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HARMONISING HOMEOWNERS' ASPIRATIONS FOR LOW-CARBON HOUSING: A CONTEXTUAL STUDY OF MYSORE, INDIA

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ABSTRACT

Mysore, a South Indian city, used to be recognised as having socially cohesive, inclusive housing typologies. Post-colonial development fuelled by economic globalisation has transformed perceptions of the house among the growing middle class, with the home becoming a commodity to demonstrate affluence and status. This research focuses on one aspect of housing - boundary condition. Alternative 3D models are generated to reflect the sustainable agenda and varied preferences of homeowners that are analysed by the environmental design method. Integrated Environmental Solutions (IES) has been adopted to identify the carbon footprint of different alternatives, which are triangulated by the environmental psychology methodology adopted during the fieldwork.

INTRODUCTION

It is important to understand housing as a social and cultural phenomenon that can allow insights in the effective formulation of localised and relevant low carbon housing strategies. Although strategies such as converge and contract (Mayer 2004) seek to accommodate developing countries' valid aspirations to achieve higher levels of prosperity, there is still an imperative to reduce carbon emissions within India. Whilst a low carbon society for developed nations can be defined as "inventing low carbon technology and reducing carbon dioxide emission by the middle of 20th century" (Skea and Nishioka 2008); for developing nations, achievement of low carbon communities must go hand in hand with achieving wider development goals. Further, while acknowledging the role of technology, emphasis has to be given to the importance of lifestyle and social change (Skea and Nishioka 2008). The complex and multifaceted society of India is interwoven with caste, religion and regional disparities, where newfound economic status and affluence in middle class segments has a critical impact in the process of sustainable development.

It is important to understand the social and cultural values of the society while examining sustainable housing strategies. The Indian middle class was rooted in social and cultural values known for their simple and thrifty living. Now they have transformed themselves to spendthrift, demonstrative people with clear signs of transformed ideology and values (Varma 2007). Though there are more people below the poverty line in India compared to the middle class, it is the very few rich and affordability of the middle class, which is getting in the way of sustainable housing. Now, the Indian middle class is considered the largest consumer group in India, which is virtually shaping the development of India.

The middle class often consciously seeks to emulate the consumption practices associated with the upper or upper middle class, with individual families often overextending themselves financially in order to obtain particular commodities that are symbols of the culture of wealth demonstration (Imtiaz and Helmut 2001, Misra 1961). It can also be summed up as, middle class individuals engage in practices designed to acquire the aesthetic and cultural knowledge necessary to adapt to shifting consumption practices (Fernandes 2000, Fernandes 2006). It is the unthinking consumption of the middle classes along with the national agenda of development that puts sustainable development at risk.

The implications of a reconfigured middle class are evident in changes to housing typologies. While investigating the strategies for sustainable housing, the primary question to be addressed is whether middle class aspirations are detrimental to sustainable housing. In India, national development and in particular urban development do not reflect the urgency or concern for sustainable development and some of the good works by research institutes or individual architects have remained as standalone efforts and failed to influence wider audiences (Piyush 2001). Furthermore, the sustainable features evident in traditional housing typologies have been overlooked in the prevailing housing, wherein the innate sustainable qualities of the Jagali housing can be contrasted with contemporary housing typologies (Nijman 2006).

The expansion of new housing has been driven by economic growth, which benefitted from economic globalisation and liberalisation. Economic empowerment serves an educated, aspirational and increasingly affluent faction within the middle class who has acquisitive value systems where housing is as much a reflection of individual status and wealth.

The urban middle class are particularly important to this research as their aspirations have an impact on consumption, which affects the environment. The results from a previous research project (Satish and Brennan 2012) and first set of fieldwork has established the significance of a bottom-up approach and lead to the pivotal question of this research: whether middle class aspirations in housing are detrimental to sustainable development. This is examined by understanding the aspirations of the middle class people of Mysore, in South India and examined for its implication on sustainable housing elements. In Mysore, as throughout India, the built environment is polarised between well-maintained and protected housing interiors and poorly organised and maintained external spaces. This paper focuses on this space and examines how these transition spaces are used to reflect their values and concerns.

BOUNDARY CONDITION

A prevalent housing typology developed across India has viewed open space more as a setback between houses and the street rather than as a shared resource (CITB 1987, HUDCO 1987). These new typologies do not encourage desired social, cultural or economic activities as these open spaces do not sustain life by performing important utilitarian, socio-cultural and perceptual functions (Correa 1983, Kaza 2007, Kaza 2010, VSF 2012). This research is thus focused on these boundary conditions, which reflect the change in society that the virtuous link between building form, bioclimatic response and social structures in the household may be broken.

To further examine the different aspects involved at boundary condition, element analysis of different activities involved at transition space have been carried out. This process helps to clarify different issues involved and the varied preferences of the homeowners. The data collected during the element analysis are coded and analysed for their implication on the sustainable agenda (Satish 2013). A closer examination of the transition space reflects different aspects that play a crucial role at this level. The factors identified include climate responsive design, building materials, transition from street to threshold space and interiors, openings and social concerns like security, demonstration and interaction.

There are drastic alterations in the transition space, the way it is defined and used over a period of time. A quick reflection based on the initial research suggests that the factors identified in these typologies also reflect a sustainability agenda. Elements of the traditional Agrahara typology reflect sustainable features. For instance, the invisible boundary along with the Jagali transition space enhances community interaction and is socially sustainable. The effective use of Jagali space along with the use of climate response materials enables Agrahara typologies to use the least amount of embodied energy and maintenance energy. In the case of the contemporary typology, the defined boundary not only increases the embodied energy, it is unsustainable as the spaces between the buildings are not used effectively and the high wall in-between the houses is not supportive of neighbours' interaction. Based on the element analysis of both typologies, modification of these factors in the new typology and its implication on sustainable features, six major elements are identified to cover the issues related to boundary conditions. They are: volume, entrance, opening, security, interaction and skin.

METHODOLOGY: FIELDWORK

The main objective of achieving sustainable strategies within the existing middle class paradigm is achieved by contextualising the broad term of sustainability to Mysore condition on one hand and reflecting the acceptability of middle class homeowners' preferences and acceptability on the other. The models and the local sustainability agenda are derived based on the previous research and first set of fieldwork. The models prepared and simulations carried out reflect the local sustainability agenda and different levels of sustainability with specific reference to boundary condition. Further fieldwork looked at the aspirations of the middle class people and their willingness to align towards more sustainable features. The models were tested with homeowners by semi-structured interview and with key stakeholders in the design and procurement process. To analyse the issues reflected in transition spaces, elements representing middle class aspirations and the sustainability agenda were identified (Satish 2013, Satish and Brennan 2012). To elicit preferences and log the choices of people, architects and builders, a 'multi sorting task' methodology was followed (Groat 1982).

DESIGN MODELS

To investigate the sustainable practices and middle classes aspirations, four models are prepared. The concern is to explore and investigate people's perception about boundary condition, so the identified elements are altered based on the sustainable agenda and people's preferences to derive four models. Furthermore, other aspects – which also play a crucial role and influence simulation results other than the identified elements – are kept constant throughout this process. For instance, the number of occupants and dwelling units are the same in all the models. Even the volume is also worked out to be similar, so that the cooling load requirement is also kept constant.

The four models reflect different boundary conditions. At one extreme a traditional bioclimatic solution that reflects past models of communal living (figure 1) and at the other, a representative model of current private sector middle class housing was constructed (Figure 2). A further two models between these were designed primarily to get a finer understanding of the exact levels of privacy and social interaction that would be embraced by potential stakeholders. Drawing conclusions from the earlier research, one model aims to reflect the ambitions and desires of the homeowners as expressed during the first set of fieldwork (Figure 3). Another model is developed with emphasis on sustainable elements and catering to homeowners' expectations (Figure 4). These four models are clearly defined with spatial, visual and physical characteristics (Figure 9).

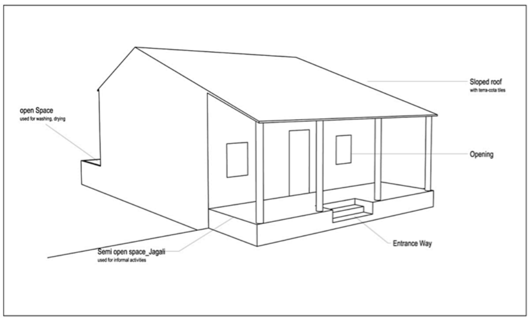

Figure 1 Model 1: Jagali typology

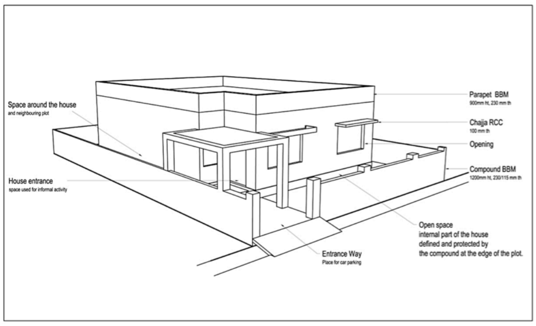

Figure 2 Model 3: Typical Plot Typology

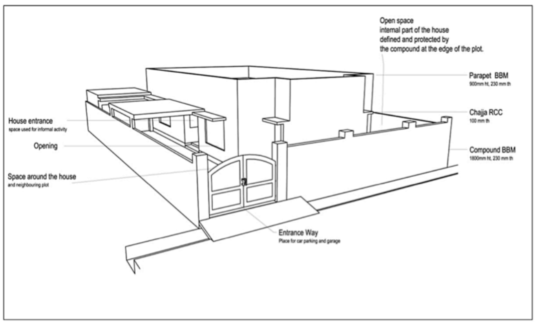

Figure 3 Model 4: Plot and high gate typology

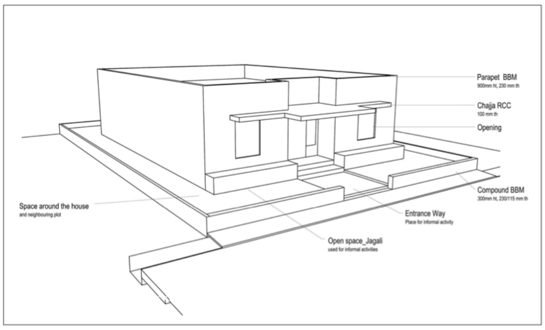

Figure 4 Model 2: Jagali + Plot Typology

These models are evaluated both qualitatively and quantitatively. Qualitatively, parameters like community interaction and cultural requirements, demonstration of wealth, and concern of security are elaborated. Quantitatively, parameters like, land footprint, embodied energy, carbon emission, opening size, climate responsive features, and source of material are analysed (Figure 9).

There are many other factors, which will impact the performance of the house and boundary condition. In this research, all other factors which could potentially alter the performance of these models other than the identified six elements are kept constant. Other effective strategies to reduce energy consumption and carbon emission, like double glazing or insulation or cavity walls to reduce the conduction heat gain are kept constant. The rationale is that some of these materials and construction methods could be adapted to any given models. For instance, cavity wall construction and double glazing will provide insulation and reduce the conduction heat gain and thus cooling load substantially. Furthermore, this could be applied to any of the four models developed, which could easily alter the sustainable strategies of any given model. As this research is not focused on interior spatial organisation and finishes or materiality of construction; construction materials and construction techniques, all these are kept constant. However, construction materials used for the front elevation have been identified as one element of the boundary condition; it is examined more as a skin than as a construction or structural material.

These four models are prepared for four typologies that include the most prevailing and well-established vernacular typologies. The first study and the literature review have been used in terms of perception, aspiration, attitude, values and aspects, which shape the social and cultural requirements along with input from key players such as architects, builders and government officials.

The models prepared reflect the prevailing typologies: which has an approximately 4-feet-high compound between neighbouring plots. The front and rear of the plots are built with a minimum setback of 1 metre or as required by the Mysore Urban

Development Authority regulations (model 2). Most of the aspiring ones (model 3) tend to have a very high gate that insulates them from the external world and there is extensive use of imported material and ostentatious finishes and large openings. The earlier Agrahara typologies (model 1) are representative of the early typologies with a raised platform in the front with small openings and use of locally available material, overlooking the street. Finally, based on the feedback from the first batch of fieldwork, a combination of climate responsive and aspirational typology (model 4) was developed.

COMPARATIVE ANALYSIS OF THE DESIGN MODELS

The qualitative outcome is triangulated with the quantitative performance of each model. The major tangible factors such as land footprint, embodied energy (Reddy and Jagadish 2003), carbon emission, and heat gain due to conduction based on size of the opening, source of material (Berge 2009), climate responsive design are compared among the four identified models (Figure 5).

The aim is to reduce carbon emissions and to investigate where one can make the greatest difference rather than targeting a particular figure or standard. In this sense, the models are rated as most or least sustainable models and hence the increment among the models is not critical but what is important is where they stand compared to other models. The rating of models from most to least sustainable is validated by testing them by simulating these models for their environmental performance before using them during the second set of fieldwork.

ENVIRONMENTAL SIMULATION FOR PERFORMANCE

The models were generated with a similar configuration in terms of built-up area, number of rooms, size of the plot and provision for minimum light and ventilation. To focus the research more on the boundary conditions, all other components such as constructional systems and spatial planning were kept as constants. Each option was then modelled first in Google SketchUp and then exported into environmental simulation package, Integrated Environmental Systems (IES), to predict energy consumption and carbon emissions. Longitude and latitude were specified for Mysore using hourly climate data from Bangalore, the nearest city to the study area.

These models were validated for their sustainable strategies by triangulating their performance before using them during the fieldwork. Integrated Environmental Systems was used to simulate these models and analyse the peak cooling plant load, total energy consumption and carbon emissions from each model. IES is a dynamic simulation software which allows one to model a building by inputting form, location, meteorology, materials and building services. The simulation engine then uses real weather data to simulate models over a year in 15 minute intervals to give a relatively accurate indication of comfort and energy use (IES 2010). Since the emphasis is on social sustainability and buildings are typical middle class homes, this research does not intend to measure or compare against a benchmark or absolute standards, rather it will investigate the performance of each model on a comparison basis. In this context, IES has been a very useful tool in analysing the building performance by defining the required parameters.

The results of the simulation for each of the four models are shown in Figure 10. with respect to conductive heat gain, cooling load, peak energy demand and carbon emissions for a representative day – May 19 – one of the hottest days chosen to analyse the heat gain and energy consumption due to cooling. The aim of this research is to access the implication of varied boundary conditions in terms of change in energy consumption and resultant carbon emissions.

For the simulation purpose, only these boundary conditions of different typologies are altered while providing an input in IES. For instance, the internal parameters like number of rooms, number of occupants, comfort conditions expected inside the house, minimum light and ventilation desired are kept constant across all the models. Details like size of the openings and their location are altered among the models. Similarly, the construction materials and internal partitions are kept constant, whereas the external finishes – either the cladding or plastering or use of construction material as external fabric – are altered according to each typology. Finally, the boundary condition as the shared party wall, independent plot system, four feet compound and very high compound with high gate details are constructed and inputted into the IES.

The outcome clearly indicates higher conduction gains, energy consumption and resultant carbon emission in the plot and high gate typology; model no 4 (Figure 3). Further, they also demonstrate the lowest energy consumption and carbon emission in the Jagali typology (Figure 5,6).

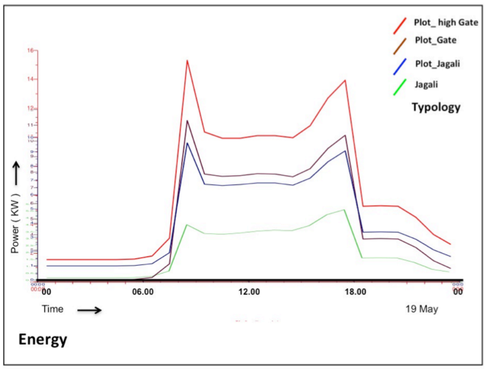

Figure 5 IES simulation: Energy consumption

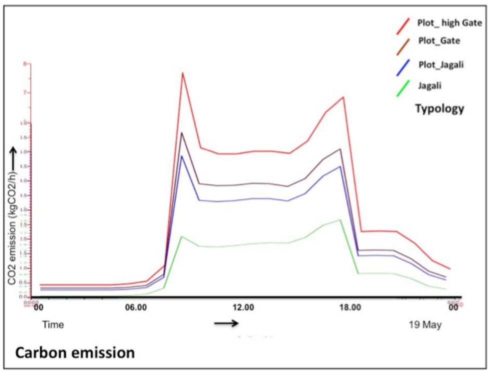

Figure 6 IES simulation: Carbon emission

A key finding is one of increased energy consumption in model four. It incurs nearly 65% more energy compared to the model 1 that incorporates the Jagali typology. Similarly, there is a difference in the performance of different models. For instance, in the case of energy consumption, the high compound typology requires nearly 300% more cooling load compared to a Jagali house. And even this will increase the conduction gain by nearly 90%. All the results are tabulated and compared in Figure 10.

The simulation output demonstrates that changed boundary conditions have an implication on energy consumption and resultant carbon emission. This also validates the hypothesis while developing models exploring different boundary conditions. It also clearly shows a direct relation between people's changed preferences, aspirations and its implication on energy consumption and carbon emissions.

Once the models are simulated and energy consumption and carbon emission are quantified, they are tested for their acceptability and preference by the stakeholders through series of qualitative fieldwork. Choices and preferences clearly represent the area in which we can expect people to support and adapt to sustainable features (Satish 2013). The feedback can be classified in to three types. First the elements which people are ready to change their preferences for the cause of sustainability, in this we can easily find the materials, skin and openings as two aspects which people are ready to align towards a sustainable agenda. There are certain elements for which they do not have very strong preferences and to some extent are ready to align themselves. In this case people might consider some adjustment but are not ready to forthrightly support a sustainability agenda. However when it comes to issues like security; people are not ready to compromise and would not be interested in sustainability issues and would not compromise on their perception of what is safe and secure for their property.

REVISED MODEL SIMULATION

This study has been very useful in disentangling one area, the boundary condition and look at each element separately so as to identify people's choices and preferences resulting in the housing typology and hence resultant sustainable concerns rather than broadly summing up the boundary conditions as unsustainable in present context.

This study is also helpful in identifying the areas and elements where it is easier to achieve higher sustainable goals compared to areas where there will be higher resistance to change. Revising the model to suit both peoples' choices and sustainable agenda further tests this. Peoples' choices and preferences, collected by social methods, are fed into the IES simulation model to analyse the difference in the process of sustainable housing. An IES daylight analysis of the revised model shows that adequate daylight can be achieved even after reducing 60% of the opening size compare to the plot and high gate model. To test this the plot and high gate model is altered to have 50% of original size windows which people would be ready to align with to achieve more sustainable housing.

The new IES simulation chart clearly shows a drop in the energy consumption of 40% (Figure 7). The changed window parameter has also reduced the carbon emission by 40% (Figure 8). The results clearly show that, by changing the elements which people are ready to alter, we can reduce carbon emission by a fifth. This is significant because it is useful to know where we can really target and reduce emissions.

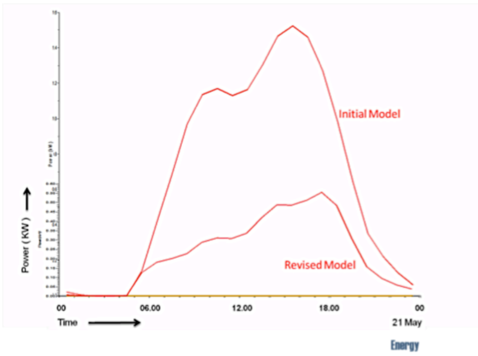

Figure 7 Post-fieldwork simulation: Energy consumption

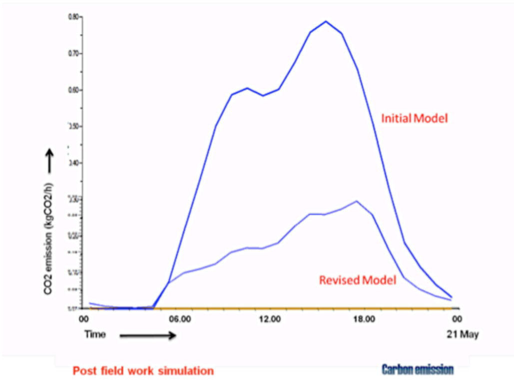

Figure 8 Post-fieldwork simulation: Carbon emission

CONCLUSION

Sustainable development can go hand in hand with the middle class but only with changes in the attitudes of the people, and their ability to relate themselves to reality. Recognising upward movement as a hallmark of the middle class and approaching sustainable development as an upward movement of technology and socio-economic issues, can be used as a way of catering for the aspirations of the middleclass whilst making them more sustainable in nature.

This research demonstrates that homeowner's attitude towards housing elements differ depending on the specific issue and on individual perceptions. Furthermore, their preferences will not only depend on the individual, but are also influenced by the building elements. For instance, middle class homeowners strongly prefer the high gate plot typology and would not like the 'Jagali' typology.

The study using survey field work and model simulations has highlighted the relatively recent shift in attitudes and cultural values relating to housing; from an inherently sustainable approach which valued shared spaces, local materials and communal activities, to one which reflects a move towards a twentieth century Western approach; of individualism, nuclear families and consumer driven values. The study also clearly demonstrates that there are elements of sustainable development like materials and openings, which people are willing to align themselves with yet there are other elements like security, where they would not compromise. Their immediate concerns would be of greater importance than the greater issues of carbon emission and sustainable housing.

India has identified housing as one of the eight national missions to reduce carbon emission as part of its commitment to reduce the vulnerability of the people to the impacts of climate change (NAPCC 2008), this bottom-up approach to identify the sustainable strategies acknowledging people's needs and aspirations should be a useful contribution to achieving carbon reduction and sustainable housing.

ACKNOWLEDGEMENT:

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NOMENCLATURE:

Agrahara layouts: One of the prototypes for residential layouts adopted during the development plan prepared in 1904. They are row houses built around a park in a U shape. The central park area was used for community socialising and as a children's play area. Each two-roomed house with a shared party wall had a small veranda and back yard.

Jagali: Jagali is a semi-open raised space, which acts as a transition from the road to the inner part of the house. People shared their leisure activities and entertainment with their neighbours in these informal spaces.

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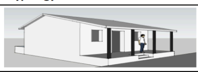
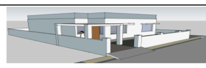
	Typologies	Model 1 Jagali Typology	Model 2 Jagali + Plot	Model 3 Plot + Gate	Model 4 Plot + High Gate
					
Description	Boundary condition	A traditional bioclimatic solution that reflects past models of communal living	A representative model of a combination of traditional and current middle class housing. Demarcation of boundary with very low wall. Combination of Jagali and plot system.	A representative model of current private sector middle class housing	a representative model of aspirations and high end / upper middle class housing
	Physical	Sharing party wall either in a row or arranged around the open space	The plot is defined more as a very low hedge to retain the permeability of the Jagali typology	About four feet high compound. Clear definition of one's territory	Very high compound. Min 6 feet high. Totally cut off from the external world.
	Spatial:	Use of semi-open space for most of the time	Opportunity to use open space for informal activity	Clear demarcation of territory. Presently, the space is not used for much of the activities.	Well defined barrier segregating the inside and outside. Open space and landscape areas for personal consumption.
	Visual	House and central open space are visually connected. Kids can play and people can use the Jagali for informal gatherings/activities	Developed more to suit the prevailing plot typology. Scope for interaction among neighbours.	There is a visual connection if not physical. Owners have the option to interact with the neighbours.	Insulated and visually cut off from the street and neighbours.
Qualitative	Communal / Social	Community oriented. Common open space and other than the rear utility area, there is no individual house open space	Scope to use open space for most of the day	Scope for informal interaction with the neighbours and street. Not much importance for the exterior open spaces and community activities	Totally cut off from the neighbours. Introverted, independent and more importance for privacy. Independent of neighbours and not involved in community activities.
	Economics / reflection	More emphasis on culture than economics (Rangoli). More functional	More functional	Combination of function and appears. Skin and compound used for demonstration of one's aspiration.	Skin and compound used for demonstration of one's aspirations
	Security	Social security, compact community and known neighbours	More importance attributed to social security	Compound used as a psychological barrier, main door with steel shutter	Compound itself acts as first level of defence. Totally grill and very high individual security.
	land foot print	13 Smt / person	27 Smt / Person	27 Smt / Person	43 Smt / Person
	Embodied energy	Use of least embodied energy and lifecycle energy	Less embodied energy		Use of very high embodied energy and lifecycle energy
	Total energy: Including embodied enargy, solar gain and maintainance energy	0.47 MWh / SQM	0.57 MWh / SQM	0.63 MWh / SQM	0.78 MWh / SQM
Quantitative	carbon emission	0.24 t CO2 / SQM	0.29 t CO2 / SQM	0.33 t CO2 / SQM	0.40 t CO2 / SQM
	Openings	Very small, just enough light inside.	Narrow openings, enough light for the interiors	Wide openings, no relation to direction and requirements	Very wide openings. Spanning most of the wall
	Climate responsive features	Climate responsive, roof, wall, construction and materials were reflective of local climate	Jagali area is shaded and could be used for most of the day	Design is independent of climate	Highly insensitive to the climatic condition.
	source of material	Use of locally sourced materials	Emphasis on use of locally sourced materials	Combination of local and imported materials.	Use of imported materials
	Security	No/least number of materials used for security other than the regular wooden door	Steel door as additional security to the main and rear doors	Steel grill for the portico area	Entire or most of the plot is covered by a grill
Summary		Most sustainable typology	Some of the features are sustainable	Some of the features are unsustainable	Least sustainable typology

Figure 9 Design Models_ comparative analysis

IES Simulation Result	Typologies ->	Model 1 Jagali Typology	Model 2 Jagali + Plot	Model 3 Plot + Gate	Model 4 Plot + High Gate
Parameters	General description				
Energy Consumption / SMT	Energy consumed by electrical appliances is considered. For uniformity's sake, it is converted to SMT and all the models are compared to the base results of Jagali typology as 0	Bench mark	20 % more than Jagali Typology	35 % more than Jagali Typology	65 % more than Jagali Typology
Cooling load	This simulation result accounts for the energy consumed to cool the internal spaces to a comfortable temperature of 23 degree.	Bench mark	100 % more than Jagali Typology	200 % more than Jagali Typology	300 % more than Jagali Typology
conduction gain	Window size is altered in each typology and with other construction materials being constant, the simulation result reflects the conduction heat gain due to size of the opening	Bench mark	58 % more than Jagali Typology	65 % more than Jagali Typology	90 % more than Jagali Typology
Embodied Energy	Source of the material, energy consumed for the processing and transportation are considered to qualify the other simulation results	Locally resourced material and construction system. Least materials imported from beyond 10 miles	Most of the materials Locally resourced and few materials imported from beyond 10 miles	Some of the materials are locally resourced and few materials are imported from beyond 100 miles	Least materials used. Locally sourced and most of the materials are imported from far away
Total energy consumption	It includes energy consumed due to electrical appliance, maintenance and cooling load.	Bench mark	138% more than Jagali Typology	175% more than Jagali Typology	275 % more than Jagali Typology
Carbon emission / SMT	Total carbon emission due to energy consumed due to maintenance and cooling energy. To bring in uniformity, it is converted to SMT and all the models are compared to the base results of Jagali typology as 0	Bench mark	20 % more than Jagali Typology	35 % more than Jagali Typology	65 % more than Jagali Typology
Summary		Most sustainable typology	Some of the features are sustainable	Some of the features are unsustainable	Least sustainable typology

Figure 10 IES simulation result