Public Low-Cost Housing in Myanmar

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Abstract—One of the goals of every family is having a home for their own. Low cost housing for low income level family is an important sector for every country. In our developing country, need to provide improved housing and related community facilities in both urban and rural areas, especially for low to middle income groups. The study reveals that factors in determining a quality low-cost housing arranged in descending degrees of importance are house safety, provision of public amenities, etc. This study aims to provide minimal essential shelter for low-income people, to upgrade the lifestyle of Myanmar low-income people with the systematic planning of living, to use local materials and simple technology to own a low-cost house in simple way, to provide good environmental infrastructure with healthy harmonious housing to meet the urban health challenges.

Keywords—Low-cost Housing, Affordable Housing, Low-income People, Building Systems, Affordable Building Materials, Construction technology, Facilities and Amenities

I. INTRODUCTION

The house is a place for living in. Housing has been recognized as an important development tool for restructuring a society and eradicating poverty all over the world.

Low cost housing is an approach in selling appropriate technology research towards housing provision. In essence the definition of a low cost house should not dwell just on the initial cost but should be made on the basis of life cycle cost of a house, thus initial construction costs, running costs, day to day operating, cleaning and maintenance costs, and periodic repair and replacement costs.

The Myanmar government has also provided adequate, affordable and quality housing projects for Myanmar society. Myanmar is considered a developing nation and challenged by economic development, providing low cost housing is limited by the resources available and the effectiveness of the programs implemented. This paper attempts to give design guidelines for public low cost housing in Myanmar.

The following paper addresses the need for low cost housing in Myanmar with the purpose of evaluating the existing circumstances.

II. APPROACH TO LOW-COST HOUSING

Affordable housing is defined as that which is adequate in quality and location and does not cost so much that it prohibits its occupants meeting other basic living costs or threatens their enjoyment of basic human rights. Housing affordability is multi-dimensional and involves more than the often-used simplified conception of the ratio of house purchase price to household income. [8]
TABLE I
AFFORDABLE HOUSING NEEDS AND HOUSING OPTIONS [9]

<table>
<thead>
<tr>
<th>Affordable housing needs</th>
<th>Low income families and the aged</th>
<th>Singles, low paid workers, students</th>
<th>Key workers, low and moderate income families</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>People who are homeless or width high support needs or on very low income, People needing support linked to housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level of assistance</td>
<td>Public / Community housing supported and non-supported tenancies</td>
<td>Low cost rental dwelling boarding houses, not for profit providers</td>
<td>Below market rental-houses, flats, secondary dwelling</td>
<td>Market rental</td>
</tr>
<tr>
<td>Group homes and crises centres and services</td>
<td></td>
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</tr>
</tbody>
</table>

Affordable housing cycle is running with step by step as the following. [1]

- Public private partnership agreement for developer and government & mobilization and skills training programs for urban slum dwellers
- Construction of urban middle income housing units sold at market rate
- Qualified low-income slum residents apply for “Micro-Mortgage” financing & housing program
- Developer’s profit from market rate units reinvested to build low-income housing project
- Middle-income and low-income housing stock increased, low-income families escape slums and earn formal land title

III. LITERATURE REVIEW

A. Livable Living Space [4] [6]

1) Analysis on the Setting of Low-Income House: In low-income families, all of the daily activities and the use of space are same. Most of the activities are taking in living room, such as sleeping, studying, praying, relaxing, working & dining. Cooking and dining functions are in kitchen. Most of the functions are mixed use in only one room to save the cost. The more mixing the functions perfectly, the more saving the cost.

2) Analysis on the Use of Furniture in Low-Income Family: There are two types. The first one is analysis on the use of furniture in simple low-income family in Myanmar. The second is analysis on the special types of furniture for simple low-cost housing in foreign countries. In foreign countries, there is special standard furniture for low-cost housing or public housing projects. There is not like that in Myanmar. Myanmar low-income peoples are used only the old simple style furniture. Most of Myanmar furniture is mobile types. So, some types of furniture are better than the special standard furniture in foreign countries. The suitable affordable furniture for low-cost housing projects should be defined in Myanmar. Because those can reduce the use of space and the cost of the house.

3) Analysis on the Dimension of Use of Space: There are two types in analysis on the dimension of use of space. The first is analysis on the use of space in simple low-income family in Myanmar. And the next one is analysis on the use of space in simple low-cost housing in foreign countries. Some of the furniture can combined as a group or like all in one. The use of space can be reduced because of that kind of combination of furniture. Also the no. of rooms can be reduced because of that kind of combination. The use of space is really depending upon the setting of furniture. Combine the furniture as the new. Save the use of space. Save the cost.

4) Study on Standards for Space Dimension: There are main four types of standards on studying on standards for space dimension in low-cost housing for low-income family.

Figure 2 Example of the Function of Low-Income Family in Low-Cost House
They are Time Saver Standards, The United Nations, The American Public Health Service and Other Norms and Standards.

B. Building System [3]

1) Sustainability for Low-Cost Housing Projects: There are two types of balanced sustainability and technical sustainability. In balanced sustainability, the importance of the four pillars for sustainability: social, economic, biophysical and technical sustainability. This requires achieving efficiency regarding planning, financing, and management and construction performances.

In technical sustainability, it implies good quality materials and serviceability in the built environment. Diversification and innovation of design and building materials have to meet the needs for durable and safe structures. Technical sustainability also implies sharing of information at all levels. Furthermore, the overall goal is to achieve the same or equivalent service by using less material and energy. It also implies energy saving during the construction and performance of the structure, moreover to minimize damage in nature as a result of urbanization. Furthermore, the use of materials by the current generation must not hamper the housing possibilities of future generations. Sustainable urban development, including low-income housing projects, can be seen as alleviation of certain social problems and promotion of good physical health and family environment for this and future generations.

2) Description of House Wall System: House design involves structural functionality, purpose and aesthetic issues that can be achieved through traditional or contemporary technological approaches. Whatever approach is used, “a house cannot be built without fundamental knowledge of building materials and construction”. Design and construction techniques differ depending on the external loads and local conditions such as geology, soils, climate, and natural hazards.

Building components and building materials have different service live times regarding aesthetic, economic, functional, physical and technical performance over time. It is therefore important to differentiate between the main elements of a structure, such as foundations, floor, walls, roof, ceiling, opening frames and sanitary elements. Walls and foundations play important roles in the stability of the structure as well as in the percentage of the total cost and construction time.

Local regulations stipulate technical requirements, and performance tests, on wall (and other) systems in most countries. Typical parameters that are considered include:

- Structural Strength
- Structural Stability
- Structural Requirement and In-Service Performance
- Thermal Performance
- Acoustic Performance
- Water Resistance and Damp-Proofing
- Durability

There are typically three common wall systems being used in house construction, (i) massive (ii) frame and (iii) core.

Improvements of wall system design aim to: reduce waste, reduce amount of required materials, and simplify assembly and increase accuracy and speed of construction.

In the massive wall system, that is a construction based on one type of material (a base). The type of material is commonly soil, natural or synthetic fibres, masonry, etc. It can be used with or without additives, moulding, binder, and special surface protection. An important characteristic of the system is the self supported walls. Use of constructions techniques and equipment varies depending on selected material.

Adobe, a mixture of earth and water, emphasis has been put on investigating ways to increase the stability and resistance to erosion using various additives.
TABLE II
WALL BUILDING SYSTEMS, ADVANTAGES AND DISADVANTAGES [3]

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massive System</td>
<td>+ Reduced number of materials and components</td>
<td>- High quantities of the same material needed</td>
</tr>
<tr>
<td></td>
<td>+ Materials could be manufactured insitu</td>
<td>- It needs wall finishing to perform well</td>
</tr>
<tr>
<td></td>
<td>+ High thermal capacities (common in hot arid climates)</td>
<td>- Needs support and centering during construction (verticality problems may cause the failure of the structure)</td>
</tr>
<tr>
<td></td>
<td>+ Medium to high resistance to dampness</td>
<td>- Possibilities of insects and vermin attack</td>
</tr>
<tr>
<td></td>
<td>+ Medium construction speed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+ Accessible information for design, construct and maintenance</td>
<td></td>
</tr>
<tr>
<td>Frame System</td>
<td>+ Medium resistance to natural hazards</td>
<td>- Increase variety of components, equipment and skills</td>
</tr>
<tr>
<td></td>
<td>+ High construction speed</td>
<td>- Intermediate level of accessibility of information for design, construct and maintain</td>
</tr>
<tr>
<td></td>
<td>+ Medium innovative design and construction techniques</td>
<td>- Compulsory use of wall finishing</td>
</tr>
<tr>
<td>Core System</td>
<td>+ Very high thermal performance</td>
<td>- Partially or totally imported material</td>
</tr>
<tr>
<td></td>
<td>+ High resistance to dampness</td>
<td>- Need industrialised production rises basic cost</td>
</tr>
<tr>
<td></td>
<td>+ Very high construction speed</td>
<td>- Needs Environmental control during manufacturing</td>
</tr>
<tr>
<td></td>
<td>+ Lighter elements to erect</td>
<td>- Special design and connections</td>
</tr>
<tr>
<td></td>
<td>+ Reduce site work</td>
<td>- Less access information for design, construct and maintenance</td>
</tr>
<tr>
<td></td>
<td>+ High innovative design and construction techniques</td>
<td>- High skill workers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Sophisticated and conventional equipment during construction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Higher possibilities of insects and vermin attack</td>
</tr>
</tbody>
</table>

Burnt clay bricks, need no painting, oiling or preservatives. They are fireproof and, waterproof and insect and fungus proof as well. They have low thermal expansion resulting in fewer cracks than in cement. No extra materials are needed except mortar.

Rammed earth, walling systems are formed by compacting earth in temporary or permanent forms. Negative aspects with soil constructions: non-stabilized soils show excessive absorption of water, low resistance to abrasion and impact, if not sufficiently stabilized or reinforced, low tensile strength, increasing vulnerability to earthquakes, low acceptability amongst social groups, due to numerous examples of poorly constructed and maintained structures, commonly lack of references for building performance and standards, relatively high-energy consumption during manufacturing of products such as burnt clay products.

Reinforced cement is a mix of water and cement which has been reinforced with polypropylene fibre, glass fibre or steel / steel mesh to increase compression and flexural resistance. The fibre mix in situ is not common.
The walls are often consist of prefabricated panels, decreases the lead-time for erection and assembly of elements. Negative aspects with reinforced cement: shrinking could be uncontrolled if no additives are incorporated, difficult to achieve even density in fibre mix if mixed by hand, certain reinforcements need special calculations.

Concrete blocks and concrete, can be hollow or massive with mortar or interlocked as a dry-stack masonry system. The masonry could be a non-reinforced or reinforced load-bearing wall, depending on local conditions and standards. Construction could achieve efficiency if well supervised and performed. Negative aspects with masonry: long term shrinkage of units placing wall under tension thereby increasing cracking, mixing of mortar must be done under control to obtain good results or cracks may appear, necessary to plaster and paint with waterproof painting, requires on site supervision, methods of jointing must be controlled.

Timber is one of the most commonly used materials for houses. Flexibility in design depends on the type of timber and needs of the end user. Negative aspects with timber: maintenance is needed; deforestation in large scale causes environmental problems, storage needs to be covered, sensitivity to fires and biological agents.

In the frame wall system, a frame, or skeleton, wall system consists of vertical, horizontal and angular members (timber, steel, reinforced concrete, etc.), joined together to form a load-bearing framework. The space between the members can remain open or be filled with different materials. These materials will either give the characteristics of solid walls (e.g. masonry) or lightweight walls (e.g. composite boards).

Natural fibre frame is a traditional technology with variety of shapes and construction techniques, governed by climate conditions and specific social environment. Single fibres are less resistant to compression but in larger quantities, and if twisted and interlocked, they can be used as structural elements. In-fill material usually consists of leaves and other types of fibres. Negative aspects with natural fibre frame: low life performance, requires extensive maintenance, vulnerability to biological agents, tendency to absorb moisture, accelerating the deterioration process, low resistance to physical impacts, rapid propagation of fire.

Aluminium frame is the system can be combined using cement board panels. The panels are produced with a range of different densities, combined with additional isolating materials. Walls need special accessories in order to provide inter-panel locking. The system has been found to be structurally resistant, well insulated and easily mounted if handled properly. Negative aspects with aluminium: not a standard solution, recommendations for usage is needed, specially designed range of fixing accessories, panels must be stored and handled with extra care.
Steel frame is able to encase many different materials: concrete or mud, precast panels, polyurethane foam, timber particle board, bricks, etc, thus allowing a large variety of solutions. The design of prefabricated steel frames, especially the interlocking links and clamps, varies from company to company. Negative aspects with steel frame: special design for joints, anti-corrosion measures must be considered.

Timber frame can be made in site or be prefabricated. The cladding has many possibilities, such as timber particleboard, fibreglass mesh with cement and plaster or fibre cement sheeting. The layout is flexible to users need and the elements easy and fast to assemble under supervision. Negative aspects with timber frame: special design for joints, need for supervision at site.

The core wall system consists of a combination of materials:

- An inner, or core, material that commonly uses a polymer matrix resin to achieve desired requirements such as temperature performance, chemical resistance, fire resistance etc.
- An external layer as protection or cladding such as mortar
- An outer reinforcement of metal sheets, fibre etc.

Polystyrene is used to increase thermal insulation properties. New solutions have been developed since almost a decade ago and are still being improved.

A special machine is needed to manufacture the metal profiles. The design has differed depending on location. Negative aspects with polystyrene: special equipment for manufacturing, relatively high base cost.

Polystyrene is used as core in a lightweight three-dimensional welded frame with sprayed concrete to achieve the required thickness. It is a monolithic wall system with many properties similar to conventional building elements. The most suitable use is for one-storey buildings and for certain industrial purposes. Typical characteristics are: structural stability, crack resistance, excellent thermal properties, good moisture barrier, good fire resistance and rapid assembly.

Metal web or Wire wall, consists of an expanded metal web filled with conventional cement mix, developed in South Africa. The walls are mounted in galvanised channels with a rod pile foundation system. The floor is a reinforced mesh and the roof of alternating tile type. It is quick to mount and no special equipment or skills are needed for construction and assembly. Negative aspects with metal web or wire wall: walls need to be plastered, if the walls shall be cover with sheet steel or aluminium, additional accessories are required, foundation needs special accessories and in most cases a ring beam of reinforced concrete, special machine required to manufacture the expanded metal web.

The type of building system should be chosen depending on the local condition.

C. Affordable Building Materials

There are two types in affordable building materials. They are Raw (Natural) building materials and Processed building materials.
TABLE III
DIFFERENCES BETWEEN NATURAL RAW AND PROCESSED MATERIALS [3]

<table>
<thead>
<tr>
<th>Natural Raw Materials</th>
<th>Processed Materials</th>
<th>Conventional</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Organic - Animal products (feathers, skin, hair) - Leaves and fibres - Natural rubber - Soils - Wood</td>
<td>• Natural Raw - Leaves and fibres - Soil - Wood • Artificial / Synthetic - Cement - Concrete - Steel - Plastic - Paper</td>
<td>• Artificial / Synthetic - Polymers - Composites • Recycled material - Waste materials - By products</td>
<td></td>
</tr>
</tbody>
</table>

Natural resources: Natural or synthetic and processed by humans

Produced through natural processes: Produced by means of technological processes and chemical reactions

Simple equipment used: Simple and/or sophisticated equipment used in production and during construction

Labour intensive during construction: Less labour intensive during construction

1) Raw (Natural) Building Materials: Traditional techniques involve local labour and the use of available natural raw materials such as earth, soil, natural fibres, natural rubber, stones and timber. The advantage of natural raw materials is based on environmental principles and social involvement. Disadvantages of natural raw materials are their dependence on local availability, water absorption, resistance to natural hazards, such as hurricanes, earthquakes etc., and resistance to eventual impacts, contamination susceptibility and social acceptability.

2) Processed Building Materials: Materials (which could be natural or man-made) such as concrete, ferrocement and other fibre cement mixes, glass, metal, polymers and recycled materials. 'Processed materials’ are substitutes for raw materials and are generally regarded as more technologically developed/advanced, with altered chemical, mechanical or physical properties. The choice between processed- and natural raw materials should always be based on local requirements. The advantages: specialized applications, improved properties, higher productivity and timesaving during construction.

D. Construction Methodology

Figure XII shows the basic components of housing affordability.

![Figure 12 Basic Components of Housing Affordability][8]

Construction Methodology is running steps by steps and based on the Literature Review. Figure XIII is the procedure of the Construction Methodology.

![Figure 13 Construction Methodology][8]
E. Facilities and Amenities

1) Education Facilities: That includes pre-school and formal school services. It must be within safe walk distance. The children should have walking access without having to cross any vehicular streets. Maximum should not exceed ½ mile.

2) Religious Facilities: An important role not only in the religious but also in the cultural and social activities of the community. If the population is from the same religious background, the problem is simple.

3) Social and Cultural Facilities: That includes public library, health centers, community centers, youth center, centers for the elderly, and shopping center.

4) Open Space and Recreational Facilities: There are four types of open space in a recreation system. They are_ Home-oriented space, Home cluster or sub-neighbourhood common space, Neighborhood space, and Community space.

IV. FOREIGN CASE STUDIES AND EXISTING CONDITION

A. GTZ Low-Cost Housing Project (Addis Ababa, Ethiopia) [2]

Figure 14 GTZ Low-Cost Housing Project

GTZ low-Cost Housing Project is located at the Addis Ababa, Ethiopia. The target group is low-income family group. The numbers of units are 696. The area is 45,191 (metre square) m sq with an adjacent production site of 12,000 m sq. The client is Addis Ababa City Government.

Figure 15 Basic Resources of GTZ Low-Cost Housing Project

That project consists of 28 buildings. There are six types of dwelling_ A to F. Different household sizes are varying from 22 metre square (m sq) to 105 m sq. Most of the functions are mixed use only in one main room. The building system is the simple construction with RCC building with columns and beams, and brick walling.

About the facilities and amenities, the health care is serviced by private practitioner and there is no provision in any others.

B. Green-Square Close Project (Brisbane, Australia)

Figure 16 Green-Square Close Project

Green-Square Close Project is located at the Hurworth Street, Redhill, Brisbane, Australia. The target group is low-income family group. The numbers of units are 112. The area is 21,600 sq ft. The client is the private developer.

Figure 17 Basic Resources of Green-Square Close Project

That project consists only one building with 10 storeys. Different household sizes varying from 36 m sq to 135 m sq. The room is the studio type and mix use in functions. The building system is built with precast concrete construction. But there is also used some timber posts in some areas to make warmly feeling. About the facilities and amenities, the health care is serviced by private practitioner and there is a little green garden inside the building.

C. Existing Condition in Foreign Countries

Remark from Case Study 1 (GTZ): Existing in the developing country. That is built by government and involved many different types of plans and designs. But all of the uses of space are designed by using rules & regulation for low-cost housing in Ethiopia.

Remark from Case Study 2 (Green-Square): Existing in the developed country. That is built by private sector. Private built but all of the uses of space are designed by using rules & regulation for low-cost housing in Brisbane.

Comparison from case study 1 & 2, the existing condition in foreign countries is coming out. In foreign countries, there are rules and regulation defined by government.
That is controlled all of the setting of the low-cost housing projects which are built by government or non-government.

V. LOCAL CASE STUDIES AND EXISTING CONDITION

A. Muditar Low-Cost Housing Project 1 (Mayangone Township, Yangon, Myanmar)

Muditar Low-Cost Housing Project (1) is located at Mayangone Township, Yangon, Myanmar. The target group is low-income family group. The numbers of units are 480. The client is the private developer.

That project consists of 3 building with 9 storeys. Household sizes are same with 480 square feet (sq ft). Most of the functions are mixed use only in living room. The building system is the RCC building with columns and beams, and using brick walling. About the facilities and amenities, the health care is serviced by private practitioner and there is a multi-purpose hall for religious services.

Transportation is good. Water supply system is running by ground tank. Electricity is getting from transformer, sub-meter for every units. Common streets and stairs lighting are provided. Sewage line is running into the septic tank and roads are concrete.

B. Kyan Sit Thar Housing Estate (Hlaing Thar Yar, Yangon, Myanmar) [7]

Kyan Sit Thar Housing Estate is located at the Hlaing Thar Yar Township, Yangon, Myanmar. The target group is low-income family group. The numbers of units are 760 & 848. The area is 30 acres. The client is the Department of Human Settlement and Housing Development, Ministry of Construction.

That project consists of two types of dwelling. They are 2 bedroom 4 storey and 3 bed room 4 storey room type apartments. Most of the functions are mixed use only in living room. The building system is the RCC building with columns and beams, and using brick walling. About the facilities and amenities, the health care is serviced by private practitioner and there is the Basic Educational Middle School, and also a multi-purpose hall for religious services in there.

Transportation is good. Water supply system is running by ground tank. Electricity is getting from transformer, sub-meter for every units. Common streets and stairs lighting are provided. Sewage line is running into the septic tank and roads are concrete.

C. Existing Condition in Myanmar

Remark from Case Study 1 (Muditar): That is built by private sector with simple design. Private built and all of the uses of space are designed as the owner want.

Remark from Case Study 2 (Kyan Sit Thar): That is built by government and involved two different types of plans. All of the uses of space are designed by the DHSHD decisions.

Comparison from case study 1 & 2, the existing condition of Low-Cost Housing in Myanmar is coming out. In foreign countries, there are rules and regulation but not in Myanmar. Low-cost housing projects in Myanmar are built as the designer or developer wants. The rules and regulation for low-cost housing projects should be defined in Myanmar.
VI. CONCLUSION

The delivery system of low-income housing projects can be improved by considering options for alternative design and materials. These play an important role in the economic development for formal and informal sector. Technical sustainability, such as energy efficiency, diversification, life-cycle analysis of materials, control, responsibilities, impacts on nature and health, should receive more attention. The budget condition or estimate is also important and the result design is needed to catch save the cost, good in quality and enough in size and space. But need to remind is that the social perception and attitude influence negatively on choice of design and material.

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