Analysis of Informal Settlements Based on World Bank Guidelines

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いわゆるスラム街で暮らす人々が建てた非合法の粗末な住居。それは不衛生で災害に弱いと言われているが、調べてみると意外なほど人々の生活の知恵が詰まった安上がりで合理的な建物だった。フィリピンでの貴重なケーススタディ。

Abstract

In 2011, the World Bank, funded by the Trust Fund for Environmentally & Socially Sustainable Development (TFESSD) conducted a research in Mumbai, India with the agenda to address climate change with low cost green housing. This research aimed to make the informal settlements in Mumbai to be both climate resilient and climate responsive.

Slums mostly attract attention towards the economic condition of the people inhabiting such settlements and because of the strong stigma against these marginalized members of the society, significant opportunities to learn and understand unorthodox construction philosophies applied in building these settlements are oftentimes missed-out. However, putting aside the social bias, there are three areas that can be focused on in investigating these settlements, namely, the materials used, its efficiency in terms of cost, and application in building construction.

This study identified the factors that make multi-level informal settlements resilient, and assessed their levels of resiliency by determining the materials and construction methods used in building these self-help dwellings and comparing them to the building guidelines prescribed in World Bank's "Building Guidelines on Informal Housing: Reducing Disaster Vulnerability through Safer Construction". This study found out that, out of the nineteen (19) building guideline requirements, seventeen (17) items or 89% were in compliance with the guidelines or alternative maintenance recommendations specified by the book.

Keywords World Bank, Multi-level Informal Settlements

Introduction: Informal Settlers, and their Past and Current Situations

The phenomenon of informal settlements, contemporary urban vernacular houses, and other poor residential neighborhoods is not new. They exist in urban contexts all over the world in various forms and typologies, dimensions, locations and by a range of names (e.g. squatter settlements, favelas, poblaciones, shacks, barrios bajos, bidonvilles). *(A. Gilbert and J. Gugler, 1992)* Informal settlements manifest on vacant and accessible lands. These are common along city fringes, rivers and seaside, railroad tracks, dump sites and even underneath bridges. The increase in population contributed to the problems of squatting.

According to Icamina and Alcazaren these spontaneous settlements house all demographics, wherein the elderly are not dissociated from the society, and the children dominate the number of population in the community. In these settlements, residents spend most of their time outside their homes and despite the messy surroundings, settlers wear clean clothes. Barbers keep kids and adults well groomed and babies get regular cleansing, which are physical evidence of pride and determination to

survive. During the day, the women are the next most visible residents, as men are usually at work, sleeping off a night of hard drinking or just plain sleeping. *(Alcarazen, 2011)*

Appearance, Construction Materials and Perception of Its Stability

Informal architecture addresses the basic need for shelter despite the lack of building materials, utilities and even the land to build on. These unconventional low-tech multi-level residential buildings are usually constructed from standard and/or recycled materials like plywood, corrugated metal sheets, plastic sheets, and cardboard boxes. Its appearance, materials and methods of construction, however, vary according to its environment.

One example is the informal settlements on water villages which uses bamboo as a common material. From above, these settlements present a very striking view as it is perceived as stitched or weaved. However, these settlements are also one of the most fragile and vulnerable types of informal settlements.

Another example is the spontaneous settlements at the main land, which are constructed with lightweight materials, raised floors, and multi-functional spaces, intended for the use of nuclear families, which are not far from the original design and function of the basic nipa hut dwellings. These settlements, due to their location and inability to blend with the generally acceptable urban aesthetics, are oftentimes perceived negatively.

Accurate, localized and available qualitative and quantitative data on the actual structures of informal settlements and associated learning platforms remain limited. Data is often ad hoc and not connected to robust city-wide monitoring and evaluation processes, so the dimensions of inhabitants' lives remain unknown to policy and planning responses. *(Patel, 2012)* Furthermore, as the study of the history and development of vernacular architecture progresses, evolutions of self-help dwellings to multi-level dwelling units are continuing to occur at a much faster rate.

Researches from decades ago up to present are more inclined to the theoretical analysis as to how and why there's been a significant increase in the production of self-built or informal houses rather than the built form and structural design of the housing itself and its evolution. One example is the issue papers presented on the United Nations Conference on Housing and Sustainable Urban Development, Habitat III Quito-2016 about Informal Settlements, which paid more attention to the relationship between the growth of informal settlement and slums, and the lack of adequate housing and land. As a result, only a partial understanding of such settlements has emerged because there has been a virtual absence of empirical data on "squatter" architecture. *(Napier, 1995)* Aside from that, though there have already been published researches on how to improve informal settlers' lives *(III, 2015)*, observers and researchers tend to pay more attention to the negative aspects that these dwellings and dwellers bring. On the same conference, slums are perceived as "degraded environment" where dwellers should be moving out because of absence of legality, substandard in terms of space and infrastructure, absence of permanent materials, etc. By neglecting how industriously-built these settlements are, and how they have achieved their identity through what they are not, or do not have, in comparison with the formally built structures.

Building Guidelines on Informal Housing: Reducing Disaster Vulnerability through Safer Construction

In 2011, the World Bank, funded by the Trust Fund for Environmentally & Socially Sustainable Development or TFESSD, conducted a research in Mumbai, India, in line with the Component 2 of "Addressing Climate Change with Low Cost Green Housing". The book aims to make the informal settlements in Mumbai to be both climate resilient and climate responsive.

Prior to this book, book 1 was published presenting Mumbai's prevalent slum housing which were broadly categorized as wet, dry and hybrid. Such houses are made from recycled or scavenged materials, and are constructed through methods that are lacking in quality and detail. Three reasons that has attributed to these issues were cited, namely, affordability, rapid timeline, and knowledge gap.

The book 2 is a structured manual that provides guidelines for the improvement of informal housing construction. It is also designed to be used as a guide for construction, maintenance, and a reference in the exploration of alternative materials for owners and contractors. It constitutes a four-part manual. The first part provides recommendations on material selection, usage and maintenance through the identification of construction material issues. The second part is focused on the assembly of

materials in house construction which covers foundations walls and roofs in consideration of a more climate responsive house through improved light and ventilation. The third part recommends an "ideal" prototype for dry, wet and hybrid housing typology. And finally, part four introduces alternatives to common practices such as existing new low cost construction methods and materials to be explored. This book is used as a guide in the measure of sustainable construction that may be used or are existent in the building of the informal settlements studied in this research.

Statement of the Problem

Slums mostly attract attention towards the economic condition of the people inhabiting such settlements and because of the strong stigma against these marginalized members of the society, significant opportunities to learn and understand unorthodox construction philosophies applied in building these settlements are oftentimes missed-out.

However, putting aside the social bias, and focusing solely on the appreciation of the construction methods and philosophies applied, there are three areas that can be focused on in investigating these settlements, namely, the materials used, its efficiency in terms of cost, and application in building construction.

Objectives of the Study

This paper aims to identify the factors that make multi-level informal settlements resilient or how far it is from being resilient through:

Inventory and Documentation of existing and available materials and methods used in building of these self-help dwellings.

Comparison and Analysis between the gathered data and the Building Guidelines created by the World Bank on Informal Housing focused on reducing disaster vulnerability through safer construction.

Creation of a measure or rating level on informal housing resiliency based on the Building Guidelines of World Bank on Informal Housing focused on reducing disaster vulnerability through safer construction.

Significance of the Study

This study recognizes multi-level informal settlements as adaptive buildings based on responses of the human condition, natural forces and environment; offering good judgement for the creative use of its raw technology on the field of Building Science, by looking at a more comprehensive and balanced understanding of both the product and process dynamics of spontaneous settlements and of the people who create and inhabit them.

Analyzing dimensions of informal dwellings can provide valuable insight into creating viable adaptations for cramped spaces for a better and more appropriate design and guidelines. Moreover, to serve as a resource for donors and policy makers through the presentation of existing approaches from slum building, for a relatively cheaper and sustainable approach to low cost house building improvement and disaster risk reduction.

Study of Related Literature

Common Perceptions towards Informal Settlements

In a paper written by Alex Ray P. Evangelista, titled *"Promoting Awareness and Appreciation of Informal Settlements through Education"*, he reiterated that slums have always been a symbol of a poor economy and is detrimental to one country's progress. Thus, they were labelled as eyesores and are being compared to primitive settlements. In the Philippines, there is an evident stereotyping against informal settlements, as slums are hardly recognized as an effective, affordable, and convenient option for the poor. When in some cases, these dwellings are more liveable than the settlements the government provides.

Contrary to the common residential units offered by the government which are like monotonous series of boxes designed side by side, shanties of informal settlements display innovativeness and ingenuity through the use of recycled materials regardless of the type of land, slope and other environmental hindrances, hazardous or not. These types of structures would usually have one single room with multiple uses, which can be as small as twelve (12) square meters. During the day it serves as the dining, living and kitchen, whereas at night, it is transformed into a bedroom for the whole family – a concept that is

very much similar to primitive dwellings.

In conclusion, the research suggests that rather than condemning these informal settlements, the general public should take the opportunity of studying the living conditions of slums along with its physical and social fabric.

In a similar research conducted by Peter Kellett and Mark Napier, titled *"A Critical Examination of Vernacular Theory and Spontaneous Settlements"*, it is stated that for the past three decades, the tradition of study on spontaneous settlements are leaning towards the cause and processes that give rise to informally produced housing rather than the built form of the housing itself. Thus, only a partial understanding of such settlements has emerged due to the virtual absence of empirical data on "squatter" architecture.

Backed up with the 7th Semester Dissertation in Bachelor of Architectural Technology and Construction Management at VIA University College of Natalia Kostelnikova, titled *"Analysis of vernacular architecture in terms of sustainability"*, she discussed vernacular architecture, its sustainable perspective and considerable adaptability in contemporary design. She focused on vernacular architecture along with a few specific kinds of dwellings made by their ancestors. Though there were no exact order or time axes presented, she related her investigations with contemporary buildings, which are connected to traditional principles or local materials.

The Use of Unconventional and Recycled Materials

Using natural or recycled materials, as well as the simple methods of construction execution, is one of the main ideas of sustainable development. *"Unconventional Building Structures in Single Family Social Housing"*, by Magdalena Zalecka Myszkiewicz", focused on the concept of sustainability with regards to unconventional low-tech structures made from natural and/or recycled materials which are believed to be self-sufficient as far as their operation, materials, construction and maintenance cost is concerned. These include off-grid houses making use of used tyres, aluminium tins, glass bottles or plastic containers. However, these unconventional dwellings were commonly associated with weakness and infectivity due to the social stigma on the dwellers and the untypical appearance of their houses, and as such applications require construction parameters on quality control, insulation and installation.

Another paper titled *"Improving Housing Durability in Informal Settlements Using Affordable Building Materials – The Case of Kibera, Nairobi"*, by Ja Walubwa and P Shah" aimed to identify the availability and accessibility of local materials in the construction of durable houses. Stones, used water bottles, corrugated iron sheets and cement are some of the affordable materials that were cited. The respondents also gave special attention to interlocking bricks as it incurs lesser cost in terms of labour and production. Research shows that informal settlers build their house in accordance with their financial capability. A guideline in a Poverty Reduction paper pointed out that in terms of slum upgrading, these dwellers should be involved in the construction and design as they themselves can give solutions to their existing problems. Thus, an effort to make informal settlers intervene and participate in the innovation of building houses was being adopted in Kiberia to ensure that slum dwellers will have a sense of ownership on their homes.

Furthermore, the research concludes that ecological structures, making use of recycled materials, can be an alternative in the construction of sustainable complex buildings and may positively affect social housing since it doesn't require high building skills, nor does it necessitate the use of specialized construction equipments.

Methodology

The study is a mix of comparative analysis and experimental research that is exploratory and interpretative in nature.

Since the type of structure that's being studied is a residential dwelling, the structure, its tenants, users, and builders are the subject of the study. Proper care has been taken on the identification of parts, materials, joints and connections for proper assessment as guided by the Informal Housing Building Guidelines.

The outcome of the study is based on the comparative results of the chosen unit as compared to the Informal Housing Building Guidelines by World Bank. Observation and documentation of the structure, in the form of as-built drawings also took place to supplement the interviews.

It also involved interviews, checking of records or documents, and fieldwork.

Research Findings

The informal housing unit that has been studied is owned by Mrs. Lolita. The building is initially a one (1) storey residence that progressed into a three (3) storey house in a span of two decades, occupying a lot that is roughly around 12.30 sqm, having dimensions of 2.75m (w) x 4.5m (h), less the area of the sidewalk which is about 4.13 sqm.

The residence is occupied by Mrs. Lolita, her husband, her daughter with psychiatric illness, her son and daughter in-law, two (2) grandsons and two (2) house-help.

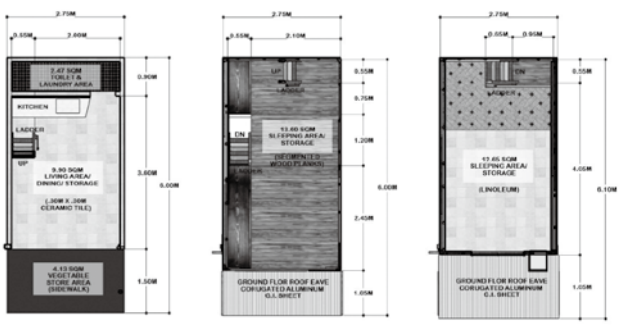

Fig. 1. Floor Plan

The ground floor consists of three spaces. First is a space occupying the sidewalk, with an area of around 4.13 sqm, utilized as an open store for vegetables. The interior of the house is divided into two areas. The larger cut is multi-purpose and is roughly around 9.00 sqm, which is used as a living, kitchen and storage area; and the remaining 2.47sqm is used as toilet and laundry area. The second and third floor, on the other hand, serves as an area for storage and sleeping. A ladder-like wooden stairs that is 0.55m wide serves as an access from the ground floor to the second floor. All upper floors are constructed with a roof eave that is 1.00m to 1.50m wide, located at the front part of the house. Floors are made from plywood and lumber scraps with linoleum on top, except for the ground finished floor that is made from slab floor and tiles.

During the day, five (5) persons are simultaneously using the ground floor, three adult females and two children. The second floor is used by a psychiatrically-ill adult female and the third floor is vacant. At night, four (4) female and one (1) male adult occupy the second floor while at a couple and two (2) children occupy the third floor, to rest and sleep.

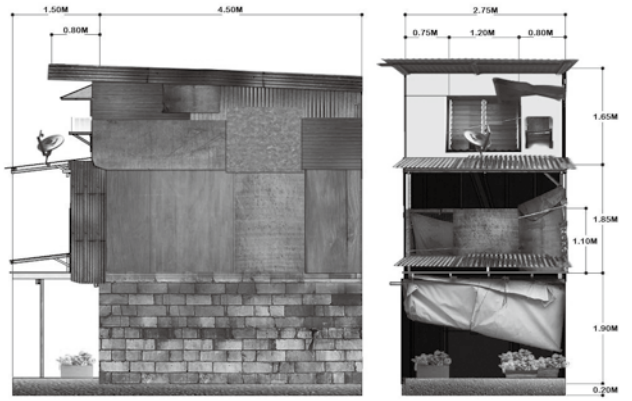

Fig. 2. Elevations

Fig. 3. Elevation Details

The average floor to ceiling height is 1.90m. Aside from the timber used in columns, beams, and stairs all other parts of the ground floor were constructed with the use of concrete and steel. The second and third floors, on the other hand, were constructed using segmented coco lumber and plywood in different sizes, with corrugated G.I. sheets on its exterior face as cladding for waterproofing purposes. Both the ground and second floor doesn't have a front wall for ventilation purposes, but uses a polypropylene rice sack and tarpaulin to protect its interior spaces from the rain. From the second floor down, the left and right walls are shared between two housing units.

Furthermore, the chosen subject has three televisions, a refrigerator, an air-conditioning unit, cable television network connection, stereo, stool chairs, foldable tables, beddings and a lot of shelves for storage.

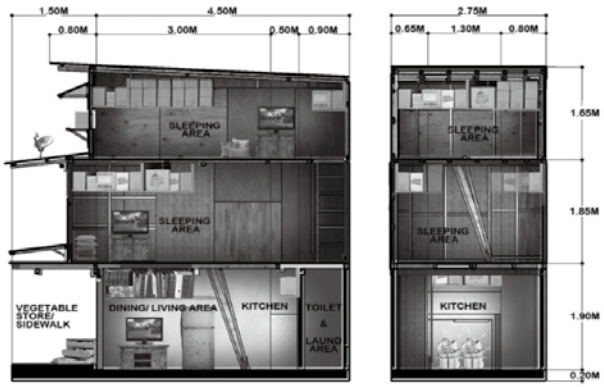

Fig. 4. Section

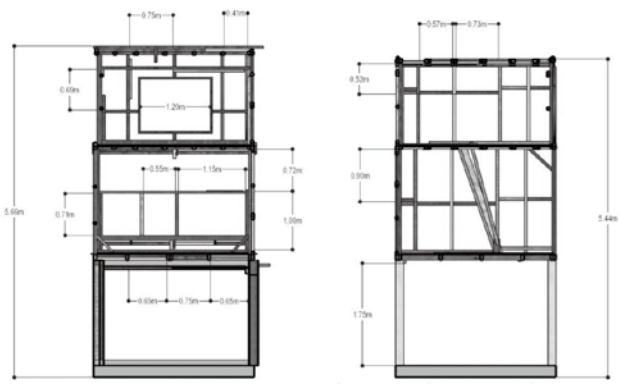

Fig. 5. Cross Section of Structural Framework

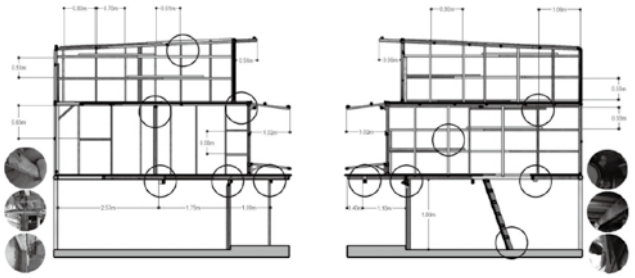

Fig. 6. Longitudinal Section of Structural Framework

Butt joints, lap joints, dado joints, mitered butt joints, cross-lap joints, and birdsmouth joints were randomly used to join coco lumbers together. A beam or column would usually have three to seven segmented lumbers in varying sizes nailed together or tied using a nylon string or rope.

Table 1. Comparative Analysis between the Study and the Building Guidelines of World Bank

Existing Conditions	Guidelines Based on Usage and Selection	Maintenance	Remarks
Structural Timber			
→Timber used as beams or columns are mostly free from crack, bend and excessive nail holes. But not all joists are. →Instead of Black Japan, Solignum is used in the Philippines to preserve and protect timber from infestations especially on coco lumbers. →Spanning sections are vertical and adjoining horizontal and vertical joist members are secured with cleats.	→Timber should be free of rot, crack, bends, excessive nail holes and infestations. →A coat of Black Japan should be used for embedded members. →Spanning sections should be used vertically; joists between horizontal and vertical members have to be secured with cleats.	→Wood with infestation, rot, and bends shall be removed.	Three out of the four items were compliant with the guideline as Solignum compensates the loss of Black Japan.
Structural Steel			
→For this specific case study, a C-channel steel was used as a composite column along with concrete mix and reinforcement bars. It is however, embedded into the ground but with red oxide coating.	→Box sections may be used as columns; Channel and I may be used as beams; Angle, T and Pipe section may be used as purlins and joists. →Use all spanning members in vertical sections. →Avoid embedding in to the ground; instead a pedestal should be built.	→Scrub off any minor surface corrosion before use. →Coat all steel with red oxide.	All three items were followed since red oxide coating is used on the structural steel member that is embedded in to the ground.

Structural Bricks			
→The counterpart of bricks in the Philippines are concrete hollow blocks (CHB) which are most of the time uniform in color, free from organic matter and salt and are externally plastered. →The ground floor exterior wall thickness conforms to the 9inch minimum requirement with reinforcement bars and plastering. The succeeding floors on the other hand which is 4.5" thick are made from plywood and lumbers with a G.I. sheet cladding that's used for waterproofing. →External concrete walls are being shared by two informal housing units for economical purposes.	→Bricks should be uniform in color, free of holes or cracks and the mortar used is free of organic matter and salt. Walls made from used bricks shall be externally plastered. →External walls shall be at least 4.5" thick. For a two-storey building, the lower floor should be 9" thick. Two to three iron bars should be laid for every 1 meter of the masonry wall. →External walls should be plastered or covered with plastic/vinyl at a minimum. →Sharing common external walls is not only economical, but also an efficient way to manage space as well as avoid water seepage.	→Should there be vertical cracks, sinking and tilting, immediate measure should be taken to identify the cause and remedy. →Fungus shall be removed by scrubbing and application of boric powder dissolved in water.	CHB serves as an alternative to bricks, all other requirement such as wall thickness, wall finish, water proofing for walls, and economical consideration were followed.
Galvanized and Corrugated Sheets			
→Corrugations are mostly installed vertically and adjoining sheets are installed with overlaps. →GI sheets were randomly nailed and bolted at the troughs and not at the crest. →For every two GI sheets that meet at a corner one sheet is folded over the other.	→Corrugations should always be vertical when GI sheets are used as wall cladding as well as overlaps between adjoining GI sheets. →GI sheets should be bolted at the crest and never at the troughs. →Corners where two sheets meet shall be secured by folding the sheet over the other. When folding isn't possible, a ridge piece shall be used.	→Rusts shall be immediately removed by scrubbing off or applying a coat of paint.	Bolts and nails are used to fix the corrugated G.I. sheets at the trough. Hence, only two out of three guidelines were followed.
Plywood			
→The plywood used for floors and walls are mostly secondhand and in varying sizes but are not used as a structural member. →Plywood are used as an exterior wall but are covered with corrugated G.I. Sheets, or just plain G.I. sheets for waterproofing purposes. →Based on observation, it is not used as a structural member on the subject of the study.	→Second-hand plywood with varying sizes maybe used or reused as cladding for floors and walls. →Avoid the use of plywood for exterior walls. If it must be, it should be coated with red-oxide and secured with plastic covering. →Should never be used as a structural member.	→Termite infested and parts with bends and stitch shall be removed and replaced.	Since the use of plywood for exterior walls is not totally prohibited, and the corrugated G.I. sheet compensates the use of plastics for waterproofing, All three requirements were followed.
Plastic/Vinyl Sheets and Tarpaulin			
→Tarpaulins are used not just for waterproofing but also as layer of protection from the excessive heat of the sun. →Since scavenged plastics vary in size, the dimensions are limiting, thus it does not fully cover the roof when used as a waterproofing material. Concrete hollow blocks and car tires are used to secure the plastic in place. When plastics are being fixed into the roof, tire rubbers are used as nailers.	→May be used temporarily for protection against water on roof or walls where plastering is difficult. →Should be thick enough to withstand weather without any holes and cracks. →If used, it should cover the entire roof; with secured corners and edges. If using nails, use a wooden pad or folded plastic piece to avoid tearing. Rubber solution may be used as adhesive when joining two sheets.	→Remove sheets after every monsoon to avoid dirt and pest infestation.	Only two out of three guidelines were followed/ applied. However the third instruction is conditional hence the "if used" term.

Conclusion

Out of the nineteen (19) building guideline requirements from the parts 1 and 2 of the book, seventeen (17) items or 89% are in compliance. That is considering the maintenance recommendations when an item or two are not existent or was not followed but has an alternative.

For the structural timber section, since most of the coco lumbers used in the construction of informal settlements are scavenged or are leftovers from a bigger construction, nail holes and cracks cannot be avoided. However, these only apply to joists and purlins. Most of the lumbers used as a beam or column are free of rot, crack, bends, excessive nail holes and infestations, at least for the studied residence. Solignum is also used for preservation purposes.

The Structural Steel section does not have a proper measure since it is not widely used in the building of shanties and from the subject itself, only one member is composed of structural steel.

The Concrete Hollow Blocks took the place of structural bricks in the building guidelines since it is what is widely used in the Philippines. The good compliance result could mean that Filipinos are well versed in the use of concrete in conjunction with hollow blocks and steel.

The guideline does not prohibit the use of plywood on the exterior wall as long as plastics or tarpaulins will be used as waterproofing. With this, galvanized iron sheet plays a great role in the construction of informal settlements. It acts as roofing, an exterior wall, a cladding that waterproofs plywood when used on the exterior walls, among many other uses. However, the proper use of this material is not thoroughly applied on the subject unit. One flaw is that bolts and nails are used to fix the corrugated G.I. sheets at the trough. Another thing is the lack of consistency in the vertical alignments of corrugations in the installation.

Although this research does not assure the resiliency of the structure being studied, 89% is a good percentage to start with.

Recommendation

Since the study is qualitative, a similar study in a quantitative manner would strengthen the findings of this research. The proponent recommends to have an actual as-built in 3D that could be subjected to a simulation of varying live and dead loads with the application of current phenomenon like the wind velocity of Typhoon Haiyan and the expected 7.2 magnitude earthquake called The Big One.

It also recommends having a study that will create a rubric based on the Building Guidelines of World Bank that is applicable to all and may be used to actually measure resilience based on guideline compliance, in consideration of all the recycled and scavenged materials that are used as alternatives in the construction of informal housing.

Lastly, to design a prototype house that is fully in compliant with the guidelines and recommendations of World Bank's Book 2 that is easily adaptable anywhere.

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