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Innovative Building Technologies – The Social Housing Angle

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Introduction

Nigeria's housing deficit of an estimated 17 million units is well documented.¹ This equates to an investment need of nearly \$600 billion when based on an average house price of a modest ₦5 million. The magnitude of this investment deficit is apparent when it is understood that \$600 billion approximates the value of all the oil Nigeria has pumped since Independence!²

Nigeria can boast Africa's largest construction market and the world's fastest growing construction sector³ as well as being the Nigerian economy's second fastest growing sector in 2012⁴ – second only to telecoms. The booming construction industry, however, serves the upper end of the market well, while there is little investment at the bottom end where the need for housing is greatest.

"The real issue with 'affordable housing' is that the real estate market has spent years investing in high-dollar commercial buildings and expensive single family homes so the pool of units for working people is close to nothing anymore."⁵

This statement is from the United States, not Nigeria – but it describes the local situation well. The Nigerian Institution of Estate Surveyors and Valuers recently reinforced the observation that "Most urban housing are (*sic*) created for high income earners."⁶ The vast majority of the population is excluded from the formal housing market altogether; 68% of Nigerians were below the international poverty line of \$1.25 per day in 2011 according to United Nations statistics.

Affordability

The housing stock that does exist in Nigeria is expensive when compared to local household incomes, primarily due to exceedingly high demand, and the cost of new construction is high by world standards.

The *median multiple* of house-price-to-income is an internationally recognised measure of housing affordability. It is defined as the ratio between median house price and median annual household income, and is covered in Agenda

¹ Federal Ministry of Lands, Housing and Urban Development, *Unleashing the Potential in Housing Sector as a Key Contributor to Nigeria's Economic Development*, Background Materials, Presidential Stakeholders Retreat on Housing and Urban Development, Abuja, 12th November 2012, p. 6

² Estimates of Nigeria's cumulative oil earnings range from \$400 million in 2004 (Hill, J.N.C., *Nigeria Since Independence: Forever Fragile?*, Palgrave MacMillan, 2012) to nearly \$1 trillion in 2011 (Ogundipe, Damola, *Oil Production, Corruption, and Its Effects on Nigeria's Post-Colonial Economy*, <http://www.africanoutlookonline.com/>)

³ Global Construction Perspectives and Oxford Economics, *Global Construction 2020*, 2009

⁴ National Bureau of Statistics, *Gross Domestic Product for Nigeria*, Abuja, February 2013

⁵ Hurt, Suzanne, "Affordable Housing Defined", *Sacramento Press*, May 3, 2010, http://www.sacramento.com/headline/26183/Affordable_housing_defined

⁶ *Premium Times*, "Institution Tasks Nigerian Government on Low-cost Housing", June 29, 2013, <http://premiumtimesng.com/news/139854-institution-tasks-nigerian-government-on-low-cost-housing.html>

21 of the United Nations Framework on sustainable development.⁷ A median multiple of 3.0 is considered “affordable” worldwide based on longitudinal data.⁸ The most recent data for actual median multiples in developed economies range from 3.2 in the United States and 5.1 in the U.K. to 13.5 in Hong Kong, long known for its crushingly expensive housing.

July 2013 data indicates a housing-price-to-income multiple of 20.45 for Lagos.⁹ This is more than six times the accepted affordability benchmark, six times the actual U.S. figure, and considerably higher than even Hong Kong. With Nigeria’s 2012 Gross National Income (GNI) per capita of \$ 2,420¹⁰ at purchasing power parity, this implies a median house price of ₦10 million and annual household income of ₦500,000. Housing in Lagos is hardly affordable to the masses.

There are multiple drivers of high housing prices. Land is expensive and construction costs – the sum of materials and labour – are high. Nigeria’s underdeveloped and uncompetitive manufacturing sector leaves the door open to imported materials, and at least 50% of construction materials, which make up some 60% of the cost of construction, are imported.¹¹ Cement, a major input, is chronically expensive in Nigeria by world standards. Recent analysis shows that construction of a basic three bedroom house costs 50% more in Nigeria than in India.¹²

Solving the Problem – A Sustainable Solution

The massive housing deficit, highlighted by the problem of affordability, should logically be approached from both supply and demand perspectives. The “top down” approach is to stimulate demand through improving availability of, and access to, mortgage financing.

Improved mortgage financing mechanisms, however, will not solve the problem at the bottom of the pyramid, which is where most of the demand in Nigeria is situated. Mortgage loans require repayment capacity; repayment capacity implies steady income. Most poor are either employed in the informal sector, which has been estimated at more than half of Nigeria’s GNP,¹³ or may not be employed at all (for example, the unemployed, or social cases – the elderly, pensioners, disabled, orphans). It has been pointed out that “Most of the low/moderate-income majority of emerging nations cannot afford a mortgage loan to purchase the least expensive commercially-built home, formal rental markets are poorly developed, and – instead – households must build their housing themselves.”¹⁴ This is certainly the case in Nigeria; the Federal Ministry of Lands, Housing and Urban Development’s own study in 2012 concluded that from an income perspective, over 80% of Nigeria’s population cannot afford a \$15,000 (₦2.5 million) mortgage even with 20 year tenure, no down payment, and zero interest, even when paying 45% of their income (which far exceeds affordability definitions).¹⁵

A “bottom up” approach does hold considerable promise, though. Supply can be stimulated by lowering the cost of constructing housing units, which expands availability.. Lower cost inherently expands access – elasticity of demand for housing is at the bottom (i.e. more people can afford a house at ₦3 million than at ₦5 million). Lower cost construction is a “can’t lose” proposition for buyers. Lower cost construction helps relieve the housing deficit regardless of financing issues. This is a sustainable, systemic solution that works no matter what else happens (or doesn’t happen) in the housing finance market

The issue remains of making the investment proposition attractive to housing developers in purely financial terms. Affordable housing development must be profitable or it won’t happen. Currently, the extreme supply shortage encourages “cream skimming” financial strategies by those in the housing construction business, which ends up targeting and serving the less price-sensitive top end of the market.

⁷ Median Multiples, <http://www.interest.co.nz/property/house-price-income-multiples>

⁸ Cox, Wendell (Demographia) & Pavletich, Hugh (Performance Urban Planning), *9th Annual Demographia International Housing Affordability Survey: 2013*, performanceurbanplanning.org

⁹ Property Prices in Lagos, Nigeria, http://www.numbeo.com/property_investment/city_result.jsp?country=Nigeria&city=Lagos

¹⁰ World DataBank, World Development Indicators, <http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD>

¹¹ Oladipo, F.O., and Oni, O. J., “A Review of Selected Macroeconomic Factors Impacting Building Material Prices in Developing Countries – A Case of Nigeria”, *Ethiopian Journal of Environmental Studies and Management*, Vol. 5 No. 2 2012

¹² Ibid.

¹³ Onyebueke, Victor & Geyer, Manie, *The Informal Sector in Urban Nigeria: Reflections from Almost Four Decades of Research*, 2011

¹⁴ Ferguson, Bruce, “A Value Chain Framework for Affordable Housing in Emerging Countries”, *Global Urban Development*, Volume 4 Issue 2 November 2008

¹⁵ Federal Ministry of Lands, Housing and Urban Development, op. cit.

Social Housing versus Affordable Housing

Social housing is defined as housing owned and provided by a Government authority for housing those with low income or special needs, which is not run for a profit. This implies a Government subvention or subsidy, and social housing is usually offered at below market rents. Housing itself may either be delivered directly by a Government entity or by private providers, including NGOs, using a public-private partnership (PPP) model. Social housing is also commonly known as low-cost public housing. Its availability is a policy decision.

Social housing is often confused with affordable housing, but the two expressions differ in important ways. Affordable housing can serve those other than low-income or special needs groups, is generally provided by the private marketplace, is usually run for a profit, and is financed fully by the purchaser or renter out of income without subsidy. Everybody needs affordable housing, not just low income families.

The U.S. Department of Housing and Urban Development provides important guidelines for affordability in terms of income: “The generally accepted definition of affordability is for a household to pay no more than 30 per cent of its annual income on housing. Families who pay more than 30 per cent of their income for housing are considered cost burdened and may have difficulty affording necessities such as food, clothing, transportation and medical care. The lack of affordable housing is a significant hardship for low-income households preventing them from meeting their other basic needs, such as nutrition and healthcare, or saving for their future and that of their families.”¹⁶

In Nigeria, public policy has favoured private sector provision; PPPs are popular mechanisms. While affordable housing is high on the agenda, social housing *per se* is not currently a high priority.

Innovative Building Technologies for Low Cost Housing

Given the extreme supply-demand imbalance; the abundance of demand at the bottom end of the market; the high cost of conventional construction techniques and materials; and the reluctance of financiers to invest in low-cost housing, innovative building technologies that drive down costs must be explored if social housing – and more affordable housing in general – is to become a realistic possibility in Nigeria. Four types of innovative building technologies which have relevance to Nigeria will be explored; these overlap and are not mutually exclusive:

1. **Dry Construction**
2. **Indigenous Materials**
3. **Green and Recycled Materials**
4. **Emerging Technologies and Composites**

1. Dry Construction refers to building construction done without conventional mortar or plaster (these are “wet” techniques). 90% of structures in Nigeria are currently constructed from concrete blocks;¹⁷ blocks vary widely in quality and the quality is mostly very low, contributing to building collapse. Although the Standards Organisation of Nigeria (SON) has established standards for concrete blocks, most block makers do not adhere to any established quality standards. In a field study conducted in 2012,¹⁸ *all* the blocks sampled from Nigerian manufacturers failed to meet SON standards. Construction with concrete block tends to be labour intensive and construction cycles are long, as the block must be cured and block structures must settle before finishing work can be done. Dry construction addresses both quality and cost issues for low cost housing.

Dry construction (with variation, also known as pre-fabricated – “pre-fab” – or modular construction) is an industrially manufactured alternative to blocks and mortar. Dry construction is innovative to Nigeria (since 90% of the market is currently served by conventional block), but it has a long history elsewhere in the world; it has been around since just after World War I in Europe, being developed in the Netherlands to serve post-war housing needs. In contemporary society, it is widely used for mass housing worldwide – examples of large developments built with dry construction techniques, cited recently by the Federal Ministry of Lands, Housing and Urban Development,

¹⁶ U.S. Department of Housing and Urban Development, “Affordable Housing”, http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing/

¹⁷ ¹⁷ Raheem, A.A., Momoh, A.K., and Soyngbe, A.A., “Comparative Analysis of Sandcrete Hollow Blocks and Laterite Interlocking Blocks as Walling Elements”, *International Journal of Sustainable Construction Engineering & Technology*, Vol. 3, Issue 1, 2012

¹⁸ Anosike, M.N., and Oyebade, A.A., “Sandcrete Blocks and Quality Management in Nigeria Building Industry”, *Journal of Engineering, Project, and Production Management*, 2012, 2(1) 37-46

are Homex in Mexico and Tata in India.¹⁹ Swedish furniture giant Ikea has joined the low cost dry construction housing trend with its BoKlok modular housing system in Northern European countries.

Dry construction covers a range of techniques:

- Wood frame/drywall
- Pre-cast components (panels) assembled on site
- Forms brought to site and structural components cast on site
- Entire structure factory-made and brought to site (“modular”)

In Nigeria, the long-established local firm Nigerite is the champion of the dry construction method. The primary cost benefit of this technique is in speed of construction – a typical three bedroom house can be built in two months using dry construction as opposed to one year with conventional techniques.²⁰ This is particularly important for developers when their cost of capital is high, as in Nigeria, where interest on bank loans can exceed 25% per annum. Dry construction accelerates the developer’s working capital cycle, reducing cost of construction outright and allowing more units to be built with the same credit line. Cost savings of up to 25-30% are claimed.²¹ Meanwhile, consistent quality can be maintained since components are factory built with industrial quality assurance in place.

2. Indigenous Materials should be more widely used as lower-cost alternatives to conventional or imported materials if construction costs are to come down. The most obvious structural application of indigenous materials is the use of compressed laterite bricks as an alternative to concrete blocks. Laterite is widely found throughout much of Nigeria and it costs between 30% and 47% less to build with compressed laterite bricks than with blocks, according to a 2012 study from scholars at the University of Agriculture, Makurdi.²² The Nigerian Building and Road Research Institute (NBRRI) promotes its designs for low cost laterite brick presses, and the Lagos firm Bolyn Constructions Ltd. has indeed manufactured and sold laterite brick and interlock presses in Nigeria for the past twenty years. As structural costs make up an estimated 22% of the overall cost of a finished house, cost reduction from using compressed laterite bricks are significant.²³

Locally-sourced lumber could be increasingly used for framing and structural applications if its quality could be improved to international standards. Currently, the quality of locally processed lumber in Nigeria is low, as it is sold “green” and the wood often cracks, splits, warps or has other structural problems after installation. Imported substitutes such as particle board are now used irrespective of inferior durability, as particle board is dimensionally stable and can be worked immediately. Previously, wood was commonly used as structural support for roofing; however wood is increasingly being replaced in this application with more expensive steel beams.

Nigerian-produced lumber is not kiln dried to the required moisture content; drying is energy-intensive, and the nation’s chronic power deficit is cited as the primary reason why Nigerian sawmills do not season their lumber adequately. However, solar-powered wood kilns (as pioneered by the U.S. Department of Agriculture in the 1970s) could be introduced to the Nigerian sawmill supply chain. Locally-operated solar kilns would increase the supply of seasoned lumber, lowering its cost and making wood framing applications again feasible in Nigeria, substituting for more expensive steel and block.

3. Green and Recycled Materials are a worldwide mega-trend and the use of so-called “waste-to-wealth” materials in construction is forecast to increase in virtually every major market. Nigeria is no exception. As resources become increasingly scarce and prices of basic items increase, reuse and recycling is a sustainable low-cost solution.

Nigeria can already claim to be the home of an innovative construction input made from recycled materials – the firm Chartwell Industries produces double Roman roofing tiles from recycled pure water nylons at its factory in Lekki. The plastic roof tiles are more durable, less prone to spoilage during installation, and less costly than

¹⁹ Federal Ministry of Lands, Housing and Urban Development, op. cit.

²⁰ Iroegbu-Chikezie, Okwy, “Dry Construction Can Bridge Housing Gap”, *The Nation*, May 7, 2013, <http://thenationonline.net/new/dry-construction-can-bridge-housing-gap/>

²¹ Ibid.

²² Raheem, A.A., Momoh, A.K., and Soyingbe, A.A., *Comparative Analysis of Sandcrete Hollow Blocks and Laterite Interlocking Blocks as Walling Elements*. International Journal of Sustainable Construction Engineering & Technology Vol 3, Issue 1, 2012.

²³ Ibid.

traditional ceramic roof tiles – virtually all which are imported at present. Chartwell plans to expand its production to long span roofing made from the same recycled plastics more of the entry-level housing market can be served. Low income individuals are served not only in the supply chain, collecting and providing the waste plastics, but also as end users who have access to a lower-cost roofing solution.

With the chronic high cost of cement in Nigeria, green alternatives have been well-explored as substitute binders or cement extenders in construction materials such as block and concrete. These low-cost recycled or waste materials include industrial fly ash, rice husk, and other agricultural wastes, all of which reduce the cost of construction without sacrificing strength or quality.

4. Emerging Technologies and Composites is a final category of low-cost materials and techniques that covers technologies not elsewhere enumerated.

Where concrete block continues to be used, an innovative, simple batch mixing technology pioneered by Cart-A-Way Systems of the U.S. and recently introduced to Nigeria²⁴ allows better quality, stronger blocks to be made on site, mitigating risk of building collapse, extending the life span of buildings, and reducing loss due to spoilage and waste.

Composite structural materials include plastic “honeycomb” panels that combine light weight with strength, “sandwich” panels typically using foam at the core, and hybrid materials that incorporate locally available natural fibres for strength.²⁵ It can be said that the ancient technique of building with mud brick strengthened with straw was the first form of composite construction. Use of composites is driven by cost factors and ties in closely with both use of indigenous materials and dry construction techniques.

The Intersection – Sustainable Low Cost Solutions

Innovative building technologies for low cost housing are not restricted to alternative materials alone.

Design. The importance of design cannot be underemphasized. It can safely be said that most low cost houses are constructed without reference to an architect, and design is often secondary even in mass housing projects when cost is of primary concern. Savings will be affected, however, when thought is given to efficient use of space – design features such as entryways, balconies, and unnecessary interior walls can add to cost without significantly enhancing utility.

Low cost housing designs should be localized for the Nigerian context as well. This varies from North to South; factors such as family size, air flow, the use of passive solar energy, and the need for security are important in design but are often overlooked.

In the Federal Capital Territory, the Fuller Center for Housing is moving forward with a low cost housing project based on the incremental housing system where buyers begin by building a very basic small house which can be “traded up” when paid off.²⁶ Other incremental concepts tie in to modular design and construction, where the basic unit can be fitted out, added to, and enlarged as the owner’s financial means grow.

High rise construction has not yet become the norm in Nigeria whereas it is the accepted solution for land availability and congestion issues in Asia. The dominant form of housing construction in Nigeria is still two-story. Building up, not out, can help address the chronic shortage of land in chronically crowded areas such as Lagos. Some innovative Nigerian developers are forwarding affordable housing designs based on concepts proven in markets such as Hong Kong.

Processes and Techniques. Innovative construction processes and techniques can be of considerable help in lowering the cost of construction. Dry construction has been addressed as the most frequently used alternative technique worldwide, and it has scarcely been used in Nigeria. Instead of a building being fully constructed on site, components are industrially manufactured and then assembled on site, accelerating the pace of construction.

²⁴ Adegboye, Kingsley, “New Block Making Technology Debuts in Nigeria”, *Vanguard*, June 18, 2013
<http://www.vanguardngr.com/2013/06/new-block-making-technology-debuts-in-nigeria/>

²⁵ Biswas, Soumitra, Mittal, Atul & Srikanth, G., *Composites - The Future Building Material*, Technology Information, Forecasting, and Assessment Council, Dept of Science and Technology, Govt of India,
http://www.tifac.org.in/index.php?option=com_content&view=article&id=542:composites-the-future-building-material&catid=85:publications&Itemid=952

²⁶ Coffey International Development, *Low-cost Housing Project to be Replicated in Nigeria’s Capital*, 19 June 2013,
<http://www.coffey.com/international-development/news/low-cost-housing-project-to-be-replicated-in-nigeria-s-capital>

Assembly is rapid, quality is consistent, and fittings and fixtures such as plumbing and wiring can be pre-installed or installed in pre-assembled units. A variation on dry construction uses block or brick, but these are formed to interlock and do not require mortar.

The importance of skills development cannot be overlooked. Dry construction requires that site workers have a different set of skills than those usually associated with traditional construction trades such as carpentry and bricklaying. Dry construction skills are a hybrid of sorts and are often specific to the methodology being employed at a given site. It is necessary that technical and vocational education and training programmes take into account the evolving needs of the skills market as innovative construction techniques become more widespread in Nigeria.

Public Policy. Government can not only favour social housing *per se*, it can also promote use of innovative building technologies and indigenous materials through procurement policies, rules, and regulations. Government is the largest single investor in fixed assets in Nigeria, and the public sector has direct influence over the source and composition of materials procured for use in its construction projects (as well as the composition of the labour force). Public projects can demonstrate the effectiveness of innovative solutions and take some of the risk out of private sector introduction of localized solutions.²⁷

South Africa is commonly cited as the leading African example of an operational social housing policy. The Government has passed the 3-million mark in providing free housing and housing opportunities in South Africa since 1994, the majority of beneficiaries being from the poorest parts of society.²⁸

Innovative building technologies can contribute to alleviating the housing deficit in Nigeria – as an integral, essential part of a comprehensive solution package that addresses both demand and supply constraints.

²⁷ It must be mentioned that the Social Housing Bill 2012 is in the Nigerian Federal Senate at the time of this writing.

²⁸ Southafrica.info, Brand South Africa country portal, *SA govt passes 3-million housing mark*, 23 May 2013, <http://www.southafrica.info/about/social/housing-230513.htm#.UgIMvtpwbcs>