

# Architectural Pedagogy: An Observation on Mid Stage Architectural Design Studio and Presentation Development

Neelima Gubba<sup>1</sup>, Monika Yadav<sup>2</sup>, Esther Kiruba Jebakumar Clifford<sup>3</sup>

<sup>1,2,3</sup>Associate Professor, JBR Architecture College, Hyderabad India

## Abstract

Research in Design Teaching Methodology has been a lesser documented subject. Creative teaching is essential in designing and empowering young architects. Architectural education has to impart alternative thinking and new methods of learning. In this paper, we will be documenting an Experimental Teaching Method in second-year Architectural students who are already exposed to the codes and basic values of Design. Since certain hesitation is inherently formed, they are confined to decisive restrictions and ground rules. These restrictions are meant to be broken, yet students need a strong case to verify the same, with concrete evidence of design inspiration, process and presentation methods while maximising the vast knowledge database inherited from the first three semesters. This gives the Design Studio Guidance team an opportunity to move out of Conventional or Traditional methods and help students face the Design Problem with a unique outlook. This Design Teaching Methodology includes Integration of different subjects such as Building services, Landscape Design and Computer Applications in the Studio Schedule. The Project is divided into various Sessions like Research, Conceptual Design, Preliminary Design and Final Technical Drawings. Evaluation is done at every stage with emphasis on the process as opposed to the Traditional Method which lays emphasis on the end product.

**Keywords:** Architecture; Presentation; Design Process; Pedagogy; Architecture Student

## 1. Introduction

A creative response has to be generated before the absolute Design activity begins. Every project starts from a mental image that is formed in the student's mind and this can only be interpreted into the design with the help of pencil and paper. The emphasis therefore on the design process is maintained with the rough ideas and drawings also being evaluated along with the final design. As an Integrated Design Studio, it is more Fragmented than Amalgamated.

In order to experiment with the alternative method of teaching to impart architectural knowledge more effectively, comprehensive planning is done. Some of the methods suggested here may have already been practised in other parts of the country in different forms. Effective learning: Making maximum use of the entirety that is learnt & reducing wastage of what is learnt. Not certified through pedagogic experiments but through experience and observation (in short duration) based study and arriving at logical solutions to the problems with conventional practices used in the context-study, based on samples of students – Contextual - General - Socio-Economic background - Exposure before and during the course. The Conventional Method or Traditional Method is listed as Context 1 and the Alternative Integrated Method is listed under Context 2. A detailed report of Context 2 is documented below.

## 2. Process of Evaluation

Evaluation and Grading of student's work have to be a transparent process. The Design Studio Team must have a justifiable means of evaluation. As the design is a conceptual product, subjectivity is quite important. Assessment is a bilateral issue and hence has to be a transparent process. Highlights of the Student's work are analysed by the student themselves so that the subjectivity will change according to the student's view as well. Grading as opposed to the number of marks is an optimal method that has reduced the subjectivity of a teacher due to the flexibility that it offers. The Evaluation process is done on 1 - 10 Scale with 10 being the best. These quantitative Data that is evaluated by the Design Studio Team is observed and recorded for this Design Methodology with the help of observation of students outcome in the form of Design Process.<sup>1</sup>

## 3. Stages of Design Teaching Process:

As the Studio begins for the semester, students are asked to recollect data and theories learnt in the previous semesters. Discussions are conducted on various topics such as Design Take Away points from the previous semester, knowledge gleaning and transfer from the studios and theory subjects from the previous semesters. A general outlook on what students

---

<sup>1</sup>Deshpande, Shireesh A., (2013). *Design Dialog: Dialectics of Design in Architecture*, 1st ed. India: Council of Architecture

have achieved so far and what they would like to learn from the present semester is surveyed and weighed.

Design Process depends on the process of evaluating a particular location through physical, mental and social characteristics with the ambition of developing an architectural solution that will both address and enhance its internal and external context.

Design Sequencing is done in order of the following:

Defining the Problem

Analysing the Problem

Developing Alternate Solutions

Deciding Best Solutions

Converting Decision into effective Action

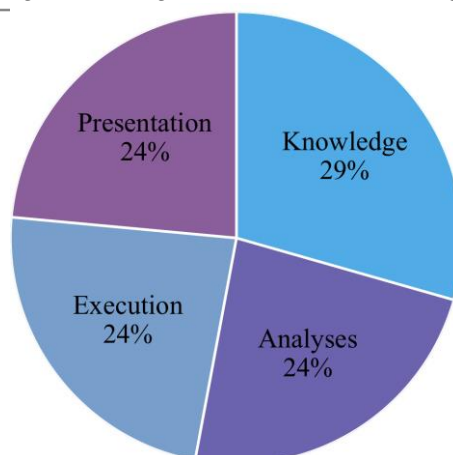
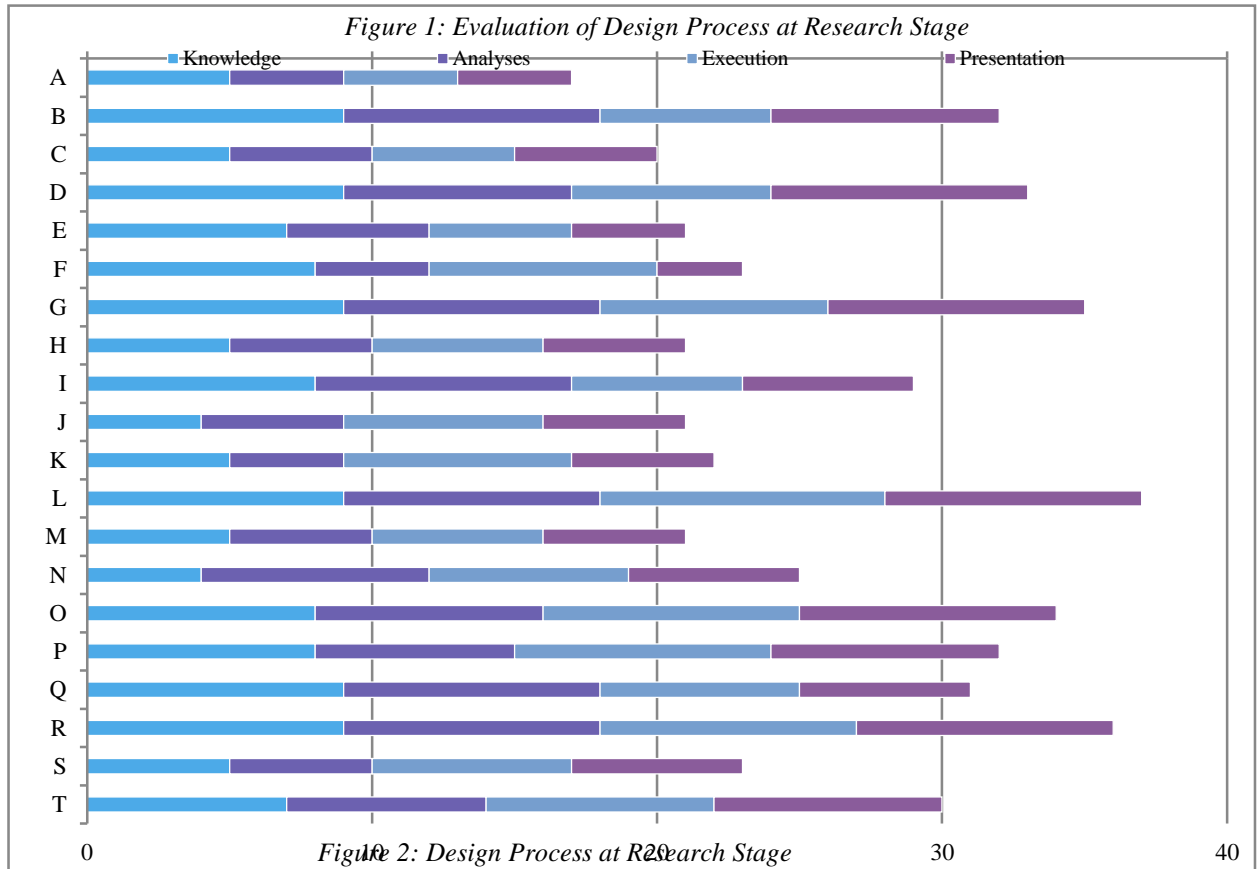
The studio is then taken forward with a brainstorming session. The different aspects of a Design Project are discussed with activities such as Word Association and Abstraction Ladder. The Design sequence already discussed now goes about in the following stages according to the Weeks:

### 3.1 Week 1:

In the Research Stage students start collecting knowledge that is ready to access. This research focuses largely on understanding the people for whom it is being designed (User Analysis) and the data needed for the same. Research is a core part of the user-centred

design. Design research both inspires imagination and informs intuition through a variety of methods with related intents.

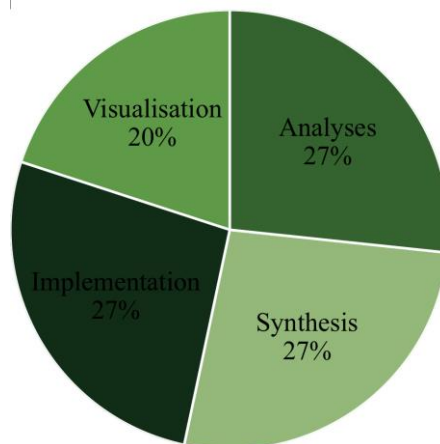
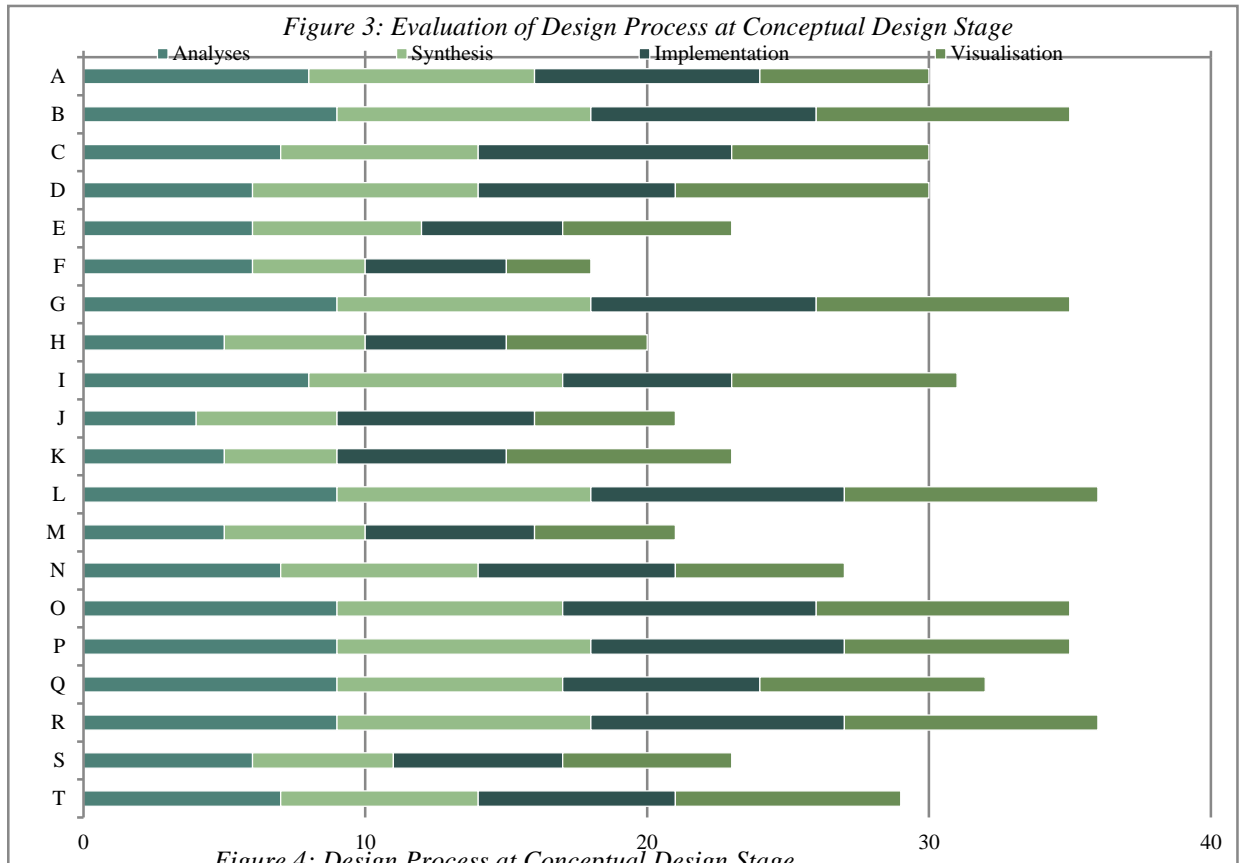
Coherent and logical studies are introduced to the students to effectively research the



Design Brief. These studies include, but are not limited to the following: Live Case Studies, Literature Case Studies, Data Collection on Standards and Design Ideas from online and library resources.

3.2 Week 2:

This is the Preliminary design (Predesign) Stage. Concepts are the designers' way of responding to the design situation presented them. The medium of translating the non-physical design problem into a physical building product. Site Study and Site Analysis is done simultaneously by the students. Varying topography, water courses, trees plants, habitats and

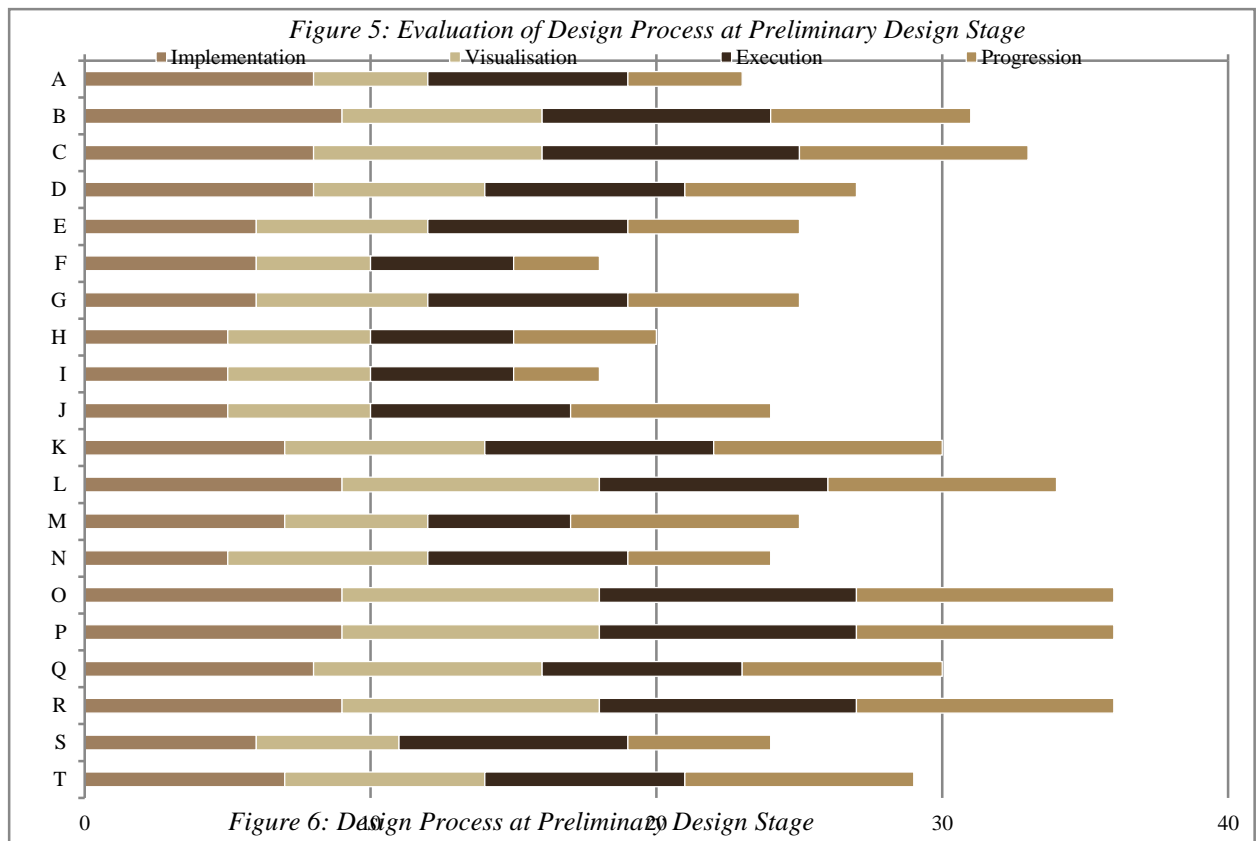


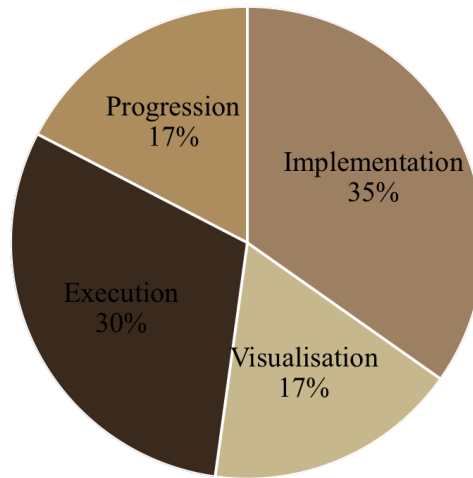
weather patterns influence the analysis of the site and the design process along with decision

making. To deal with critical issues, centrally themed air problem essences and the general issues of designing a building can be approached in a number of ways. Focus more on the early stages in design that is concept and direction. The approaches can be categorised as Functional, Materials, Contextual, Conceptual, Formal, Collaborations and Philosophical. The zoning, bubble diagrams and site analysis inferences are predominant in this stage.

### 3.3 Week 3:

This is the Preliminary Design Stage. This stage is where the student has to come up with sensible design solutions referred to and referenced from the conceptual design.



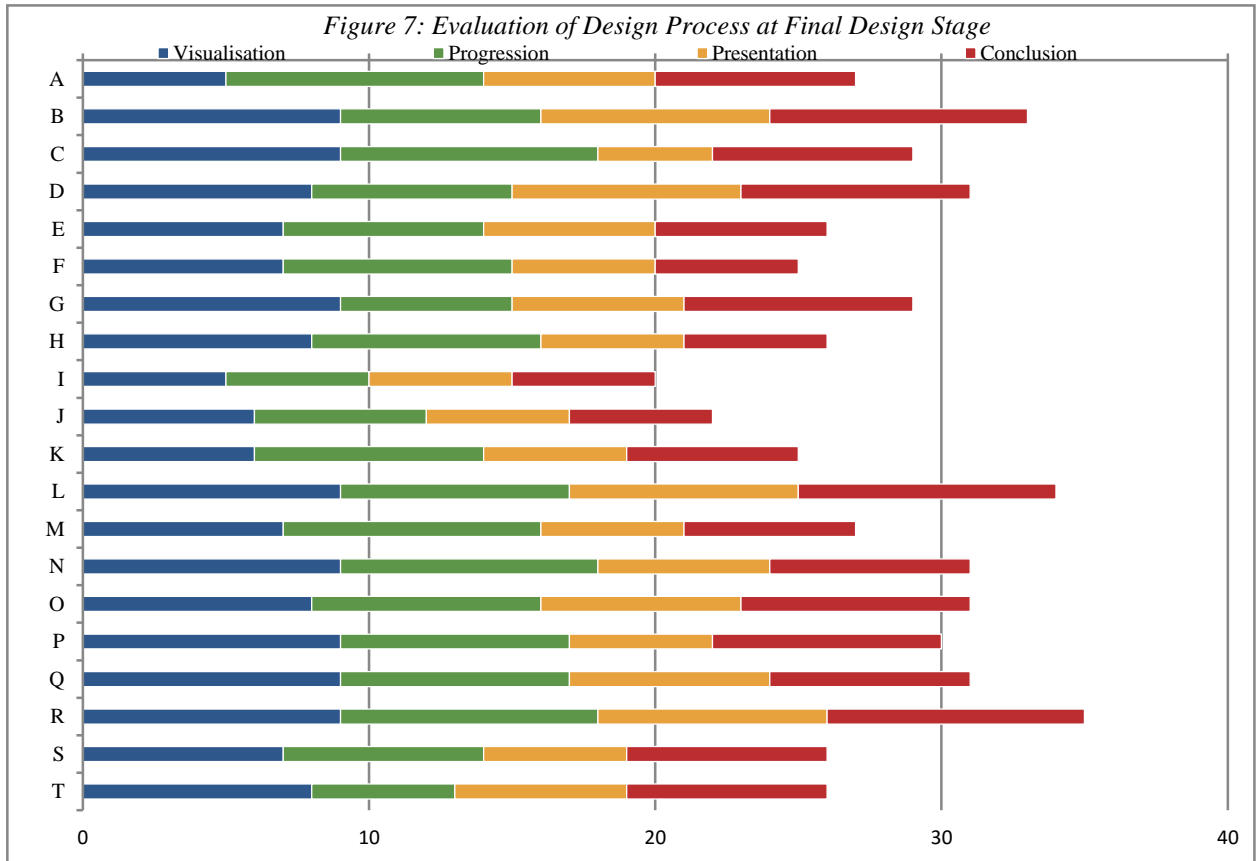


The preliminary design is executed and implemented by the students with the apt visualisation of the entire project itself. These are envisioned through View, Sections, Elevations and Spatial Planning. Emphasis is laid on working on Models and preferably Views of the design

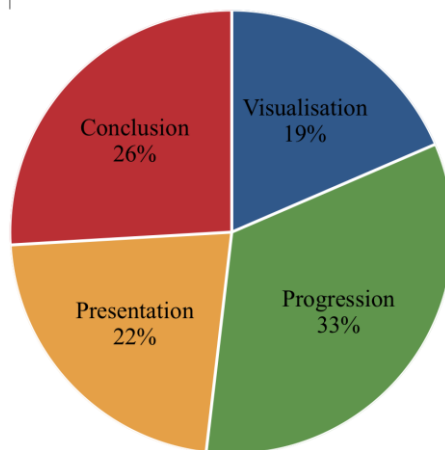
#### 3.4 Week 4:

When the final design of the building is completed and approved by the Studio Design Team, the student focuses on the design and documentation of the details of the project. This phase is the final where the presentation drawings are done. The scope of work for the final design

phase also includes physical models, coloured presentation drawings and in this particular Design Project an analyses presentation of a drawing in the style of a selected Architect (the



*Figure 8: Design Process at Final Design Stage*



Student is asked to work in the same with the help of the Computer Applications Team).



#### **4. Conclusion:**

When the overall result of the Finished Product in Context 1 and Context 2 are compared, there is a blatant difference in Visualisation of the Design by the students. Integrating various Subjects has helped students to work with better efficiently both qualitatively and qualitatively. To further improve on the Visualisation of the Students, when they work on the Massing and Forms, the introduction of activities such as Tangram Exercise, Peter Eisenman: Transformation of Cube, Paper Stacking and Addition Subtraction of Masses can be introduced.

#### **5. Observations :**

Pedagogical processes have been influenced in every era, but no pedagogical trend exists in a pure form. Design teaching methods have to take cognisance of the need to take a student along a psychologically appropriate activity of moving from what is known to what is yet to be known. In Context 1, all the research is carried out at the start of the Design Studio Process. Students tend to forget and we need to go back and forth while designing. The psychology of the student plays a major role in designing and enforcing a teaching method.

*"I hear and I forget. I see and I remember. I do and I understand."*-Confucius.

It is important to work on memory improvement basics. In Context 2 students apply what they learn in the other subjects, which will help them memorise the needed facts made significantly efficient. Learning and practising new things at the same time period will make learning even more effective. The same fact when it is learnt in multiple ways will be understood and analysed more effectively. One Student discussing and tutoring another student gives scope for a detailed discussion on the information learnt. Applying the information practically in the studio as soon as it is learnt with the integration of the other subjects of the same semester will thus inherently increase the quality of the Design Process culminating in a better Finished Designed Product.

#### **Acknowledgment**

We would like to acknowledge the support and guidance extended by Architect Professor Munavar Pasha (Principal of JBR Architecture College, Moinabad, Telangana, India). We would also like to acknowledge the inputs that Architect Gayatri J. (Director of JBR Architecture College, Moinabad, Telangana, India) gave as feedback for the Design Teaching Methodology, both traditional and conventional.

The Student Batch that we observed are the 2017-2022 batch of Bachelor of Architecture students of JBR Architecture College.

## References

1. Deshpande, Shireesh A., (2013). *Design Dialog: Dialectics of Design in Architecture*, 1st ed. India: Council of Architecture.
2. Edward De, Bono, (1983) *Teaching Thinking*, 1st ed.: Penguin Books.
3. Schmalz, Ben (2014) *The Architect's Guide to Writing: For Design and Construction Professionals*, USA: Images Publishing Dist Ac
4. Shah, Naresh & Anokar, Prasad (2015). *an introduction to PREDESIGN*, India: Council of Architecture.
5. Ganshirt, Christian (July 20, 2007). *TOOLS FOR IDEAS, an Introduction to Architectural Design*, Birkhäuser Architecture; 1st edition.
6. Joy, Kenny. (Dec 1, 2014). Innovative methods in architectural education [Online]. 21(3). pp. 876-880. Available: <https://www.slideshare.net/kennypjoy/innovative-methods-in-architectural-education>
7. Bassamtabar, Reyhaneh (2018). The Enhancement of Learning through the Design Process: Renovating the Fort River Elementary School in Amherst, MA [Online]. Available: [https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1715&context=theses\\_2](https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1715&context=theses_2)
8. Lee, Jinsop. Teaching Design: how I designed my first university course [Online]. Available: <https://www.jinsop.com/teaching-design/>
9. Chakraborty, Abhishek. What is Design Research? [Online]. Available: <https://medium.com/coffee-and-junk/design-research-what-is-it-846aa69b7c91>
10. Wong, Linda. What Are the Stages of Architectural Design? [Online]. Available: [https://www.ehow.com/how-does\\_4926841\\_what-stages-architectural-design.html](https://www.ehow.com/how-does_4926841_what-stages-architectural-design.html)
11. Neha Kolhe. (2017). Innovative Tools and Techniques to Teach Architecture. *International Journal of Engineering Research and Technology*. ISSN 0974-3154 Volume 10, Number 1 (2017) © International Research Publication House. Nagpur, India, pp. 67-71.

# **CAUSES AND EMERGENCE OF SQUATTER SETTLEMENTS AND THEIR NONACCEPTANCE TO GOVERNMENT HOUSING-A STUDY IN HYDERABAD**

**Ch.Mounika<sup>1</sup>, Ar.Emline Madonna Jose<sup>2</sup>**

<sup>1</sup>P.G.Student, School of Architecture, Hindustan Institute of Science and Technology, Chennai

<sup>2</sup>Associate Professor, School of Architecture, Hindustan Institute of Science and Technology, Chennai

Received: 16 March 2020 Revised and Accepted: 16 June 2020

**ABSTRACT:** Housing is necessary component of human livelihood. Without appropriate shelter people cannot meet their basic needs and participate adequately in society. Squatting or residing on public land illegally is a inevitable urban phenomenon in developing countries. This phenomenon is attributed to rapid urbanization due to rural to urban migration, which leads to rising costs of living, exclusionary housing markets a lack of affordable housing and urban inequality. Ultimately unplanned urban growth encourages the formation and expansion of squatter settlements. These settlements are commonly categorized as slum due to the improvised living conditions, highly congested spaces and lack of public services. Without land certificates, squatters are denied their right to adequate housing and land security, which should be protected by the government. In Hyderabad the government providing housing to the people who are residing in squatters, but squatters resist relocation. This study conducted through semi structured interviews with representatives from government agencies and squatter settlements. Conflicting perspectives between how government views squatters and how squatters view themselves exemplify how squatter settlements react to government intervention. Through the perspective of squatter, this study analyses the problems and disadvantages caused by the execution of government policies, and it also figure out the solution of those issues and enhance the living style of the slum people in squatter settlements.

**KEYWORDS:** Slums, Squatter settlements, Government policies, Urbanization, Poverty, Intervention.

## **I INTRODUCTION**

Every society whether developing and developed countries are facing some measures of housing problems and shortage of its related facilities as Hyderabad is one of the fastest growing cities is experiencing rapid urbanization. As Hyderabad is a capital city is in the process of transitioning from rural to urbanize economy followed by mass rural to urban migration. Individuals are pulled to Hyderabad for job opportunities, security and socio-economic mobility then automatically the informal settlements occupies predominantly by urban squatters. The more influential factor is the high rents in relation to urban poor that they cannot afford buy the low cost in market system.

Squatters are unable to purchase housing in the quantity at cost that they have reflection with their income. Squatters in Hyderabad reside on land without legal rights by living in formal settlements they are excluded from basic rights social services and land security. Typically provided by the government because of their landlessness. Without basic infrastructure and services provided by the government urban squatters are commonly categorized as slums. It is a failure of government to manage urban development and ensure human rights through inclusionary policies and protection of the right to adequate housing.

## **II CONCEPTUALISING THE TERMS REALTED TO SQUATTER SETTLEMENTS**

**a)Slum:** A highly congested residential neighborhood in a given city and towns which is predominantly comprised of sub-standard dwellings and is occupied mainly by persons that belong to the lowest income stratum UNCHS defines slums as contiguous settlements where inhabitants are characterized as having (i) insecure residential status; (ii) inadequate access to safe water; (iii) inadequate access to sanitation and other basic infrastructure and services; (iv) poor structural quality of housing; (v) overcrowding.

**b) Poverty:** Poverty is the state of being poor. There is no common definition for poverty that is accepted by all countries and organizations. Generally poverty refers to material deprivation and the state of being deficient in means of subsistence. The United Nations use the Human Poverty Index to rate the poverty of a country.

**c) Urbanization:** The shift of population to urban areas from rural for jobs and better livelihood is called Urbanization. The Urbanization began during Industrial revolution when people moved to industrial hubs.

**d) Urbanpoor:** The people living in the Urban areas without basic facilities or services and live in a unplanned and unhygienic areas of the city or town or in a ULB's can be termed as urban poor. Urban poverty is the term used for the poor living in urban areas – cities, towns and transitory urban areas. Urban poverty has been on a rapid rise to have assumed much more importance in the recent past. The nature and character of urban poverty as well as the means of addressing it are the same that of rural poverty alleviation.

**e) Rapid Industrialization:** Industrial growth and employment opportunities in towns and cities have appeared as influential magnets to captivate the rural population

**f) Population growth:** There is a delay between the vast growth of population and the construction of houses. These shortages indicate in creating slums

**g) Lack of zoning:** If zoning regulations are not imposed in the initial stage of development of town, then there is a possibility for industrial area to invade residential area. Within a short time there will be overloading with the evolution of slums.

**h) Decentralization:** By decentralization the rich and middle class people relocate to the expansion areas, concluding the poor in the overloaded part of the town to make it more contagious. Therefore the slum colonies start expanding at a fast rate. Unhealthy conditions are initiated due to lack of public facilities like water supply, Drainage, sanitation and light etc. The sub-human conditions of slums substantially affect the health and life of people. There is a complete lack of social and cultural life.

### **III AIM**

The aim of this research is to study and analyze the motivations behind government and squatter settlements actions in order to demonstrate why government has been unsuccessful to manage squatter settlement.

### **IV METHODOLOGY OF RESEARCH :**

- a) To find the chief factors for emergence and development of squatter settlement in the city.
- b) To analyze the socio economic and demographic condition of the squatter settlement in that area through survey.
- c) To determine the policies in that area.
- d) Identify the progress of the expansion of town.
- e) To know the living conditions and infrastructure facilities available in slum areas through survey.
- f) To study the health and nutrition level of slum dwellers
- g) To see the various policy measures and programs initiated by the government
- h) Examine the nature and extent of slum and factors responsible for growth
- i) Identify the problems and constraints of slum development.

### **V SCOPE:**

This study will help to gain knowledge in the area of illegal land tenure for housing as an input for policy formulation as well as fill knowledge to gap between urbanization and illegal settlement. This research studies both the government policies and squatter settlements to create the implementation strategies.

**VI CONVENTIONAL APPROACHES TO TACKLE THE PROBLEM OF SLUMS:** Three distinctive approaches to tackle the problem of slums have been seen till recent however; slums have not accounted for inclusive city planning and have remained under-privileged. The approaches are

**a) Punitive actions:** Punitive approaches involve eviction of slum dweller often forcefully; and sometimes relocation within city on another site but most of the time at outskirts of the city without any assistance. Punitive

approach mainly focused on demolishing the informal settlements and clearing the land mostly without any substitute for its inhabitants. Ex: rehabilitation.

**b) Curative actions:** Adaptive or curative approaches involve upgrading the level of physical, social, and economic urban services as well as land and tenure security in slums. Upgradation in physical services include improvements of drainage, footpaths and streets including street lights for security and night activity; and sewage and solid waste collection services. Ex: slum upgradation

**c) Preventive actions:** A preventive or proactive measure provides opportunities to urban poor and enables them to find affordable housing solutions rather than to be pushed to settle in slums. A proactive approach also greatly enhances the capacity of cities to fulfill the needs of the newly migrated population. It is often comparatively more effective and easy to implement than conventional measures. However, most of the planning approaches have missed the proactive approach. And unfortunately, the proved saying of—prevention is better than cure—is still not adopted by international development community; as claimed by Barjor Mehta and Arishdastur. Ex: slum redevelopment.

**VII VARIOUS REASONS FOR ORGANIC EVOLUTION OF SLUMS AT DIFFERENT SITE CONTEXT:**

**a) Near Water:**



- Water being primary requirement
- Catchment area: No legal houses are constructed in that areas
- Source of food like fishing since no payment for food.
- Employed in ship loading and unloading activities.
- Mainly due to low purchasing power of slum dwellers in formal land market when compared with high income groups

**Figure 1 and Figure 2** showing how settlements formed near water

**b) Sub urban areas:**



- 1st contact to any city
- Type of livelihood
- Less rented values
- Near to their work place. Usually they work in factories and dhabas.
- For clay molding of the statues like vinayaka etc.,

**Figure 3 and Figure 4** showing how settlements formed in sub urban areas

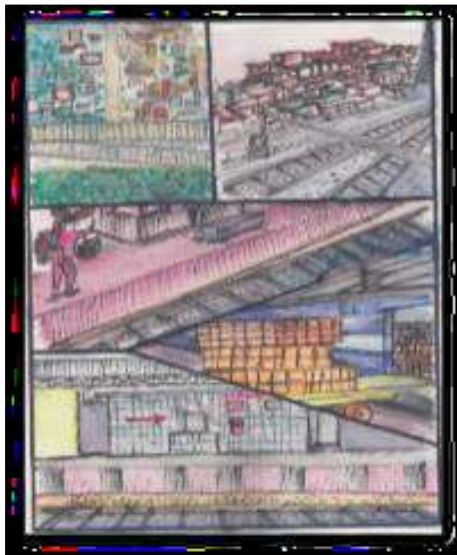
**c) Hilly areas:**



- Religious based if there are any temples in that hill.
- Work based
- Income based-they don't need to pay rent.
- Racial base
- Lack of education
- Choice of work for livelihood
- Political influences-they can get the services easily.

**Figure 5 and Figure 6** showing how settlements formed in hilly areas

**d) Near Railway tracks**



- First entering point to the city. While the people newly entering to the city they don't have any communication to the inhabitants
- Different cadres of people work in the railways – low cadres like tea selling people, coolies etc.
- Export and import of goods from the trains and parcel spaces.
- They can easily access the services like water, toilets etc.,
- To collect the waste nearby places through trains and they generate some income after that they move to other places for work.
- Government should not construct besides the railway track due to resonance of sound that's why constructions should not done.so people are easily occupying that land and creating informal settlements.

**Figure 7** showing how settlements formed near railway tracks

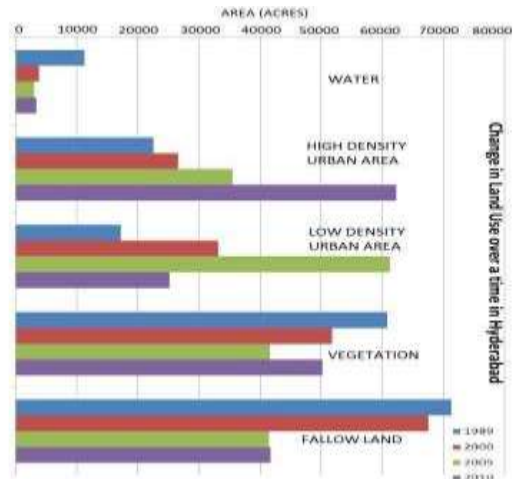
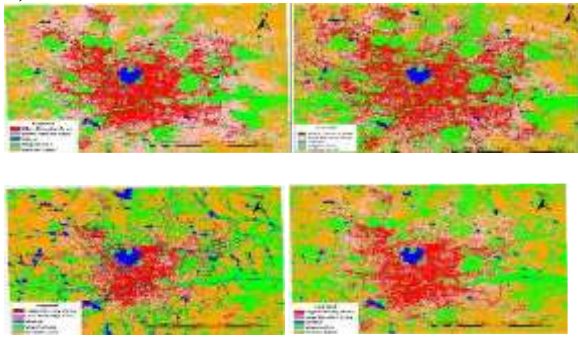
**VIII STUDY AREA - MACRO ANALYSIS -HYDERABAD**

In Telangana state Hyderabad is the capital and largest city.in this city population of about 6.9million with about 9.7 million in Hyderabad metropolitan region making it the 4th populous city and 6th most populous urban agglomeration in india.

- Total no.of slums-1466,Notified slums-1156,Non notified slums-310,Total slum area- 28.16sq.m(4.5%of the total area),Slum population-18.05lakhs,Slum households-4.21 lakhs

**a) Economy:** The main economic activity of Telangana is agriculture. The state has also started to focus on the fields of it and also the state has 68 special economic zones.

**b) Land use:**



**Fig-8** Land Use Classification **Fig-9** Land use classification Source: www.slideshare.net/aaqibiqbal940 result for 2005 result for 2010 /Hyderabad- housing

Because of the urbanization squatter settlements are daily increasing and slowly vegetation and greenery part decreasing.

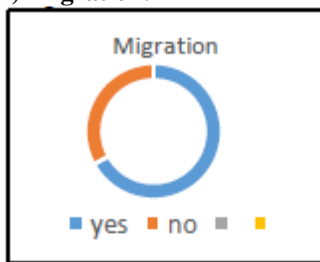
**c) MICRO ANALYSIS:**

In Hyderabad rassolpura slum is the biggest slum. According to the 2006 study rassolpura had about one lakh people inhabiting this slum. And also finding our way into narrow roads from the Begumpet main road the first thing we see as we enter rassolpura slum was an inauguration stone for 2bhk scheme announced by the government. And also I noticed that rassolpura slum divided into multiple parts. I have taken one part in this slum called indirammanagar for this study. A Survey was done to know their way of life and also what all the reasons behind nonacceptance to government housing are there.



**Figure-10** rassolpura map Source- googleearth.com

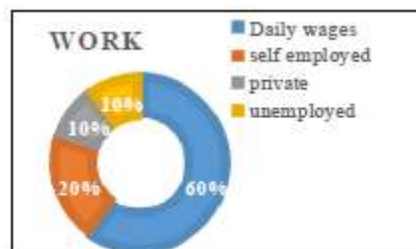
**i) Migration:**



**Inferences:**

- 67% of the people are the permanent residents in the locality for more than 40 years
- 33% of the people are the migrants.

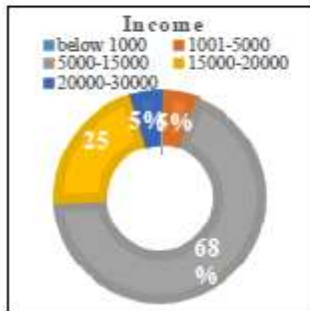
**ii) Work and Employment:**



**Inferences:**

- Most of the urban poor in rassolpura are working on the daily wages in the industries, maids etc.,
- Hyderabad is famous as industrial hub, it hub
- Very few of them are dependent on the self-employment
- Nearly 10% of the urban poor are unemployed in this slum

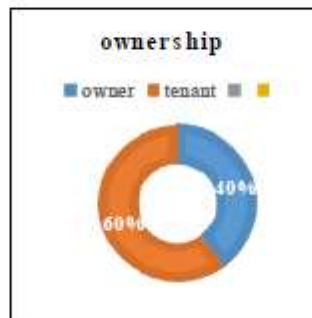
**iii) Income:**



**Inferences:**

- Income levels of the people is very less compared to that of major metros in the state.
- 65% of the people are earning in between ₹5000-15000
- The people are daily Wage based works and every day Wage may be a maximum of ₹ 500.

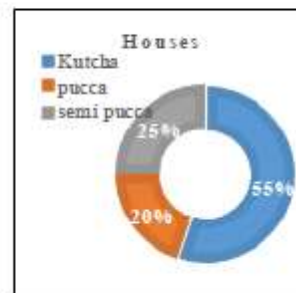
**iv) Housing:**



**Inferences:**

- Though most of the people are living in the localities for a long time, I observe very few of them own their houses.
- 60 % of the people residing in the area are tenants.
- Only 40% of them own their houses.
- Reason may be because of their low income levels.

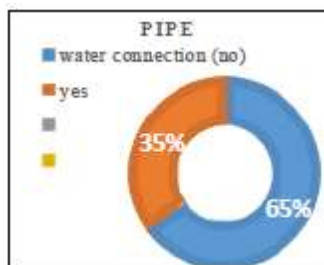
**v) Type of houses:**



**Inferences:**

- I observe only few houses are pucca in the rasoolpura slum.
- Only 20% of the houses are pucca.
- The rest of the houses are almost equally shared between semi pucca and kutchha.
- 25% of the houses are semi pucca.
- 55% of the houses are kutchha.

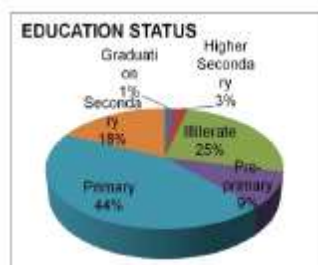
**vi) Infrastructure:**



**Inferences:**

- Source of water supply is mainly water tankers.
- Either municipal tap , hand pump or tankers
- Hand pumps are present at community and individual levels equally.
- And individual is only 35%
- Hand pumps both at community and individual is 15%

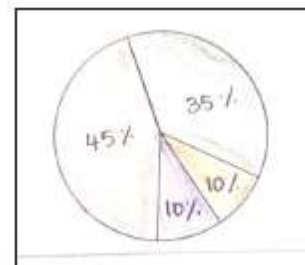
**vii) Education status:**



**Inferences:**

- The educational status of total Hyderabad is 82.9% literacy rate.
- The literacy rate is 45% of the total slum population.

**viii) Age group**



**Inferences:**

- It has been noted that 10% of the slum dwellers are between the age 16 to 25 while 10% of the population are between the age 41 and 60.
  - 45% of the residents are between 25 to 40. Below 16 – 10%
- 16 - 25 – 35%  
 25 - 40 – 45%  
 40 above – 10%



**ix) Spatial Analysis:**

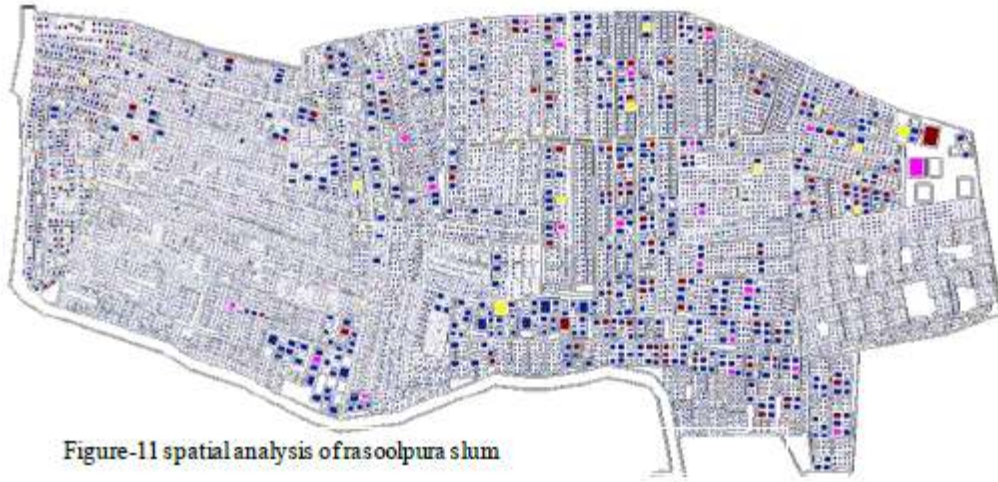


Figure-11 spatial analysis of fraseoolpura slum

**Street-1**

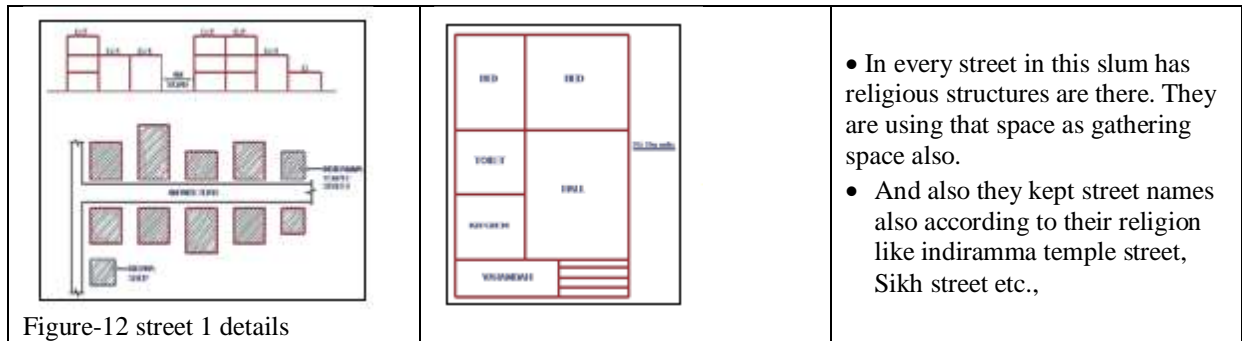


Figure-12 street 1 details

**Street -19**

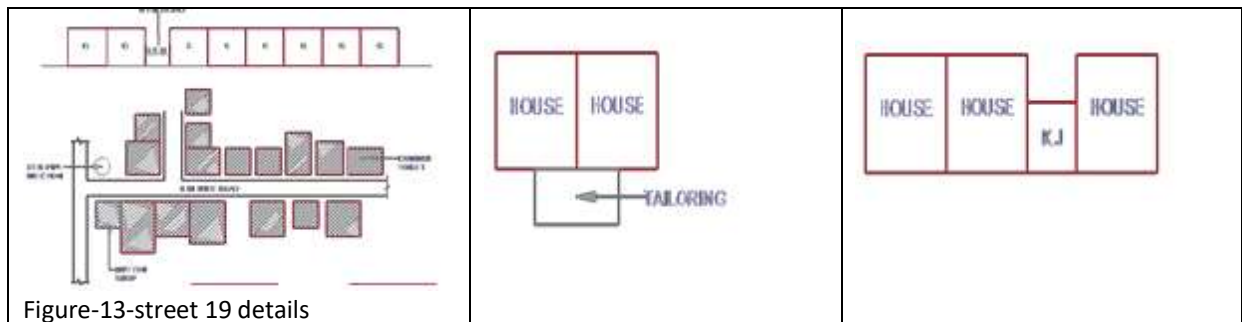


Figure-13-street 19 details

**x) Observations:**

- Existing of two major roads of slum starting and ending are connecting to the main ways.
- The roads leading through the slum are broad and clean.
- Once in 3 days the garbage collection people will come and collect the garbage.
- There exist potential areas around the site were bore wells could be built to provide cheaper water as a n alternative to piped water.
- Water tanker is coming for distribution of water weekly once.
- Construction of the buildings in zero proximity to the existing roads i.e., congestion of the residential area.
- Narrow pathways inside the slum and roads became drainage channels with deep gullies.
- Majority of the buildings have no access to open spaces.

- Some storm water drains are completely blocked by the residents.
- The people live in the slum are disposing waste in to the canal and some open spaces. Because of that some areas we cannot access also.
- If this system happens in the future also then the whole area will face problems and there will be no land available to live.
- In this site the water is vulnerable to contamination especially as waste from the latrines and bathrooms penetrate to the water table.
- There are no technical schools which would help in skilling the youth to reduce on the current levels of unemployment.
- Several community based organizations that engage in income generating activities do not have official places where the potential members in the community could use when subscribing to a specific association.
- Pedestrians are forced to walk along the vehicular road.
- The ever green population in the area might affect future planning of the roads due to increased encroachment on the planned areas.
- Some permanent structures have been constructed on areas which are supposed to be road reserves.

**IX INFERENCES:**

According to the analysis the slum design should be replicate their livelihood. Inclusive housing is not exclusive to any particular social or economic group. It does not try to equalize everyone and bring them to the same socio-economic level, but rather accepts and respects their differences.

It would include all groups of people whether of different economic strata, religious beliefs, familial and household structure, jobs or professions and disabilities.

Sustainable architecture is architecture that seeks to minimise the negative environmental impact of buildings by efficiency and moderation in the use of materials, energy and development space and the ecosystem at large.

Sustainable architecture uses a conscious approach to energy and ecological approach to energy and ecological conservation in the design of built environment

And mainly the design should **create horizontal environment in to vertical planning**. Because in urban areas no space is there for the horizontal development that's why same environment we have to create into vertical development.

**Upliftment:** Through inclusive and integrated housing the middle income groups will influence the lifestyle and surrounding of the weaker sections will develop.

**Bridging the Gap:** The need of the hour is to change the mentality of people towards the conventional practice of isolation of Lig.

**Sense of Security:** The integrated building with horizontal and vertical cluster gives feeling of security

**Maintaining Interaction:** Inter and intra level interaction: to create an inclusive housing the economic group should have interaction.

**Clamping:** Stocking creating various terraces at different levels, uplifting vertical interaction.

**Acceptance of life style:** Every community has different type of life style is there that should be acceptable by everyone.

**X CONCLUSIONS AND WAY FORWARD:**

- Often the policies initiated never reach to the stage of completion due to political influences hence changes in policy making towards a strategic vision and planning for short term, medium and long term solutions.
- The slum redevelopment or relocation programmes should always ensure that basic necessities which are deprived in the existing conditions are provided as an incentive to the slum dwellers.

- Government should ensure that the housing provided for the slum dwellers enables for the same employment opportunities that they have been working with .then they will get a chance to work and easily they will relocate the place.
- Sense of place: in most of the efforts taken to improve conditions of urban squatter settlements by architect there has been the eviction of squatters and resettling them in vertical, high rise buildings.
- In most of the slum redevelopments planners designing of these buildings are substitution for squatters but their regular pattern has been ignored. Therefore no open space for social and children activities had been provided.
- And also they construct their houses with the local and traditional materials like wood, stone etc., those materials have local character while constructing any houses fir them.in that government should use the local and available traditional materials that what comfortable for them.
- Main and common characteristics of slums is that these are consisted of vibrant communities of people and incorporate a whole range of social and community spaces like temple, church, shopping malls etc.,
- Only thinking of the housing is not that much use for them but with that government should concentrate on basic services like water supply, sanitation etc.,
- If the slum placement is not disturbing our future development then government should improve the infrastructure development in that existing slum rather than relocation, for example slums are forming in hills if that hill is not disturbing the government plan then they can provide the safety measures to improve the slums and also provide access to the infrastructure services.
- Existing slum should be redeveloped translate the better living condition.
- Land occupied under slums must be legalized and revised in the development plan as sites for housing of the urban poor.
- Self-help approach has to be implemented while constructing housing for slum dwellers.
- Once the government legalizes slum land and provides the slum dwellers with tenure rights they can individually and or through their cooperative take loan from housing banks to pay for the construction cost of their houses but that should be followed compulsory if government changes also.

**XI REFERENCES:**

1. <https://www.merriam-webster.com/dictionary/slum>
2. <https://thewire.in/books/india-urban-poor-gayatri-jayaraman>
3. Marshall's.(2010)of squatters and schemes: considering city level strategies for housing the poor in India. Retrieved from Dspace@MIT
4. [https://www.researchgate.net/post/cause\\_of\\_slums\\_in\\_urban\\_areas](https://www.researchgate.net/post/cause_of_slums_in_urban_areas).
5. <http://costford.org/material.php>
6. <https://www.longdom.org/open-access/prapid-urbanisation-squattersettlements-and-housing-policy-interface-inethopia-thecase-ofnekemtetownp-2167-0587-1000211>
7. <https://2bhk.telangana.gov.in>.
8. <https://www.gktoday.in/gk/article-on-problem-of-slums-in-india/>
9. <https://journals.sagepub.com/doi/10.1177/0956247814537958>

# FRAMING THE DESIGN STRATEGIES FOR NET ZERO ENERGY OFFICE BUILDING

Guided by:  
Ar. Sangeeta Sharma

Submitted by:  
Ar. Aparna Bhattacharyya  
M. Arch. (Architecture)  
3<sup>rd</sup> Semester  
Roll No. 115010400

SCHOOL OF ARCHITECTURE  
BABU BANARASI DAS UNIVERSITY  
Lucknow (U.P.)  
India

## ACKNOWLEDGEMENT

Behind these pages are hidden tones of hard work, sleepless nights and guidance of many people. To begin with I would like to thank my parents, my sister, in-laws, specially my husband and daughter who helped me sustain my belief in my endeavors to achieve my goals.

I sincerely thank Ar. Sangeeta Sharma, my guide for guiding me in every stage.

I would like to thank Ar. Varsha Varma, Ar. Richa Gupta for their kind support.

I would like to thank all the concerned authorities for helping me during my studies.

Last but not the least I would like to thank my faculty members and my friends for their moral support.

## INDEX

### ACKNOWLEDGEMENT

#### 1. SYNOPSIS

- INTRODUCTION
- AIM AND OBJECTIVE
- SCOPE AND LIMITATION
- METHODOLOGY

#### 2. LITERATURE STUDY

- PUSAT TENAGA MALAYSIA'S ZERO ENERGY OFFICE, MALAYSIA
- DPR CONSTRUCTION PHOENIX REGIONAL OFFICE, PHOENIX, ARIZONA, USA

#### 3. CASE STUDY

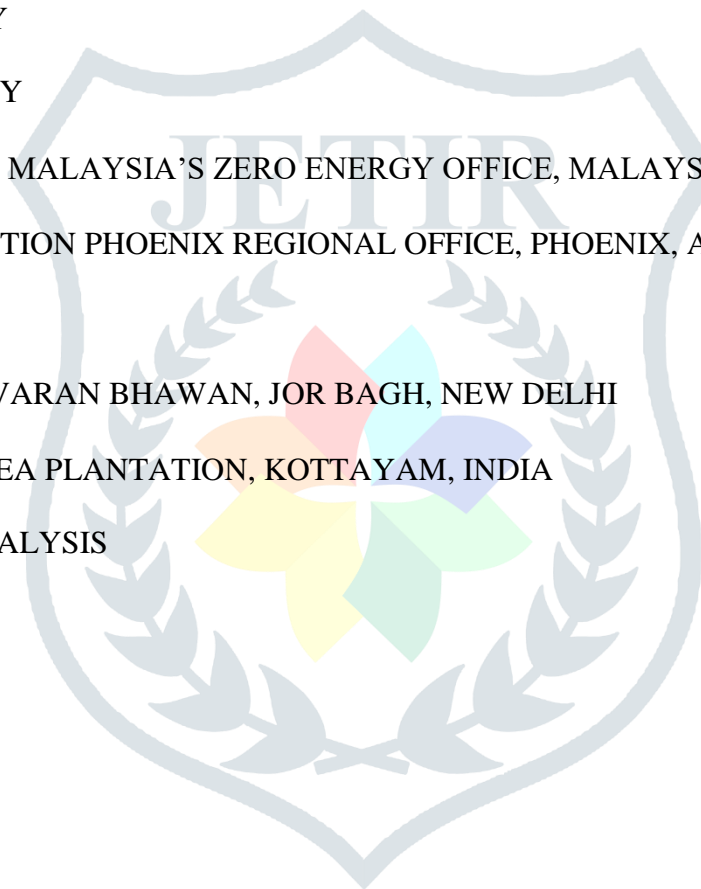
- INDIRA PARYAVARAN BHAWAN, JOR BAGH, NEW DELHI
- MALANKARA TEA PLANTATION, KOTTAYAM, INDIA

#### 4. COMPARATIVE ANALYSIS

#### 5. SWOT ANALYSIS

#### 6. INFERENCES

#### 7. BIBLIOGRAPHY



## SYNOPSIS

### INTRODUCTION

- Amid growing concerns about rising energy prices, energy independence, and the impact of climate change, statistics show buildings to be the primary energy consumer.
- This fact underscores the importance of targeting building energy use as a key to decreasing the nation's energy consumption.
- The building sector can significantly reduce energy use by incorporating energy-efficient strategies into the design, construction, and operation of new buildings and undertaking retrofits to improve the efficiency of existing buildings.
- It can further reduce dependence on fossil fuel derived energy by increasing use of on-site and off-site renewable energy sources.
- The concept of a Net Zero Energy Building (NZEB), one which produces as much energy as it uses over the course of a year, recently has been evolving from research to reality.
- Currently, there are only a small number of highly efficient buildings that meet the criteria to be called "Net Zero".
- As a result of advances in construction technologies, renewable energy systems, and academic research, creating Net Zero Energy Buildings is becoming more and more feasible.
- While the exact definitions of metrics for "Net Zero Energy" vary, most agree that Net Zero Energy Buildings combine:-
  - Exemplary building design to minimize energy requirements.
  - Renewable energy systems that meet these reduced energy needs.

- The net zero concept is applicable to a wide range of resources due to the many options for producing and conserving resources in buildings (e.g. energy, water, waste).
- Energy is the first resource to be targeted because it is highly managed, expected to continually become more efficient, and the ability to distribute and allocate it will improve disaster resiliency.
- Net Zero Energy Building Principles can be applied to most types of projects, including office buildings in both new construction and existing buildings.

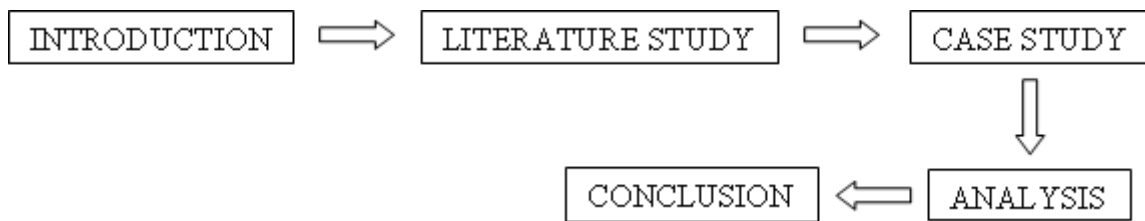
## AIM AND OBJECTIVE

- To study and develop the various methods and strategies of design that will result in reduced energy needs for office buildings and technological advances that will allow and enable this.
- To study and evaluate the viability of application of on-site renewable sources of energy in order to achieve Net Zero Energy building status.

## SCOPE AND LIMITATIONS

- The net zero concept is applicable to a wide range of resources due to the many options for producing and conserving resources in buildings (e.g. energy, water, waste).
- Net Zero Energy Building Principles can be applied to most types of projects, including office buildings in both new construction and existing buildings.
- Currently, there are only a small number of highly efficient buildings that meet the criteria to be called “Net Zero”.
- As a result of advances in construction technologies, renewable energy systems, and academic research, creating Net Zero Energy Buildings is becoming more and more feasible.

## METHODOLOGY



## LITERATURE STUDY

### LITERATURE STUDY 1

#### PUSAT TENAGA MALAYSIA'S ZERO ENERGY OFFICE, MALAYSIA



### Project Data

- Project Name
  - Malaysia Energy Centre: Zero Energy Office
- Location
  - Section 9, Bandar Baru Bangi, Bangi, Selangor



- Completion
  - July 2007
- Site Area
  - 2 hectares
- Gross Floor Area
  - 4,000 m<sup>2</sup>
- Number of Rooms
  - 41 rooms
- Building Height
  - 47.50 metres
- Client/Owner
  - Malaysia Energy Centre (Pusat Tenaga Malaysia-PTM)
- Architecture Firm
  - Ruslan Khalid Associates
- Principal Architect
  - Professor Dato' Ruslan Khalid
- Necessity—the mother of all inventions—lends her mark of approval to Pusat Tenaga Malaysia's (PTM) new Zero Energy Office (ZEO).
- While buildings play a fundamental role in providing the recreational and work structures that people work, play and live in, it is also impossible to ignore the negative effects they can have, especially when a sustained amount of massive energy is needed to power them.
- Heeding the call to best manage energy resources, PTM's ZEO rises to the occasion by capitalising on energy efficient measures implemented through various facets of the overall design.

- Construction work on the building started in March 2006, which was followed by the successful installation and commission of the four solar building integrated photovoltaic (BIPV) systems in June 2007, leading to the completion of PTM's ZEO in July 2007.
- Fashioned after the Low Energy Office (LEO) building initiated by the Ministry of Energy, Water and Communications (MEWC) in Putrajaya, the PTM's ZEO building has placed Malaysia on the regional map as the first completely self-sustainable building in Southeast Asia.
- Spread over a 5-acre site in Bandar Baru Bangi, Selangor, the building, located 40 kilometres south of the city centre of Kuala Lumpur, operates on the dynamics of both passive and active techniques and onsite renewable energy generation, as exemplified in the solar BIPV system.
- The building is seen as a feasible and timely solution to growing concerns surrounding the pressing issues of global warming and energy security.
- Figures point to the alarming reality that in developed nations, buildings tend to take up a third of total energy consumption.
- The business of sustainability is big news, by any standards.
- The PTM's ZEO building serves as a pilot project that provides a platform for proof of concept in driving forward the goals of the Malaysian building industry (developers, consultants, architects, local professionals and academia at large) in the subject of sustainable building design.
- This is great news as most buildings in Malaysia are energy inefficient—most of them record higher Building Energy Index (BEI) beyond the benchmark for Energy Efficient Buildings (EEB) set at 135 kWh per square metre per year (the kWh per square metre of the BEI is derived based on dividing the total kWh or electricity used per year by the building area based on metre square calculations).

### Energy efficient architecture

- Pre-programmed into the building's DNA are energy efficient features and the BIPV system—they make up the backbone of this self-sufficient, fully sustainable landmark.
- As such, PTM's ZEO building does not use fossil fuels, driving home the point that an office building need not consume electricity derived from this source.
- Instead, all electricity needed by the building is being generated by its own solar BIPV systems.
- In all, four different solar BIPV systems utilising four different technologies have been installed into PTM's ZEO.



Atrium with glass semi-transparent PV modules (11.64kWp)







Monocrystalline PV modules (27kWp) on the carpark roof



Polycrystalline modules (47.28kWp) on the main roof

## Types of PV panel

North-South Axis

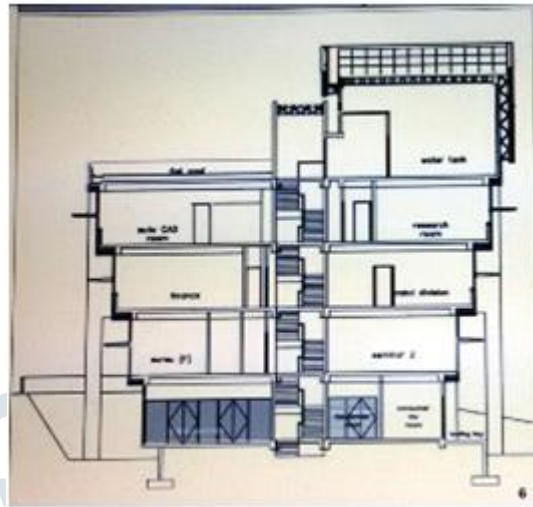
Types of PV Panel	PV Panel	Information
Package A Poly-Crystalline		<ul style="list-style-type: none"> <li>• Panel 394 nos</li> <li>• Produce 47 kWp</li> <li>• 356 meter square</li> </ul>
Package B Amorphous silicon		<ul style="list-style-type: none"> <li>• Panel 95 nos</li> <li>• Produce 6kWp</li> <li>• 100 meter square</li> </ul>
Package C Mono-Crystalline, see through		<ul style="list-style-type: none"> <li>• Panel 64 nos</li> <li>• Produce 12kWp</li> <li>• 110 meter square</li> </ul>
Package D Mono-Crystalline		<ul style="list-style-type: none"> <li>• Panel 150 nos</li> <li>• Produce 27 kWp</li> <li>• 200 meter square</li> </ul>

- The first and biggest component features the 47.28 kWp polycrystalline BIPV system on the main roof; the second component lies with the 6.08 kWp amorphous silicon BIPV system incorporated into the second main roof; the third system stored in the atrium of the building highlights the use of the 11.64 kWp monocrystalline glass-glass BIPV system; and lastly, the car park roof is fitted with 27 kWp monocrystalline BIPV system.
- The solar BIPV systems are all linked up to grid-connected inverters that convert the produced direct current (DC) electricity into alternating current (AC) electricity.
- For purposes of verifying the electricity production, electricity generation is recorded through the meter.
- In this case, no battery is installed as the generated solar electricity is directly consumed and the net surplus sold to Tenaga Nasional Berhad (TNB) on a net meter basis.
- Looking at the example of a total BIPV capacity of 92 kWp, the anticipated target for annual electricity generated from solar BIPV systems stands at 102 MWh.

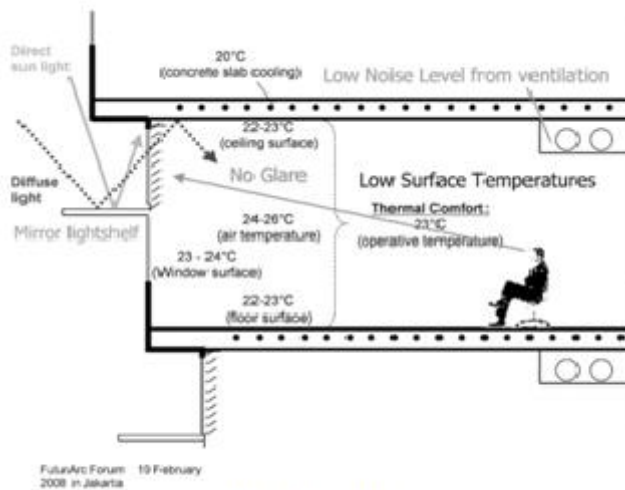
- To date, the BIPV systems have produced about 103 MWh/year average, based on actual output over three months.



Colour of office interior reflects light



Step-in design (self-shading)



Typical section

- Buildings that are not energy efficient would need more than 92 kWp as compared to PTM's ZEO.
- This is because the super energy efficient (EE) features of ZEO reduces the energy consumption of the building and complements the 92 kWp solar BIPV to make the total payback time for the whole systems to be less than 22 years.
- And this is based on current subsidised electricity tariff and technologies that are mostly imported today.

- It is acknowledged that the costs of future electricity would increase and the EE as well as the solar technologies would reduce.
- Furthermore, it is important to bear in mind that there is no payback price for the environment.
- To achieve the super EE outputs, the building incorporates features utilising passive techniques as well as orientation and vegetation, balanced with active features seen in efficient lighting systems, floor slab cooling, double-glazed windows as well as a thermal wall at its east- and west-facing façades.
- The implementation of high performance glazing and sealed double-glazing also complements the call for energy efficiency.
- This is reflected in its ability to harness high visible light at low infra-red (IR) and ultra-violet (UV) transmittance.
- The result is the effective harnessing of natural daylight minus, to a great degree, unnecessary heat radiation into the building.
- Playing an unseen yet fundamental role in the sustainable design feature of PTM's ZEO, the floors of the building take on a cooling effect role, thanks to the insertion of embedded tubes within the concrete floor slabs.
- During the day, the stored cooling effect is released from the floor slabs to the rooms above and below them, directly contributing to the cooling effect of the building that is also supplemented minimally by air-cooling systems.



Colour of building exterior minimises heat gain

- Careful thought has also gone into the preservation of air quality achieved via the process of dehumidification.
- Given the fact that dehumidification of air quality in buildings consumes a great amount of electricity, a desiccant heat wheel that operates by replacing incoming hot and humid fresh air with cooler and drier exhaust air is used to counteract this effect.

#### **Emphasis on holistic design approach**

- The critical approach towards ZEO is the holistic design involving all consultants, led by the architect, working together in order to achieve the client's zero energy vision.
- The initial architectural concept of the building was enhanced with super EE features, followed by the solar BIPV capacity to offset the remaining energy demand.
- The usage of solar BIPV technology not only displaced conventional building materials, but also adds value to the architecture of the building.
- Today, PTM's ZEO continues to function as a showcase building to facilitate and explore the concept of sustainability in buildings, while assisting to create opportunities for the involvement of other relevant industries.

- The building is exemplifying the use of energy efficiency, with solar BIPV setting a new standard for sustainable building in the ASEAN region.



Maximising daylighting

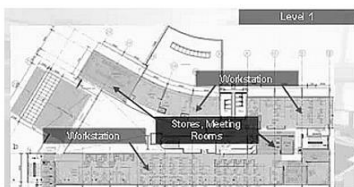
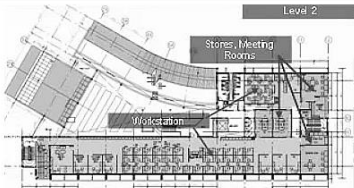




Glass semi-transparent PV modules (11.64kWp)

Daylighting



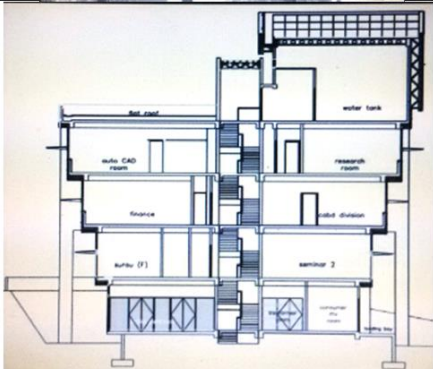


Malaysia Green Technology Coporation office building’s internal layout

Level	Layout plan
Level One	
Level Two	
Ground Level	
Lower Ground Level	



**Types of Shading**

Types of Shading	Photo
Plate Shading	
Fixed Ram Unit	
Step-in design (self-shading)	



Building façade facing to the north



Building façade facing to the south

East-West Axis

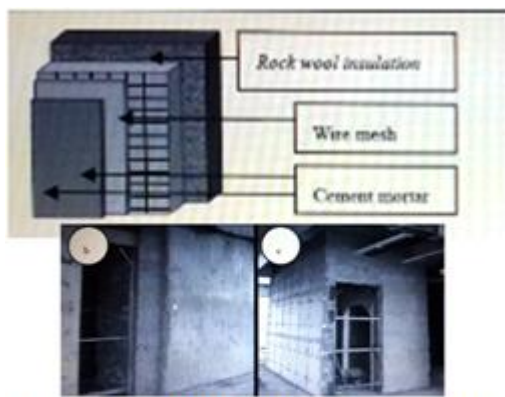


Building façade facing to the east

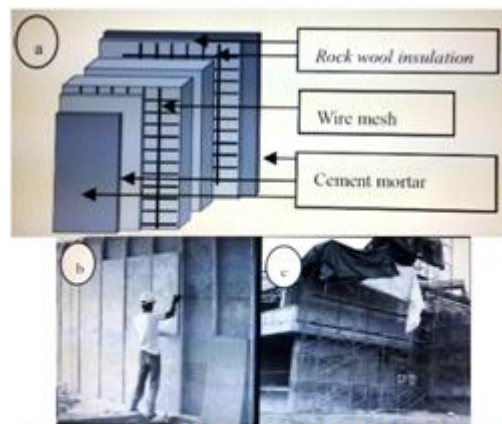


Building façade facing to the west

Malaysia Green Technology Corporation office building's orientation.



(a) Office building internal wall  
(b) & (c) Internal wall installed with insulation system during construction of the building



(a) Office building external wall  
(b) & (c) External wall installed with insulation system during construction of the building.



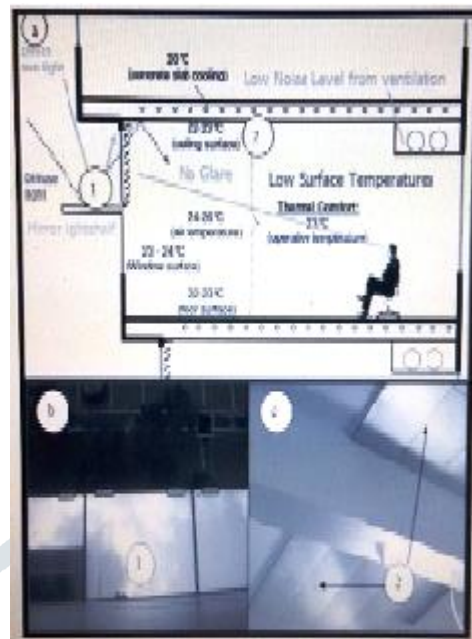
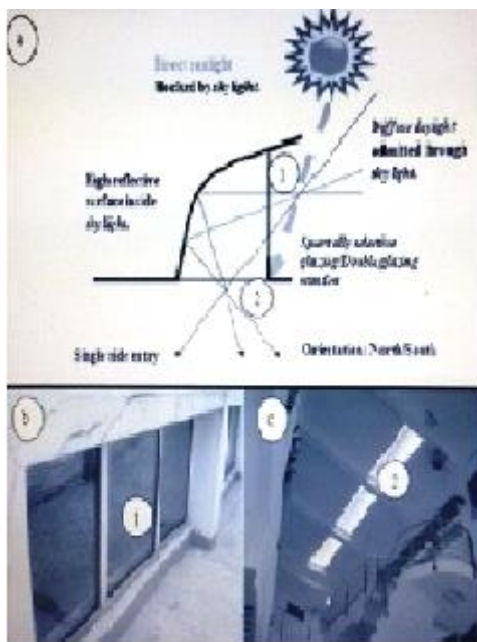
Polystyrene layer is installed on the uppermost floor of the office building (Source: Malaysia Green Technology Corporation, 2010)



The photo showed the installation of Styrofoam during the construction of the roof.



Mineral wool layer is installed on the slanting roof



- Diffuse daylight admitted through sky light.
- Spectrally selective glazing.
- Daylight source from skylight

- Diffuse daylight entered into building.
- Mirror light shelf
- High reflective surface on the ceiling surface



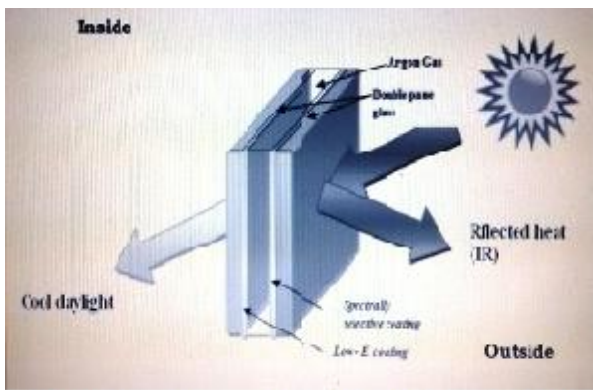
Light source enter the building through BIPV panel



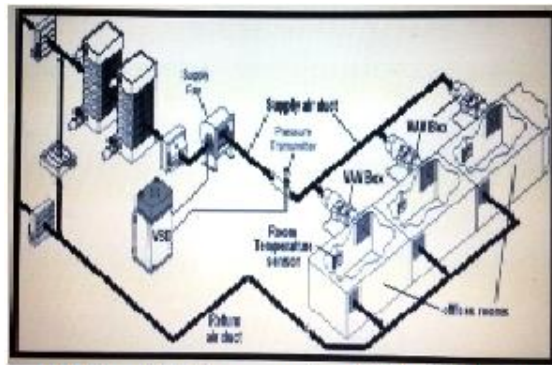
PEX pipe installed on the slab during the construction process.



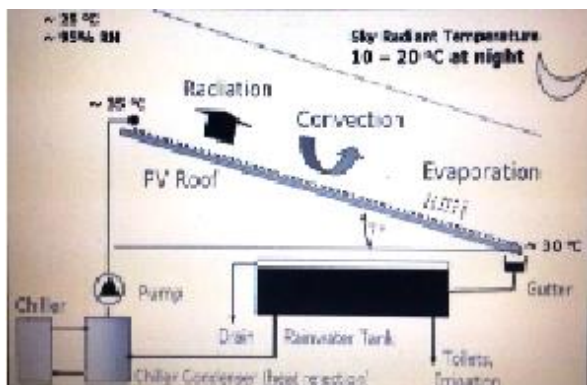
Chilled metal ceiling (CMC)



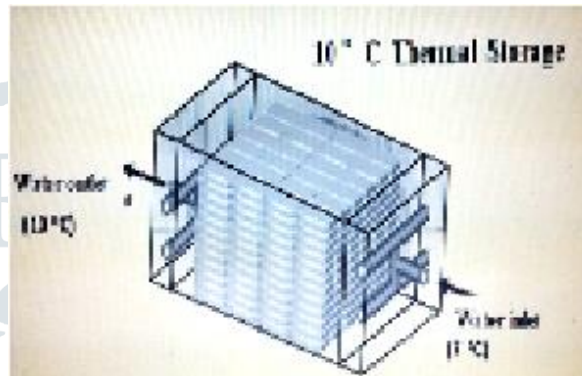
Schematic diagram of double glazing window



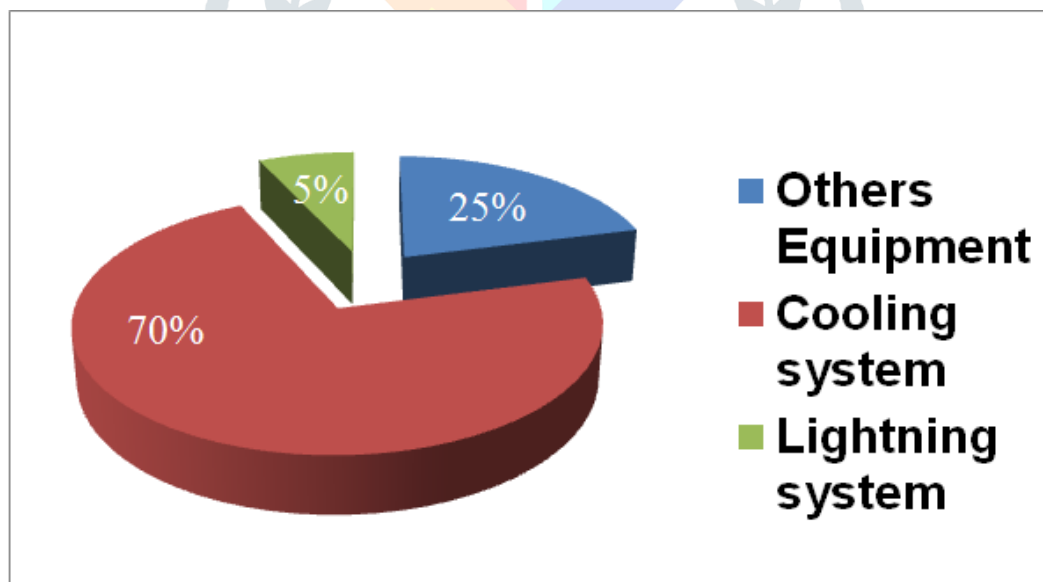
VAV and VSD system installed in Malaysia Green Technology Corporation office building.



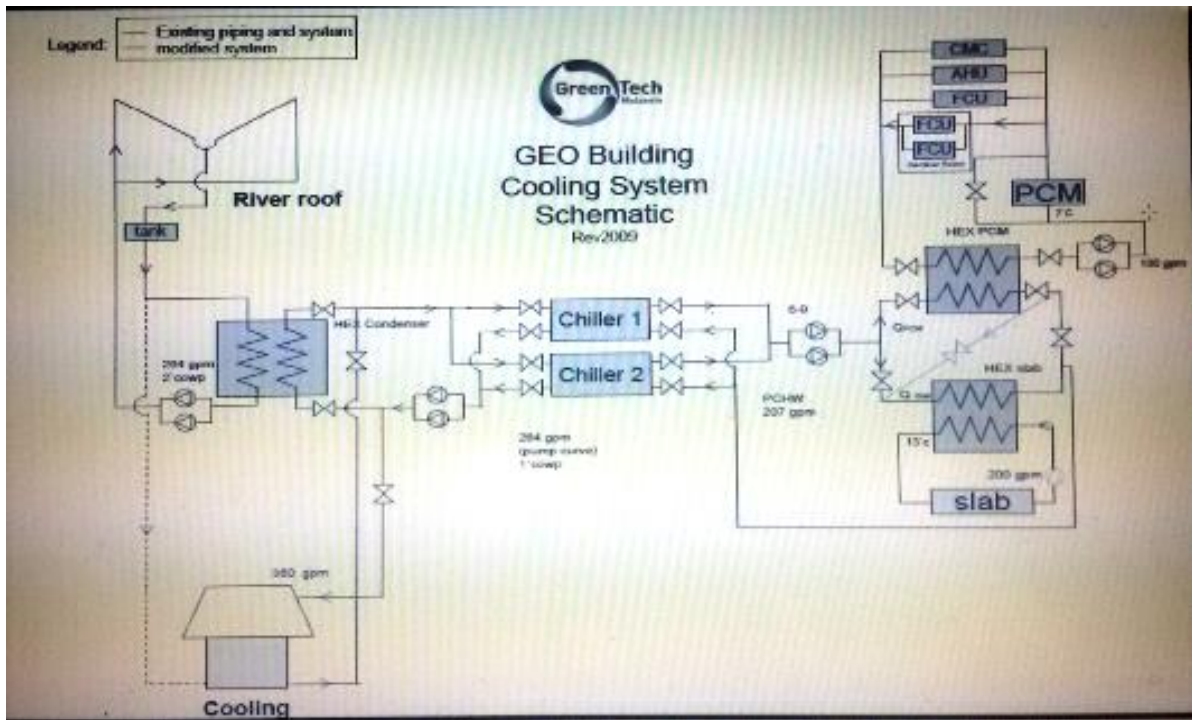
Cooling process happens on trickling cool roof.



Phase Change Material (PCM)



Distribution of energy consumption for Malaysia Green Technology Corporation office building.



Schematic diagram of the cooling system

**DPR CONSTRUCTION PHOENIX REGIONAL OFFICE, PHOENIX, ARIZONA,  
USA**



### General Information

- Building Name: DPR Construction Phoenix Regional Office
- Building Location:
  - City: Phoenix
  - State: Arizona
  - Country: USA
- Construction Type: Existing Building Renovation or Retrofit
- Project Size: 16533 ft<sup>2</sup>
- Market Sector: Private
- Building Type: Office
- Project Completion Date : October 7, 2011

- Architect Name(s): Mark Roddy
- Firm: Smith Group JJR, Phoenix, Arizona
- A living laboratory for the community, DPR's LEED®-NC Platinum, net-zero energy office is a unique example of urban revitalization and sustainability.
- Conceptualized as a “workplace of the future,” DPR created an open-office environment housing 58 workstations and floater spaces, nine conference/training/innovation/mediated technology rooms, support spaces, fully-equipped gym/locker facilities, and a zen room for a quiet retreat.
- DPR incorporated passive/active cooling solutions including 87 operable windows, four shower towers, an 87-foot long, zinc-clad solar chimney, and a 79 kW-dc rated photovoltaic solar panel covered parking lot to control the indoor environment naturally and produce energy onsite.
- A Lucid Building Dashboard system is utilized to allow DPR to monitor and share building water and gas usage, lighting and power consumption, and photovoltaic energy production in real time.





## Features



- In 2013, the office was certified as a Living Building Net-Zero Energy Building (NZEB) from the International Living Future Institute (ILFI) through Challenge (SM) program.
- It is the first in Arizona and only the second in the U.S. to achieve NZEB certification.
- It was, at one point, the largest building in the world to receive the certification.

- DPR created an adaptive response to the environment via innovative building solutions.
- The office utilizes rapidly renewable wood products, recycled and reused materials, and adapts alternative ways to light and condition the space by incorporating natural ventilation through the use of operable windows, shower towers, a solar chimney and Big Ass Fans to drastically reduce the building’s power demand.
- The expansive walls of windows and 82 strategically positioned Solatubes nearly eliminates the need for artificial daytime lighting 365 days a year
- A first-of-its-kind commercial building in the Valley, DPR’s office has become a showcase for neighbors, colleagues and students.
- It serves as a statewide example of how sustainable design can be integrated into an efficient, effective, and environmentally responsible office space.

**SWOT ANALYSIS**




LITERATURE STUDY I	LITERATURE STUDY II	CASE STUDY I	CASE STUDY II
<b>PUSAT TENAGA MALAYSIA’S ZERO ENERGY OFFICE, MALAYSIA</b>	<b>DPR CONSTRUCTION PHOENIX REGIONAL OFFICE, PHOENIX, ARIZONA, USA</b>	<b>INDIRA PARYAVARAN BHAWAN, JOR BAGH, NEW DELHI</b>	<b>MALANKARA TEA PLANTATION, KOTTAYAM, INDIA</b>
			
<b>STRENGTHS</b> <ul style="list-style-type: none"> <li>• Integration of Passive and Active Strategies Leads to Net Zero.</li> <li>• Net Zero Energy is achieved by the proper</li> </ul>	<b>STRENGTHS</b> <ul style="list-style-type: none"> <li>• Integration of Passive and Active Strategies Leads to Net Zero.</li> <li>• Adaptive response</li> </ul>	<b>STRENGTHS</b> <ul style="list-style-type: none"> <li>• Integration of Passive and Active Strategies Leads to Net Zero.</li> <li>• Energy efficient planning.</li> </ul>	<b>STRENGTHS</b> <ul style="list-style-type: none"> <li>• First Net-Zero energy building in India.</li> <li>• Energy cost savings payback</li> </ul>



<p>integration of both active and passive system.</p> <ul style="list-style-type: none"> <li>• Super energy efficient features of ZEO reduces the energy consumption of the building and remaining energy need being fulfilled through the application of BIPV system.</li> <li>• The initial architectural concept of the building was enhanced with super EE features, followed by the solar BIPV capacity to offset the remaining energy demand.</li> <li>• The usage of solar BIPV technology not only displaced conventional building materials, but also adds value to the architecture of the building.</li> <li>• The building is exemplifying the use of energy efficiency, with solar BIPV setting a new standard for sustainable building in the ASEAN region.</li> <li>• Careful thought has also gone into the preservation of air quality achieved via the process of dehumidification.</li> <li>• Given the fact that dehumidification of air quality in buildings consumes a great amount of electricity, a desiccant heat wheel that operates by replacing incoming hot and humid fresh air with cooler and drier exhaust air is used to counteract this effect.</li> </ul>	<p>to the environment.</p> <ul style="list-style-type: none"> <li>• To minimize the energy needs, energy efficient measures have been taken care of.</li> <li>• Remaining energy need is fulfilled by onsite generation.</li> <li>• All these measures helped to get net zero energy target.</li> <li>• Hierarchy of open spaces, design consideration of modern office space and culture.</li> </ul>	<ul style="list-style-type: none"> <li>• Landscaping as climate modifier.</li> <li>• Hierarchy of open spaces, design consideration of modern office space and culture.</li> <li>• Proper natural lighting is provided at all spaces thus cutting down the electricity consumption.</li> <li>• IPB reduces energy requirement by 70% overall vis-à-vis conventional             <ul style="list-style-type: none"> <li>• N-S Orientation – Insulation on wall &amp; roof– Extensive</li> <li>• Greenery to reduce heat load</li> <li>• Maximizing Day lighting to reduce lighting loads</li> <li>• Extremely Low Lighting Power Density – 5w/sqm</li> <li>• Planning to Minimize AC loads (Keeping open atrium for cross ventilation, Non conditioned lobbies)</li> <li>• Efficient HVAC with Screw Chillers, Chilled Beams, etc.</li> <li>• Ground based heat exchange for Condenser Water</li> <li>• Remote Computing - thin client servers</li> <li>• Energy efficient appliances (5 star BEE)</li> <li>• .... SPV’s for the remaining load.</li> </ul> </li> <li>• Integration of Green Architecture and on-site generation by solar photovoltaic system.</li> <li>• Access Friendly to differently-abled persons.</li> </ul>	<p>in fewer than five years.</p> <ul style="list-style-type: none"> <li>• Complete disconnection from the unreliable grid, functioning solely on self-generated solar power</li> <li>• Reduction of up to 47 tons of carbon emissions per year, saving an estimated 97% in diesel fuel consumption.</li> <li>• Capability to sell excess electricity generated back to the grid, making the complex an energy-plus building.</li> </ul>
--	---	---	---

<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>• Only surface parking is provided which at times becomes insufficient and creates chaos.</li> <li>• Access Friendly to differently-abled persons should be considered.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>• Access Friendly to differently-abled persons should be considered.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>• No weaknesses reported till date.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>• Methods adopted to get net zero target is suitable only for small scale projects like this.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>• Continuous development in technology and increased awareness among people will develop the market.</li> <li>• Can be a very good solution towards sustainable development and help to get rid off energy crisis.</li> <li>• Proper development with expertise teamwork from the base level is helpful for achieving the net zero target .</li> </ul> <p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>• Improper planning and mismanagement lead to the failure of these type of projects.</li> <li>• Without expertise teamwork may fail the project.</li> <li>• Technical failure can be the cause of not achieving net zero target.</li> <li>• Total cost of the project should be taken care of from the beginning either the excessive project cause can be the main reason for the project failure.</li> </ul>			
<p><b>INFERENCES</b></p> <ul style="list-style-type: none"> <li>• Net Zero Energy office building is possible.</li> <li>• Integration of Passive and Active Strategies Leads to Net Zero.</li> <li>• Zero needs a thoughtful approach and takes a coordinated effort.</li> <li>• Owner needs to set measurable goals and communicate those to the team.</li> <li>• Net Zero Energy is a target today, but will be a requirement tomorrow.</li> </ul>			

**INFERENCES**

LITERATURE STUDY I	LITERATURE STUDY II	CASE STUDY I	CASE STUDY II
<p><b>PUSAT TENAGA MALAYSIA'S ZERO ENERGY OFFICE, MALAYSIA</b></p>	<p><b>DPR CONSTRUCTION PHOENIX REGIONAL OFFICE, PHOENIX, ARIZONA, USA</b></p>	<p><b>INDIRA PARYAVARAN BHAWAN, JOR BAGH, NEW DELHI</b></p>	<p><b>MALANKARA TEA PLANTATION, KOTTAYAM, INDIA</b></p>
			

<p><b>INFERENCES</b></p> <ul style="list-style-type: none"> <li>• Net Zero Energy is achieved by the proper integration of both active and passive system.</li> <li>• Super energy efficient features of ZEO reduces the energy consumption of the building and remaining energy need being fulfilled through the application of BIPV system.</li> <li>• The initial architectural concept of the building was enhanced with super EE features, followed by the solar BIPV capacity to offset the remaining energy demand.</li> <li>• The usage of solar BIPV technology not only displaced conventional building materials, but also adds value to the architecture of the building.</li> <li>• The building is exemplifying the use of energy efficiency, with solar BIPV setting a new standard for sustainable building in the ASEAN region.</li> <li>• Careful thought has also gone into the preservation of air quality achieved via the process of dehumidification.</li> <li>• Given the fact that dehumidification of air quality in buildings consumes a great amount of electricity, a desiccant heat wheel that operates by replacing incoming hot and humid fresh air with cooler and drier exhaust air is used to counteract this effect.</li> </ul>	<p><b>INFERENCES</b></p> <ul style="list-style-type: none"> <li>• Adaptive response to the environment.</li> <li>• To minimize the energy needs, energy efficient measures have been taken care of.</li> <li>• Remaining energy need is fulfilled by onsite generation.</li> <li>• All these measures helped to get net zero energy target.</li> </ul>	<p><b>INFERENCES</b></p> <ul style="list-style-type: none"> <li>• Net Zero Design</li> <li>• IPB reduces energy requirement by 70% overall vis-à-vis conventional</li> <li>• N-S Orientation – Insulation on wall &amp; roof– Extensive</li> <li>• Greenery to reduce heat load</li> <li>• Maximizing Day lighting to reduce lighting loads</li> <li>• Extremely Low Lighting Power Density – 5w/sqm</li> <li>• Planning to Minimize AC loads (Keeping open atrium for cross ventilation, Non conditioned lobbies)</li> <li>• Efficient HVAC with Screw Chillers, Chilled Beams, etc.</li> <li>• Ground based heat exchange for Condenser Water</li> <li>• Remote Computing - thin client servers</li> <li>• Energy efficient appliances (5 star BEE)</li> <li>• .... SPV's for the remaining load.</li> <li>• Integration of Green Architecture and on-site generation by solar photovoltaic system.</li> </ul>	<p><b>INFERENCE S</b></p> <ul style="list-style-type: none"> <li>• First Net-Zero energy building in India.</li> <li>• Energy cost savings payback in fewer than five years.</li> <li>• Complete disconnect on from the unreliable grid, functioning solely on self-generated solar power</li> <li>• Reduction of up to 47 tons of carbon emissions per year, saving an estimated 97% in diesel fuel consumption.</li> <li>• Capability to sell excess electricity generated back to the grid, making the complex an energy-plus building.</li> </ul>
---	--	--	---

- Integration of Passive and Active Strategies Leads to Net Zero.

# To Create a Zero Energy Building...

## STEP 1 Increase energy efficiency

- Efficient building construction
- Efficient systems and appliances
- Operations and maintenance
- Change in user behavior



## STEP 2 Address remaining needs with on-site renewable energy generation

