlations and overlaps between the case studies to the identified parameters conducive to activity and usage patterns.

In Delhi, there had always been a two-way relation between "individual and city". From colonized dwellings to DDA plotting to today's experimenting contemporary dwellings there is a major influence of the country's urban vernacular on the type of construction happening. Another significant aspect of the architecture of Delhi has been the high rate of inflow of foreign cultures and technologies coupled with migrations and increasing population. So, to understand Delhi architecture, the study of the time of the built with the user's economic and social background is very crucial.

This study focuses on residential dwellings since they posses the following characteristics:

- The typology of the building that influences the psychology of a man most is a dwelling.
- Delhi has a diverse nature of houses.
- Delhi is a highly dense city with a large influx of people coming and leaving the city.

Considering today's environmental issues there is an urgent need to reframe the basics of architecture that we follow and what better it could be than taking lessons from the traditional vernacular of the city.

The 8 selected case studies are, divided within the period ranging from the 1950s to the 21st century. The starting 4 did not involve architects while the latter was designed by eminent architects with sensitivity to the user regarding formal and informal interactions coupled with climatic and social aids.

As discussed, the dwellings in Delhi, for this study have the following characteristics in common-

A. Open spaces

It had been made sure that all the dwellings have one or more open spaces in the plan, although it can vary from verandas, atrium, courtyard, gardens, and patios. The case studies taken have tried to secure some green areas to be in harmony with nature. Some have been lived up to the basic requirements of the user in terms of character it should have imparted some have not. The study would try to quantify these characters and draw some inferences.

B. Multifamily usage

All the dwellings chosen are catering to multiple families at a time. In the following cases, they all are different generations of the same family. This provided flexibility in design to incorporate common spaces for interaction at the micro-level and insertion of open spaces in it.

C. High-density low rise community

With the low viability of land giving open spaces is a bigger challenge in comparison to low-density societies so all the dwellings are a part of the dense fabric of the city with maximum utilization of land available. This allowed for more innovative design strategies.

2.11 Parameters of analysis

For a detailed analysis of the response of courtyard spaces concerning the neighboring built edge in the 8 selected case studies, there needs to be common parameters on which they can be analyzed for which the background study has been completed in the previous literature.

2.11.1 Tangible elements

Tangible elements are directly affecting the physical characteristics of the space including climatic comfort, accessibility, circulation and effective transition from one place to another

- Site area
- Built area
- Figure-ground
- Architectural elements
- Climate
- Air movement
- Scale and proportion-The scale of an open space affect the perception of the user as to how he perceives the building element and space relative to other forms in its vicinity. Scale and proportion define the characteristics of any space through its size. While the scale relates to the user, the proportion relates to the position and surroundings of any object.
- Degree of the enclosure-The degree of enclosure of space is a measure of its volume that is experienced by the user. Be it small or large it harvests feelings and reactions of human beings. It creates a feeling of intimacy, cohesiveness, protection, and security.
- Degree of permeability- In response to any space degree of visual and physical interaction is known as the degree of permeability.
- Spatial organization/hierarchy- The arrangement of various elements in respect with one another in a given plane is Spatial Organization
- Constructional element- This includes doors, windows, etc.
- Aesthetics- The aesthetics of space are shaped by many factors, such as color, light and shadows, and material expression
- Function
- Vegetation- Amount and type of green spaces and plants present and their purpose or effect.

Facade/shading devices- Type and use of different devices and their effect on the space.

2.11.2 Intangible elements

Intangible elements include psychological and visual attributes that affect how the user perceives certain space

- Cultural implications
- Social implications- How society influences space.
- Contextual response- How every space responds to its context in the form of form, space, quality, etc.

· Safety- it is important that the space is safe despite its openness and also there is a sense of individuality and visual pleasure as the user accommodates the place.
· Visual treat
· Psychological and perceptual effect

2.12 Comparative analysis

The 8 selected case studies are divided majorly into 2 categories the first one is the non-architect built post-independence dwellings which showcase the condition and understanding of open spaces just after colonial rule and economic slowdown of 1990. The other part is modern dwellings built by eminent architects through the surroundings and users are the same for all.

- Agarwals Residence- 1957
- Sunil Batras Residence- 1968
- Joshis Residence- 1993
- A multiple floor Residence- 2008
- House B123- 2014
- Brick veil- 2015
- Cleft house- 2016
- 1/18 house- 2017

2.12.1 Reason for Selection

1950s- 2000s

Agarwal's Residence- 1957

This is a residence built in the very next decade of independence. This house form shows the effect of migration in the city through its architecture. It has the minimum aesthetics and displays the need for quick and efficient house form which fulfils the basic requirements of a house then.

Sunil Batra's Residence- 1968

This residence was built in the 60s when the situation was comparatively stable so this house displays the comparatively modern technique along with side offsets in addition to front offsets and rear offsets that were there before.

Joshi's Residence- 1993

This is a house built at the time when the economic slowdown struck India. So this house portrays how can with minimum ornamentation and available means open spaces can be designed in the dense fabric of the city

A multiple floor Residence- 2008

This was chosen as it portrays a typical multi-storey building that was being built at that time with no modern intervention and much thought given to nature and built strictly according to bye-laws.

The 2000s- till now

House B123- 2014

This house was chosen as these houses have tried to adapt the courtyard and its attributes in a contemporary manner in the form of atrium terrace gardens and central open space covered with a glass roof.

Brick veil- 2015

This house displays another aspect of courtyard house that were social interaction. This house doesn't certainly a central common space but has a buffer courtyard space between road traffic and built. Providing another aspect of residential open spaces.

Cleft house- 2016

This was chosen as it portrays a very modern approach towards central social space with modern technologies and materials. This case introduces a new prototype of a courtyard house sandwiched in a densely packed urban fabric.

1/18 house- 2017

This project displays how a normal design can also incorporate a courtyard space in the same planning. The highlight of this project is how different aspects of courtyard spaces like spatial planning, openings, proportions, etc were tried to be explored.

Design Variants of the courtyard				
Attributes	Agarwal's House	Batra's House	Joshi's House	Multiple House
Form	rectangular	rectangular	rectangular	rectangular
Shape	U shape	L shape	L shape	L shape
Area				
No. of Floors	3	3	3	5
Orientation	SW-NE	SW-NE	SW-NE	SW-NE
Shading Device	overhead	overhead	overhead	Overhead
Water	no	no	no	no
Vegetation	no	no	no	no
Aspect Ratio	nil	nil	nil	nil
Function	Garden- no Lighting- yes Ventilation- yes Playground- no Interaction- no	Garden- no Lighting- yes Ventilation- yes Playground- no Interaction- no	Garden- no Lighting- yes Ventilation- yes Playground- no Interaction- no	Garden- no Lighting- yes Ventilation- yes Playground- no Interaction- no

Figure 1. Design Variants of Courtyard

Design Variants of the courtyard				
Attributes	B123 House	Brick Veil House	Cleft House	1/18 House
Form	rectangular	others	others	rectangular
Shape	U shape	L shape	I shape	U shape
Area	600 SQ ft.	645 SQ ft.	600 SQ ft.	170.5 SQ ft.
No. of Floors	4	5	5	3
Orientation	SW-NE	SW-NE	SW-NE	N-S
Shading Device	roof	overhead	roof	Overhead
Water	no	no	no	no
Vegetation	no	yes	no	no
Aspect Ratio	0.375	0.258	0.240	0.189
Function	Garden- no Lighting- yes Ventilation- yes Playground- no Interaction- yes	Garden- yes Lighting- yes Ventilation- yes Playground- yes Interaction- no	Garden- no Lighting- yes Ventilation- yes Playground- no Interaction- yes	Garden- no Lighting- yes Ventilation- yes Playground- no Interaction- no

Figure 2. Design Variants of courtyard

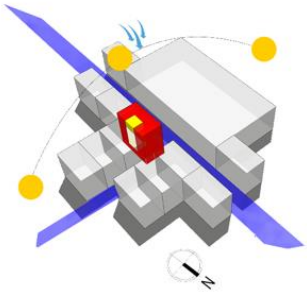
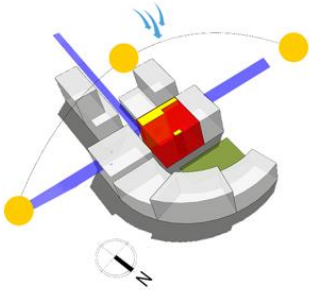
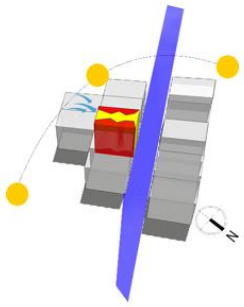
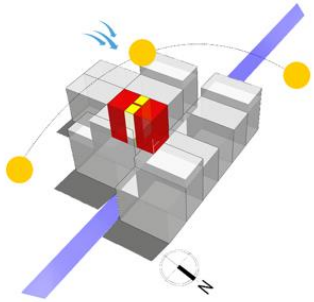
ATTRIBUTE	B123 House	Brick Veil House
Siting		
	Cleft House	1/18 House
		

Figure 3. Site Study

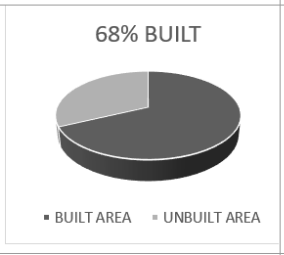
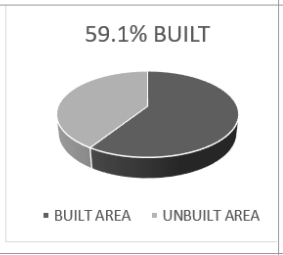
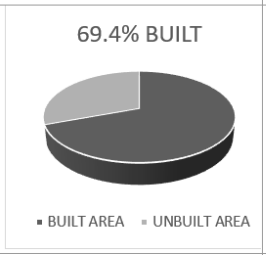
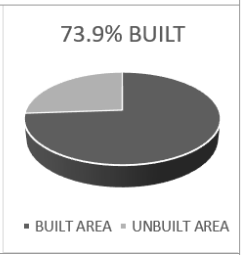
CASE STUDY	AGARWAL'S 1957	BATRA'S 1968	JOSHI'S 1993	MULTIPLE 2008
SITE AREA	1377 SQ FT.	2840 SQ FT.	1054 SQ FT.	1937.5 SQ FT.
GROUND COVERAGE	936.36 SQ FT	1675.5 SQ FT.	731 SQ FT.	1431.6 SQ FT.
UNBUILT AREA	440.64 SQ FT.	1164.5 SQ FT.	505.9 SQ FT.	505.9 SQ FT.
% UNBUILT AREA				
RATIO B/W UNBUILT AND BUILT	1:2.1	1:1.4	1:2.2	1:2.8

Figure 4. Site Analysis

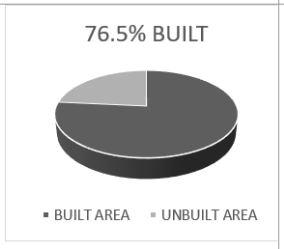
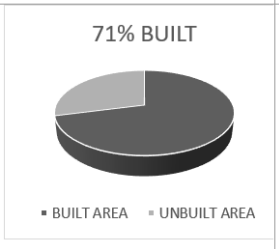
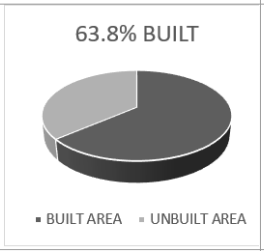
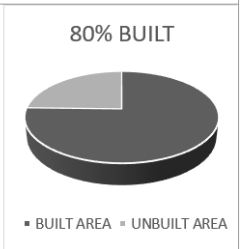
CASE STUDY	HOUSE B123-2014	BRICK VEIL HOUSE-2015	CLEFT HOUSE-2016	1/18- 2017
SITE AREA	8353 SQ FT.	10000 SQ FT.	3512 SQ FT.	6900 SQ FT.
GROUND COVERAGE	6387.8 SQ FT	7116.2 SQ FT.	2241.5 SQ FT.	5541.9 SQ FT.
UNBUILT AREA	1965.2 SQ FT.	2883.8 SQ FT.	1270.5 SQ FT.	1358.1 SQ FT.
% UNBUILT AREA				
RATIO B/W UNBUILT AND BUILT	1:2.1	1:2.46	1:1.7	1:4

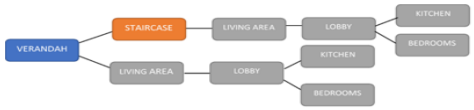
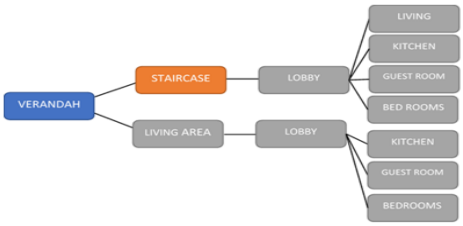
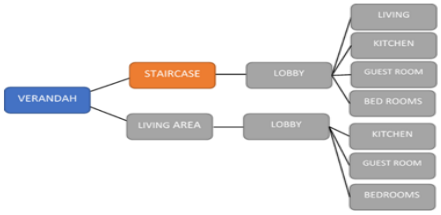
Figure 5. Site Analysis

SPACE	SPECIAL CONFIGURATION	AGARWAL'S 1957	BATRA'S 1968	JOSHI'S 1993	MULTIPLE 2008
	USES OF COURT	Offsets, used for Balcony openings	Offsets, used for Balcony openings	Offsets, used for Balcony openings	Offsets, used for Balcony openings
SPATIAL ELEMENTS	THRESHOLD	Level difference, material change	Level difference, material change	Level difference, material change	Level difference, material change
	VOLUME	open to sky,			
CONSTRUCTIONAL ELEMENTS	STAIRCASE	Internal, not opening to open space	Internal, not opening to open space	Internal, not opening to open space	Internal, not opening to open space
	ROOF	open	open	open	open
	DOORS AND WINDOWS	wooden	wooden	wooden	wooden
	WALL	Brick wall	**Brick wall**	**Brick wall**	**Brick wall**
EXPRESSION	FAÇADE DESIGN	Plaster finish	Plaster finish	Plaster finish	Plaster finish

Figure 6. Spatial Analysis

SPACE	SPECIAL CONFIGURATION	HOUSE B123-2014	BRICK VEIL HOUSE- 2015	CLEFT HOUSE-2016	1/18- 2017
	USES OF COURT	Offsets, used for Balcony openings	Offsets, used for Balcony openings	Offsets, used for Balcony openings	Offsets, used for Balcony openings
SPATIAL ELEMENTS	THRESHOLD	material change	Level difference, material change	material change	Level difference, material change
	VOLUME	4 storeys high	4 storeys high	4 storeys high	4 storeys high
CONSTRUCTIONAL ELEMENTS	STAIRCASE	Internal, opening to open space	Internal, not opening to open space	Internal, spiral staircase opening to open space	Internal, not opening to open space
	ROOF	glass	Open to sky	Glass	Open to sky
	DOORS AND WINDOWS	Glass doors and sliding windows	Openings on outer skin and wooden doors and windows	Glass doors and sliding windows	All the sides are open
	WALL	Glass walls on one side and brick wall on other	Brick walls	Glass and balconies on all sides	1 side, open from all the other
EXPRESSION	FAÇADE DESIGN				

Figure 7. Spatial Analysis

ATTRIBUTE	Agarwal's House	Batra's House
Spatial Organisation		
	Joshi's House	Multiple House
		

SPACE	SPECIAL CONFIGURATION	HOUSE B123-2014	BRICK VEIL HOUSE- 2015	CLEFT HOUSE-2016	1/18- 2017
	USES OF COURT	Offsets, used for Balcony openings	Offsets, used for Balcony openings	Offsets, used for Balcony openings	Offsets, used for Balcony openings
SPATIAL ELEMENTS	THRESHOLD	material change	Level difference, material change	material change	Level difference, material change
	VOLUME	4 storeys high	4 storeys high	4 storeys high	4 storeys high
CONSTRUCTIONAL ELEMENTS	STAIRCASE	Internal, opening to open space	Internal, not opening to open space	Internal, spiral staircase opening to open space	Internal, not opening to open space
	ROOF	glass	Open to sky	Glass	Open to sky
	DOORS AND WINDOWS	Glass doors and sliding windows	Openings on outer skin and wooden doors and windows	Glass doors and sliding windows	All the sides are open
	WALL	Glass walls on one side and brick wall on other	Brick walls	Glass and balconies on all sides	1 side, open from all the other
EXPRESSION	FAÇADE DESIGN				

Figure 8. Spatial Analysis

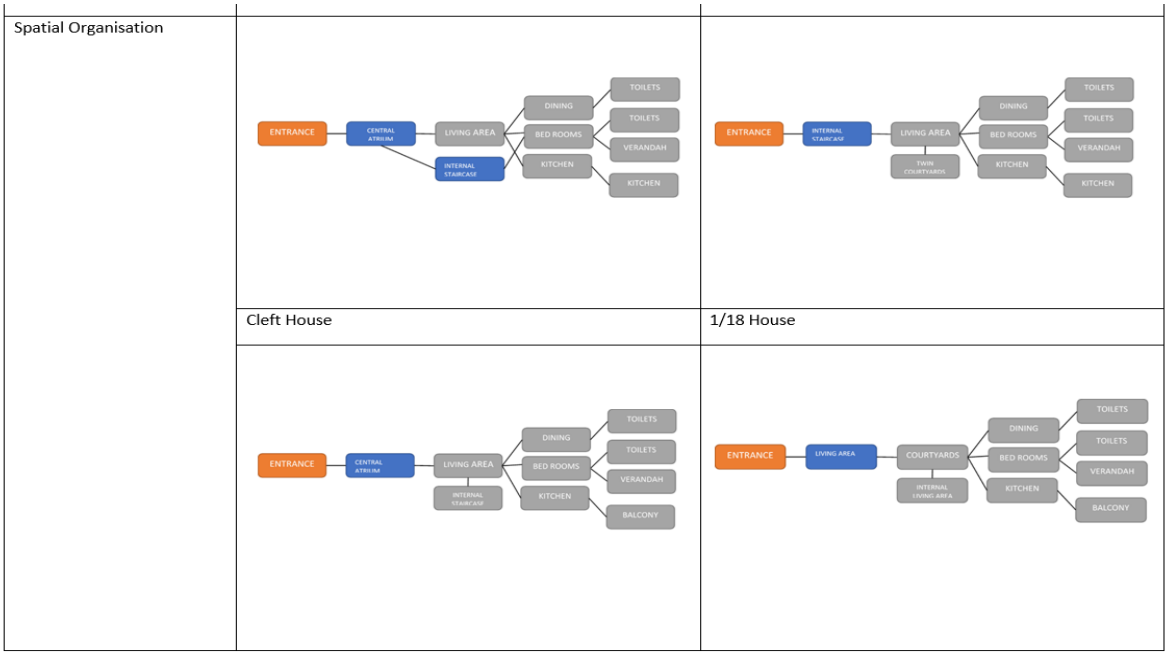


Figure 9. Spatial Organisation

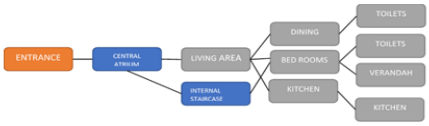
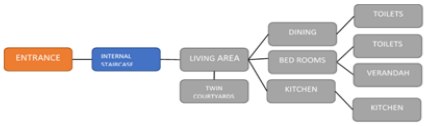
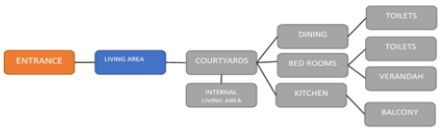
ATTRIBUTE	B123 House	Brick Veil House
Spatial Organisation		
	Cleft House	1/18 House
		

Figure 10. Spatial Organisation

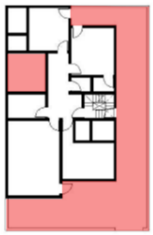
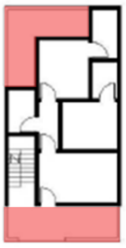
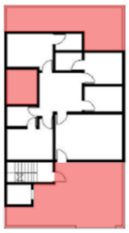
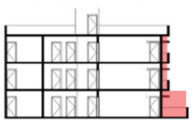
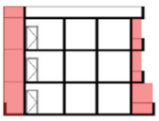
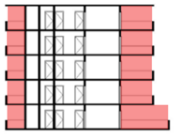
ATTRIBUTE	Agarwal's House	Batra's House	Joshi's House	Multiple House
BUILT EDGE				
VARIATION IN PROPORTION AND SCALE				

Figure 10. Built Edge

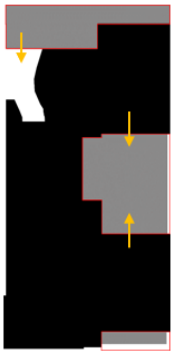
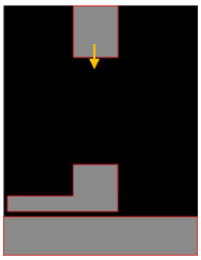
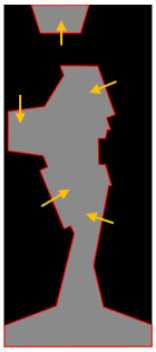
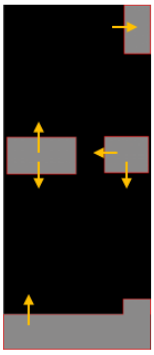
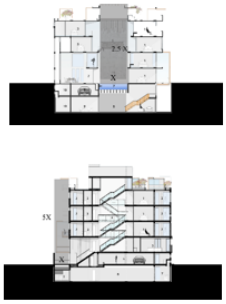
ATTRIBUTE	B 123 House	Brick Veil House	Cleft House	1/18 House
BUILT EDGE				
VARIATION IN PROPORTION AND SCALE				

Figure 11. Built Edge

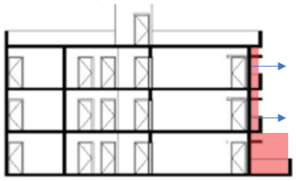
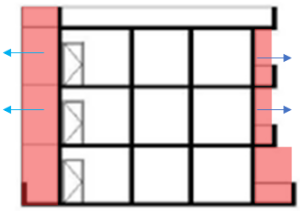
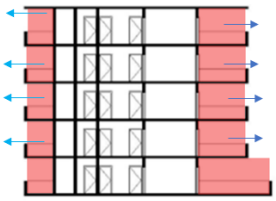
VISUAL CONNECTIVITY		
	 Agarwal's House	 Batra's House
	 Joshi's House	 Multiple

Figure 12.Visual Connectivity, Devloped by author using published drawings

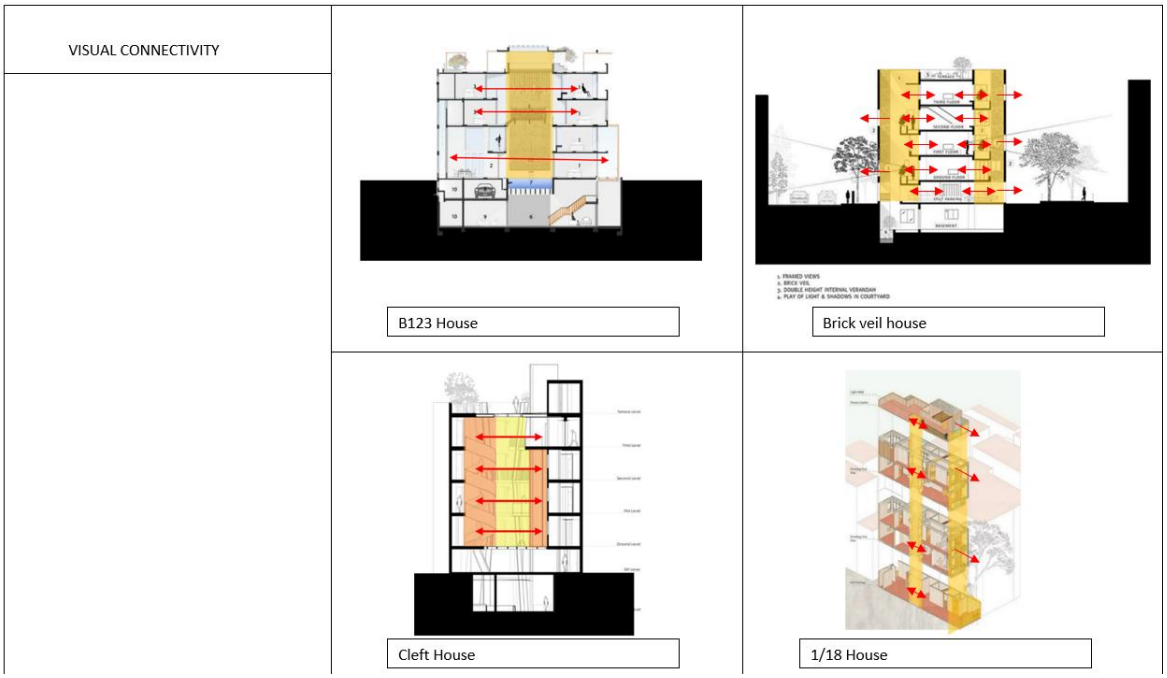


Figure 13. Visual Connectivity, Developed by author using published drawings

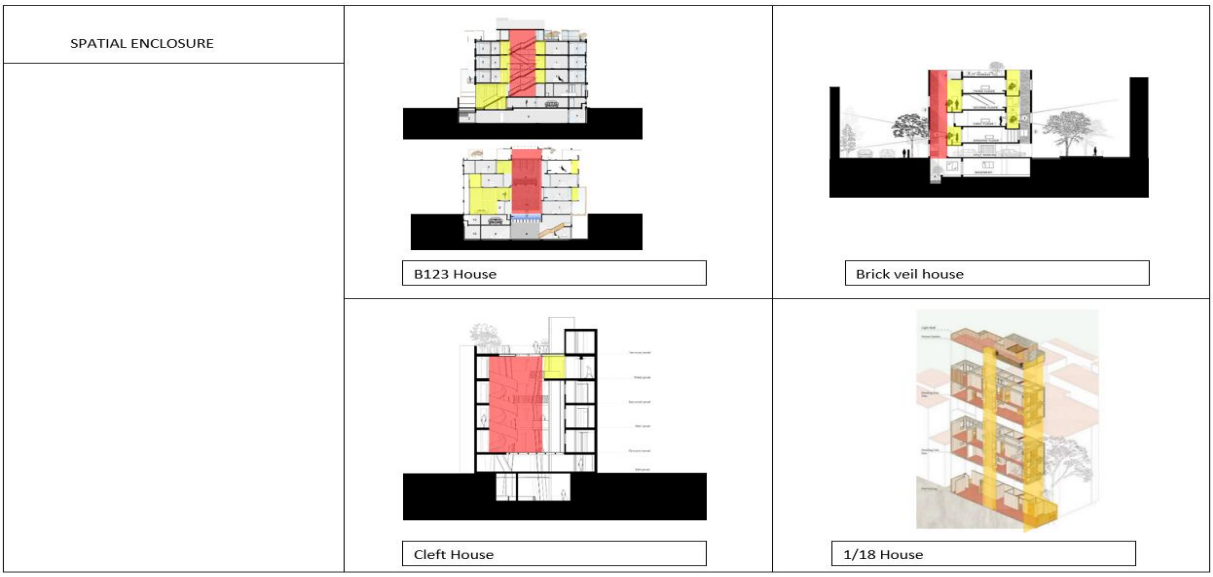


Figure 14. Spatial Enclosure, Developed by author using published drawings

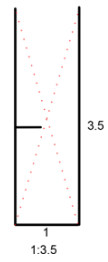
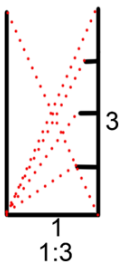
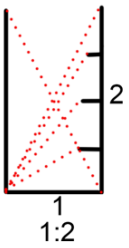
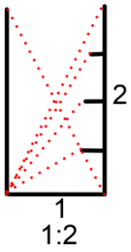
ATTRIBUTE	B123 House	Brick Veil House
Scale and Proportion		
	Cleft House	1/18 House
		

Figure 15 . Scale and Proportion

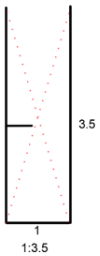
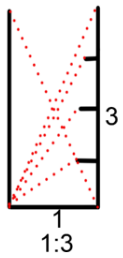
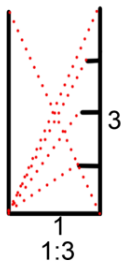
ATTRIBUTE	Agarwal's House	Batra's House
Scale and Proportion		
	Joshi's House	Multiple House
		

Figure 16. Scale and proportion

III. Result

This study has intended to understand the relevance of courtyard spaces in today residential architecture and its conception in terms of its spatial arrangement and character in response to the climate factors majorly sun and wind, social characters in terms of porosity and visual connection, and physical and perceptual attributes in terms of the spatial enclosure, scale, and proportion, built edges, etc.

The study reflects that the idea of courtyard space has been highly influenced by various factors. The changing trends, culture, and needs are major of them. The result is a lack of uniqueness and character. Spaces are either lacking sense of enclosure or are not able to fulfill the desired function and hence are rendered leftover and deserted.

All the 4 modern examples taken are avant-garde solutions to if not all then to the major problems of today's' architecture. But the same could not be said about the DDA plots as they were made by the commons without the involvement of architects. Also, at that time building bye-laws were under construction, and the country was facing several economic slowdowns in the 1960s as well as during the 1990's so not much of technological advancement in this category was witnessed. The only open spaces they could afford were incidental open spaces- offsets. Their design lays maximum focus on maximizing built usable space.

On the contrary, if we talk about modern projects there are still traces of modern adaptation of courtyard spaces in terms of shape, material, character, enclosure, and flexibility. It was observed that open spaces in each of the cases were designed in a roughly similar manner, with planned open spaces placed in almost center of the site, for maximum spill-over possible, transitional buffers placed around them, and incidental open spaces on the outermost side, along the site boundaries.

Sitting.

In response to the site, most of the buildings are oriented in north-south direction or the long edge along east-west direction for minimum heat gain. Also as the wind direction is predominantly from SW-NE direction so to take in maximum air this configuration is proposed.

Also, the size of the openings is kept min. ranging around 15-20%. Most of the interaction is internal as planning is introvert in nature as seen in the cleft house, brick veil house, and B123 house, and interaction with the outside is kept minimum due to noises and traffic.

Spatial arrangement

The common spaces in each of the case are centralized although its shape is not necessarily rectangular or square as is the case of Cleft House also in each project the function is same that is serving as a common living area for the house where everyone comes together, also these spaces are flexible and act as

Figure 19. Siting, Author

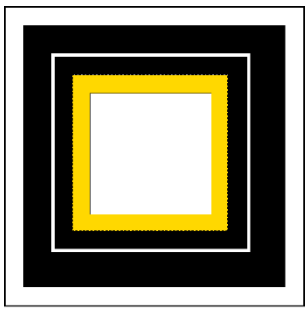


Figure 18. Built Unbuilt, Author

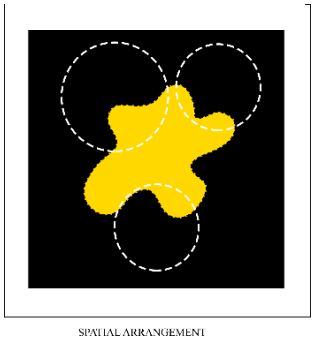


Figure 17. Spatial Arrangement, Author

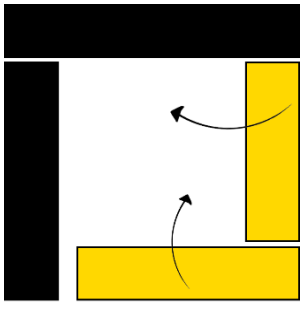


Figure 20. Enclosure,

a spillover for kitchen, dining, entrance and such spaces. If we talk about the distribution of rooms among different floors then generally each floor was dedicated to one generation of the family with rooms, toilet, living, terrace, and central open space to ensure privacy, also Individual places were just given optimum areas and more focus was on expanding common areas.

Courtyard spaces were designed such as to invite public interactions. With space opening to adjacent spaces from at least 2 sides. Also, space is connected to all floors through stairwells.

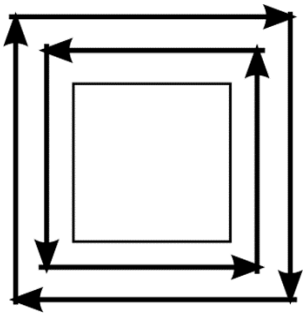


Figure 22. Circulation, Author

Spatial Characteristics

*The **enclosure*** is one of the main attributes that determine the utility of a space and also determines the comfort of the user. It should not be too rigid nor too loose. Just the right amount of flexibility is needed which can be created through alleys, transition spaces, and other connecting spaces around the courtyard. The enclosure is created by roofs and walls like glass skylight in case of Cleft House and B123 House or can be open like Brick Veil House and 1/18 House in these cases enclosure is created by secondary elements like chajjas, projections, balconies, etc.

Figure 21. Scale and Proportion, Author

also make an important attribute of making any space. It affects the physical as well as visual nature of any space and also provides comfort to the user. Proportion is the actual ratio between the dimension of a courtyard. The scale, on the other hand, is the relation with the user (Ching, 2007). The case studies display that residential buildings are more for the user then any other that's why the scale was a major consideration while making courtyards. The proportions should be 1:2 to 1:2.5 according to climate and also as suggested by GLC study (1978) but as can be seen the proportion was 1:3-1:3.5 on the outside and 1:3 almost on the interiors but the secondary elements like chajjas, plants, balconies make the proportion 1:1-1:2 in many places making it more visually and psychologically pleasing.

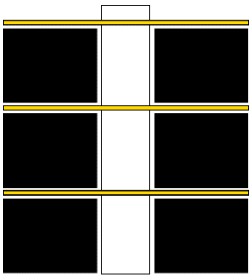


Figure 23. Visual Connection, Author

Material and construction techniques

The material and technology used in the above case studies suggest that the structural system and materials also play a functional role in making the building home. In terms of material, there have been wood, marble, granite, precast concrete panels, reclaimed wood planks, aluminum, stained-glass, terrazzo floors, and brick. This was done to match the needs and tastes of the user. The material palette provides just the right character to space. The basic thought is to reduce heat gain and reflect the sound to provide a better comfort inside.

These variations and similarities show that the conception of open spaces of Delhi is an amalgamation of various spatial concepts.

With the increasing migration rate and influx rate, the spatial characteristics of houses are not similar showing heterogeneity in planning and user type. However, the general arrangement is the same while the physical characteristics show

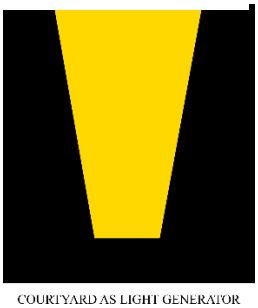


Figure 24. Courtyard as light generator, Author

some variation but nature is appropriate to provide user comfort in the modern world which is required and was provided by traditional courtyards in ancient times. The modified attributes would further help in designing a residence that is by courtyard typology and is well aware of the current changes for surviving the future.

IV. Discussion

1. Layout- building should be oriented N-S (longer axis east- west) to reduce solar radiations incident on the wall surface.
2. Position of openings- In north and south walls if walls are available if not whichever wall is available with buffer spaces to guard it. Internal openings towards courtyards.
3. Size of openings- 15%- 20%
4. Spatial arrangement- Centre of the plan so that most of the rooms can spill over.
5. Offsets- with today's bye laws it is very important to leave the offsets So, they should be used as an access to the outside society. As can be observed the dwellings were either totally introvert or totally extrovert.
6. Circulation- The circulation can be done using buffer areas, transitional spaces, passages, and even built form but it should surround the central courtyard or the courtyard should be pivot around which activities happen so that maximum use of courtyard is possible and also maximum light extracted from light well can be circulated to the rooms.
7. Degree of enclosure- Degree of enclosure of an open space is characterized by the built forms in its vicinity, and their usage is determined by user needs, and not assigned formal functions. Hence, pockets of open space must be configured one at the centre and other around the building such that they can be adopted and adapted by the end user at their own discretion.
8. Proportions- Ratio should be in accordance to the user, as can be seen a proper 1:1 courtyard is not possible for such dense population so 1:2 to 1:3 courtyards are good enough to cut direct sun light and provide proper ventilation.
9. Shape- rectangular shape followed by u shape and l shape
10. Covering- fully covered or semi- covered
11. Area of courtyard- 15%- 20%
12. Orientation of courtyard- longer axis of courtyard in NS direction.
13. Usability-courtyards are in preliminary stage and are not acting as micro climate modifier due to absence of vegetation and water body
14. Materials- in today's time atrium have proved to be highly productive and taken over courtyards due to its characteristic qualities like transparency, natural light, control over openings, ability to accommodate new technologies.
15. Landscaping- the external open spaces should have green cover for better environment effects. Swimming pools and internal gardens can be placed in the basement or at the terrace
16. Nature- the courtyard today can be an atrium or even be divided into 2 parts one which is open and other which is covered at the top. It allows more spillover of functions

V. Conclusion

The previous literature had proven that the courtyard form remains an appropriate built form even in today's densely packed society of metropolis like Delhi. However, the reproduction of traditional models has failed to impress the clients. So, we need to stop idealizing the past by merely replicating the courtyard spaces and try to conceptualize the character of the courtyard space and then use it, as was portrayed by the above-taken case studies. However, even the above considered 8 case studies have shown certain limitations in regards to a proper built open relationship in a residential building that has been tried to be compared and analysed in the text proceeding the case studies. The inferences lead us to the formation of certain recommendations as to what should be the spatial characters of the courtyard spaces for a residential building located in a highly dense medium height locality with

site area nearly 10000 SQ ft. and more than 2 generation users in the family.Also, the inferences show that Delhi's heterogeneous nature is visible even in the dwellings, in the form of materials chosen for the facade, the level of privacy through the floors, but what ties them together is the true vernacular context of the city. That is the response to climate, user and society. Each project has responded to these traits almost identically and this is the main achievement of the paper. As the paper concludes it can be said that-Courtyard typology can be modified in terms of material used, proportions, form, instead of using symmetrical and closed form,The courtyards could be asymmetrical, with interactive walls and facades, enclosure can also be manipulated using primary and secondary elements like trees, projections and openings**.** (Mishra S, 2016, understanding the change in courtyards) but the essence of traditional courtyard that is its, spatial arrangement, function, and flexibility should remain the same as they were traditionally.

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[1]. Gulati, R. (2019). Neighborhood spaces in residential environments: Lessons for contemporary Indian context. In *Frontiers of Architectural Research*. https://doi.org/10.1016/j.foar.2019.10.002

[2]. Gangwar, G. (2016). Environmental, Behavioural and Aesthetic aspects of Courtyard Design: Literature Review. *Imperial Journal of Interdisciplinary Research*, *9*, 1712–1716. http://www.imperialjournals.com/index.php/IJIR/article/view/2159