INTEGRATING RENEWABLE ENERGY WITH MICRO ARCHITECTURE, A SUSTAINABLE LIVING SOLUTION FOR TROPICAL NATIONS AN INTEGRAL PROCEDURE OF SLIM (SUSTAINABLE LIVING IN MALAYSIA)

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ABSTRACT

For this research, the areas for development focus on healthier sanitation, higher security, improvement of comfort, increase of knowledge and sustainability; while the aspect of technologies encompasses energy, clean water generation, waste management as well as a living space that is secure, comfortable and yet remains similar to the natural habitat. The purpose of this research is to ascertain the relationships between communities' grassroots needs and the technologies implemented. Through the exploration, existing technologies will be challenged in authentic tropical ecosystem on its effectives. This study authenticates a past project implemented in a specific village in Malaysia on the effectiveness of development through users' account. The prevailing trend is that the development and technologies were not fully utilized due to limited research performed on empathy, which resulted in waste of resources and unmet needs. This births forth the development process model where relationship between needs and technologies is in union. The result of this analysis can be used to determine the customization of technologies on micro architecture as a sustainable development solution. The findings may be useful in meeting rural development needs elsewhere by successively following through the SLiM (Sustainable Living in Malaysia) process model to improve efficiency and solutions delivery.

Keywords: empathy, grassroots needs, technologies, SLiM, sustainable living

1. INTRODUCTION

Sustainable development should be a good blend of anthropocentric as much as ecocentric (Mebratu 1998). Crafting solutions that involves people with zero or positive impact to the environment is ideal. Yet in the world of capitalism, the absence of economic prosperity is certainly a no go to sustain the fundamentals incorporation of any development, especially the ones that are truly sustainable. However it remains lacking among mainstream development in Malaysia, as most are still profit driven (Hezri, Ghazali, 2011) or mere "Deformation professionnelle". This is a call for united efforts from various organizations in developing an adaptable solution by way of providing specific guidelines involving stakeholders with contextualized technological incorporation using available knowledge and understanding to achieve sustainable development. Perhaps a development process model as a guideline is necessary.

Many writings pertaining sustainability were under silos where ideology very much using either institutional or intellectual structure and last but not least the existing physical structure (Mebratu 1998). Using respective unique qualities and actual case studies from various researches birth forth a development process model to attempt consistent results with the intention of making impact to local communities and later nation as a whole. The objective is to be able to evaluate actual sustainable development implemented systematically. This experiment centred upon the four steps, Sustainable Living in Malaysia

(SLiM) development process model. Using fundamentals conceptual framework of WCED as well as IIED, SLiM process focuses upon technological incorporation of sustainable technology into micro architecture exploiting comprehensive data collated concerning empathy on grass roots' needs. The following progression of the process involves knowledge transfer to ensure continuity. The SLiM development process model completes the cycle by measuring the effectiveness of the said development as possible from case study to the next exploration.

This paper covers the second step of SLiM namely "Sustainable Innovation" a progressive process after cultivating "User Experience Analysis". The appropriate technology provides sustainability by offering job opportunity to the community with minimal ecological impact (Schumacher et al. 1980). For this paper the development was carried out in a rural setting focusing on an NGO's development needs.

The location is approximately a hundred kilometres away from the city of Kuala Lumpur, in a town of Seri Menanti, Negeri Sembilan Malaysia. Research much focus upon the effectiveness of a user centric process of about actual implementation in a rural context to explore the effectiveness of SLiM process model involving grass roots needs

For this paper, the intention is to publish the effectiveness on a section of the SLiM process model where incorporation of technology into micro architecture as a sustainable solution to meet grass roots needs. Indeed the findings are specific for the community and likely to be a solution for community with similar needs. The renewable technology incorporated should meet SLiM's unique criteria addressing social needs with minimal ecological impact.

2. SLiM DEVELOPMENT MODEL, A FOUR STEPS PROCESS

Sustainability is usually measured and quantified through economic progression hence the reduction in social equity is at stake (Hezri, Ghazali, 2011). Taking from IIED where solution to sustainable development is very much by empowering the people in deciding their development with a great amount awareness pertaining the ecological impact on their decision.
Revised strategy should be in place to address each individualistic needs of a particular community. However this do not prevent the establishment of a development process model. By combining the findings for the research, the Sustainable Living in Malaysia (SLiM) development model were birthed to help drive consistency in achieving sustainability where knowledge, people and planet thrive.

SLiM version 1.0 in Figure 1 is a basic expandable model, designed based on the Malaysian context where establishing or rather re-establishment of cultural values and community living is the ultimate goal. Starting off with empathy by understanding grass roots needs as a genesis to enhance user's experience. Basically it is a gap analysis to where they are leading the stakeholders through to a process in embracing sustainability by using SLiM.

Figure 1: SLiM Development process model

3. MICRO ARCHITECTURE

Home is an evolving living spatial; it changes in form and functionality depending on the phases of life for a particular user or group of users. Taking the example when a young couple who have just begun their family hood. There is no need for extra rooms as the personal intimate moments are most cherished. Then came along children, visiting friend, relatives, stay in help maid etc, which leads to inevitable expansion to their living space. The multi rooms' adobe will soon be empty nest due to migratory of their children. The reverse-metamorphosis requires a different solution to the spatial where rooms were transformed into storehouses. Hence a lifecycle consumption of space demands a paradigm shift of how a sustainable home should be.

Micro architecture centred upon the "form follow function" design application in meeting needs and evading wants (Samsul et al. 2006) . The design principles cut through the fuss and went right into providing sufficiency for day-to-day life's needs. Through research findings from empathy, the

sustainable development focuses on the life cycle needs of rural dwellers in the light of community living. One of the best places to start is to establish boundary based on analogy of invincible, individual, family, extended family and community needs.

3.1 The Boundary Spatial

Tearing down the multi facades of architecture, a home is basically a shelter or a mere canopy over the head protecting its inhabitants from excessive heat, rain and cold. To achieve comfort, the living spatial slowly evolves into a variety of domain boundary namely bedroom, living room, washroom, hall, kitchen, study, powder room, store room etc.

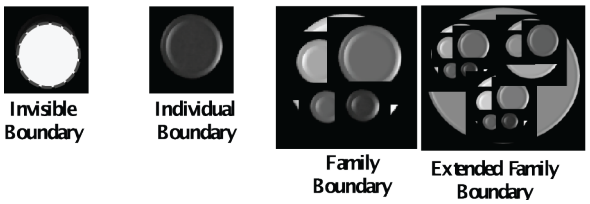


Figure 2: SLiM boundary analogy

There is no one size fits all solution, basic adobe or a home needs vary from one community to another, very much depending on the environment, culture and knowledge that conveniently shape the desire. An absolute resolution in meeting the needs do not exist, while the gap persist when solution derived from parties that has little or no understanding of their needs. Over the years, not many projects had extensive studies made prior to development creating determinism on the choice of a living development for people's needs addressing social requirement for the specific point of in life is certainly a scarcity.

3.2 Geodesic Dome the poultry land

Division of the earth is geodesic, a mathematical term popularized by Buckminster Fuller to build a "sphere or curved space of two points using the shortest path" (Mueller 2014). It is indeed an interesting structure as the sphere becomes more rounded as the division of an original triangle increases and in the geodesic sphere it is fondly known as the nV Notion (Mueller 2014) Fuller envisioned two most popular ideology namely Operating Manual for Spaceship Earth and Uthopia (Luke 2010) pertaining geodesic dome as sustainable structure due to its agility and cost effectiveness. Then again many brilliant prefab ideas such as those of Fuller's "Dymaxion" (Ashby 2000) and Azimin's eco-green public toilet (Tazilan et al. n.d.) were not being ordered in bulk either. Yet again the economic driven giants decided to build cookie cutter boxes driven by consumerism. Having the right balance requires the certain fuel to garner a sustainable development and that fuel is technology.
For this paper the grass root community needs focus upon solution that is ingenuity, low cost and sustainable. It speaks about breaking down barriers by the generation of sustainable practitioners as they no longer relying on conventional cookie cutter ideas. Hence the exploration was to bring Fuller's world changing dreams to practical use, namely chicken coop. By exploring cheaper coop building solution, it will bring about social driven economic or even cottage industry as a decentralization option for a more sustainable living concept.

The innovation is beyond the astatic with clear objective in meeting community needs. Hence the solution must be low in cost with fast construction time. Using dome calculator through DesertDomes.com website by Tara Landry, the construction was experimented together with the community using easily available construction materials such as polyvinyl chloride (PVC) pipes and polypipe. One of the main goals was to build the structure below RM500 including tools and materials. Eventually the experiment cost approximately RM2,000 for 4 attempts with 2 operating domes using three variety of nV notion. The best choice of materials for dome below RM500 is by using the Polypipe on a 4V dome. Result details were shown in Table 1.

Table 1: Experiment summary table

Geodesic Dome Experiment Summary Table									
No.	Choice of material	nV	Remarks	Day 1-3	Week 3	Month 3	Month 6	Month 9	Future improvement
1	PVC pipe (20mm)	3V	The connectors were using 3 inch pipe	U					To Innovate on a dome connector
2	PVC pipe (20mm)	4V	The connectors were using 3 inch pipe	U					To Innovate on a dome connector
3	Polypipe (20mm)	3V	No connector used. Struts were joined through cut sections.	S	S	E			To Innovate on a dome connector
4	Polypipe (20mm)	4V	No connector used. Struts were joined through cut sections.	S	S	S	S	E	To Innovate on a dome connector
Note:									
U	Unsuccessful								
S	Successful								
E	End of Life								

The application of boundary is this innovation realises sustainability on a few facets including cock and chicken ratio for health sustainability. Using moveable structure like this promotes natural foraging and concurrently reduces animal feed cost. The structure is then being moved bi-monthly to maintain a healthy ecological cycle as highly fertile soil covered with natural fertilizer. Rejuvenation of the land is carried out through manual ploughing, mixing or even open composting through natural microbiological activity. Having a new-untouched plot for the structure continues the process of naturally supplement the poultry while propagate.

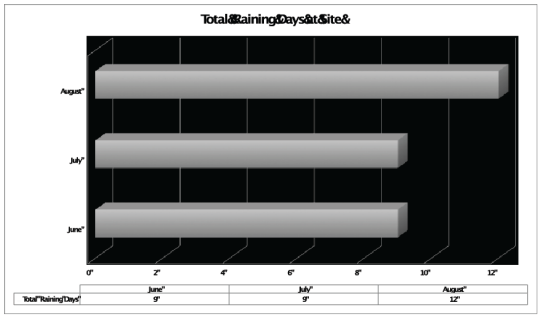
4. RAINWATER HARVESTING

Water is one of the most important resources for any living space especially in upholding hygiene and for cleaning purpose be it towards the physical unit or the users. One key sustainable aspect is to design a solution that is able to provide for this necessity. Thus rainwater harvesting is the natural route towards sustainability. Being in the equator and located in a valley, the research is to validate on commonly used calculation with actual data in supplying carbon free water source for the home. The roof area was approximately 150sqft with the width of 10 feet and length 15 feet as a water catchment area. Based on the rainwater harvesting formula provided by GBI (Green Building Index) under WE (Water Efficiency) the estimated rainwater collected per annum should be 2,670mm (Malaysian meteorological department).

Annual Rainfall Seri Menanti (mm):	2,670	mm
Roof Area (m^2):	15	m^2
Coefficient Run-off:	0.7	unit
Percentage diverted water%: NA		
Maximum litres of rainfall collected:	28,035	mm
Average monthly:	2,336	mm
Average Daily:	78	mm

Based on actual rainfall and overall consumption, the rainfall should be sufficient to cope with actual demand. Data were collated during the research period to ascertain calculated data with actual field data. Recorded data shows approximately 30 days out of the total three months of data collected were sufficient without any form of energy required for water supply. Details are provided in Figure

Table 2: Total number of raining days recorded for the period of 30 days



Month	Total Raining Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
June	9					x		x				x			x					x	x	x					x			x		
July	9															x	x	x		x	x	x	x						x		x	
August	12		x	x	x				x				x			x					x	x	x					x	x			x

4.1 Rainwater Harvesting Components

The research system comprised of parts that is easily sourced locally to reduce dependency on imported technologies or the need of extensive logistic carbon footprint. A basic rainwater harvesting system comprises of these three main parts namely gutter, first flush and water tank. The function of a first flush system is to help deliver better water quality. After flushing out particles or dust in the air as well as other possible contamination such as bird droppings etc that may exist on the roof only will the water be diverted into the tank. First flush being one component with incremental technological input with a simple float system closing into the PVC joints reducer. Thus by having locally sourced materials to build the system will ensure sustainability for maintenance and continuity.

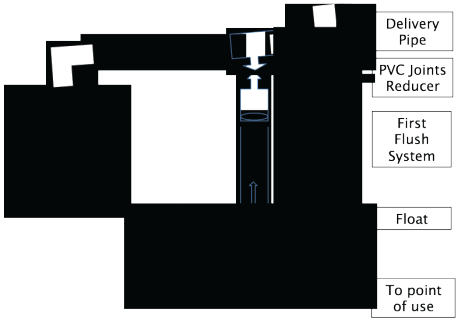


Figure 3: Rainwater Harvesting Components

5. CONCLUSION

This research investigated with micro architecture, as a possible answer to our sustainability needs. Using a popular statement by the remarkable E.F. Schumacher, small is indeed beautiful. A smaller footprint reduces ecological impact while cheap and light structure allows the said to be moved as wish. Perhaps a physical shift is as important as a paradigm shift to achieve sustainability in the present. Limitation of dwellers in a space adhere to the law of boundary inspires natural growth.

Sustainable development is not limit to growth but limit to capitalistic growth. Just as urbanization need not be a threat to rural area provided the latter has equal or better allure to the Malaysian communities. By having a process model together with its case study, sustainable development has become tangible beyond dollar and cents. The research findings are not intended to remain in the field science level where transmission into an applied science is envisioned. It has to be a collaborative action disposition between the academia, private sectors and the public sectors.

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