

BUILDING WITH SHIPPING CONTAINERS: A SUSTAINABLE APPROACH TO SOLVING HOUSING SHORTAGE IN LAGOS METROPOLIS

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Abstract: The growth of the population in the metropolitan Lagos has assumed an alarming proportion, therefore the provision of urban infrastructure and housing to meet this demand is not at commensurate level, which has resulted in acute shortage of housing. The idea of using shipping containers as a building component and in architecture is by no means new in Lagos Metropolis. Most shipping container architecture conversions have however been for temporary accommodation needs, for example, storage, make-shift shops, emergency shelters and site offices. However, this concept of using shipping containers as modular building components in architecture and green prefab home building designs is still foreign to building practitioners and residents of Lagos state. The housing industry in Lagos Metropolis therefore needs to increase its building output, quality and speed of erection. There are plentiful stocks of ISO shipping containers at the Lagos port, and the use of these as building components offers faster construction time and guaranteed quality, especially where the fit out is pre-fabricated prior to installation of the unit. Also shipping containers are a widely available, low cost resource. The paper provides the assessment of the feasibility of using ISO shipping containers to provide solutions to housing shortage in Lagos Metropolis. It also sets out to provide a view of the viability of this medium, together with the problems that may occur in implementing their use. Adopting a case study approach, the paper researches on the present use of ISO shipping containers as temporary structures in Lagos Metropolis and highlights on its present challenges and inhibiting factors. A review of literatures supporting or critiquing this method of approach to solving housing shortage is examined, while questionnaires are used to sample public opinion and identify prospective user's perception on this new innovation. Also challenges facing the adoption of this method of construction and design were highlighted. Conclusions are drawn from the research findings and recommendations proffered on how this novel form of recycling ISO shipping containers for housing can be projected positively in the Lagos Metropolis.

Keywords: ISO shipping containers, Modular, Pre-fabricated.

INTRODUCTION

While the growth of the population in the metropolitan Lagos has assumed a geometrical proportion, the provision of urban infrastructure and housing to meet this demand is, not at commensurate level. This has resulted in acute shortage of housing to the teeming population with Lagos alone accounting for about 5 million deficit representing 31% of the estimated national housing deficit of 18 million (Oshodi, 2010). The extent of the housing shortage in Lagos is enormous. The inadequacies are far-reaching and the deficit is both quantitative and qualitative; even those households with shelter are often subjected to inhabiting woefully deficient structures as demonstrated in the multiplication of slums from 42 in 1985 to over 100 as at January 2010 (Igbinoba 2009). The problem of providing qualitative housing has been a concern for both the government and many individuals. Appreciating these problems, both the government (Public developers) and these individuals (Private developers) through their various activities strive to balance the gap in housing supply and demand, but the cost of building materials, stringent loan conditions from mortgage banks, government policies amongst other problems have been affecting housing delivery (Ademiluyi and Raji, 2008). One major problem of housing delivery is the issue of cost of building materials, this and other factors like cost of land acquisition have been the major setbacks in providing affordable homes for the urban populace in Lagos state, of which 60% of residents are tenants and have to pay rent as high as 50-70% of their monthly incomes since most of the existing accommodations are provided by private landlords. It is against this backdrop that the paper seeks to look at an alternative approach and method of construction through which both public and private developers can provide sustainable housing in Lagos metropolis. The paper focuses on the use of ISO shipping containers as alternatives for solving acute housing shortage in Lagos. Growing popularity and pressure for sustainable development across the globe has gradually increased the interest of architects, builders, developers and end-users all over Europe and America in cargo container structures for green housing alternatives. This is because it's too expensive for a country to ship empty containers back to their origin and therefore much cheaper to buy new containers from Asia. The outcome of this situation is an extremely congestion of ports globally with empty shipping containers that are just waiting to become a home, office, apartment, school, dormitory, studio, emergency shelter, and everything else etc. This is also witnessed in the West African coasts where International trade is witnessing unprecedented growth of 364 per cent in cargo traffic, as recent survey in the region's ports (Leadership, 2011). Figure 1 shows the congested Lagos port at Apapa. The



Fig. 1: Apapa container terminal – picture courtesy OTAL

Source: http://ports.co.za/news/news_2010_07_29_01.php

objective of this project is to highlight the importance of adopting innovative approaches and methodologies to address housing shortage. The paper argues that adopting shipping containers for alternative usage like housing could be one of many sustainable approaches employed to curbing housing shortages. The paper gives a brief overview of the shipping container, also known as an ISO shipping container or Intermodal Steel Building Unit (ISBU), stating the benefits of this recyclable component for housing, while also providing various view point of literatures reviewed in the cause of writing the paper.

LITERATURE REVIEW

The Sustainable Box

The ISO shipping container is a 40' (12.1m) or 20' (6.058m) by 8' (2.438m) wide and 8' (2.438m) high box made of steel, with a minimum internal floor area of approximately 27.95m² and 13.6m² respectively dependent upon the manufacturer (Smith, 2006) . Figure 2 shows a typical ISO container used for housing.

Originally developed in the 1950's by Malcolm Mclean, the UK architect, Nicholas Lacey made a leap by turning the temporary steel box to permanent accommodation. The ISO shipping container has been designed to stringent standards, not only to withstand the extreme weather conditions on sea voyages, but to withstand the stacking of 9 fully laden containers. This means that they are an excellent modular unit and their inherent strength, weatherproof nature and availability makes them an ideal modular structural component or as a whole standard accommodation unit. This modular technology enables construction times and cost to be reduced by up to half that of traditional building techniques while remaining significantly more environmentally friendly (Intermodal Shipping Containers and Architecture). Containers can provide temporary solutions to a particular shortage, be it housing, office space or another accommodation need. They can be used in disaster areas or areas of need and for key worker homes or student housing. The reuse of a container as a prefab building component in architectural design provides a second use (for a container) and assists in reducing the embodied energy of buildings, which is lower in comparison to other building materials as the unit has already been used for other purposes, possibly for a number of years, where as normal building components and materials are typically a first use of a material. Therefore as a by-product the shipping container can be seen as a sustainable component viable in providing houses in mass where there is a shortage of housing.

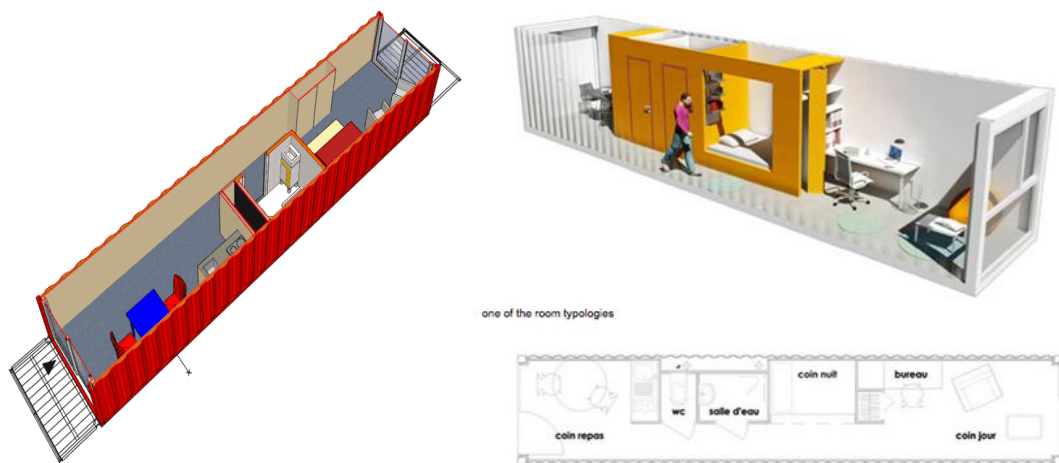


Fig. 2: 20' ISO shipping container accommodation

How Sustainable are the Shipping Container houses?

With the green premise growing in popularity across the globe, more and more people are turning to cargo container structures for green alternatives (Pagnotta, 2011). So many shipping containers are littered across the globe ,causing congestion because it's too expensive for countries to ship them back empty to their origin. Also Alter (2011), observes that shipping container architecture today has become all the rage. Though can be said in Parts of Europe, United Kingdom and other developed nations, this is not the case in Developing countries where the containers are still used in their

original state as temporary shops, offices and storage facilities on building sites. Very little research is put into how these rigid structures can be turned into architectural splendours, or for solving affordable housing shortage, especially in Nigeria, Lagos state, being the focus of the research paper Alter (2011), also noted that these containers were once expensive, now they are cheap and ubiquitous, and designers are doing amazing things with them. There are many benefits to the use of shipping containers as architectural models, some of these benefits are: strength, durability, availability, and cost. The abundance and relative cheapness of these containers comes from the deficit in manufactured goods coming from North America, Asia, and Europe. In Nigeria, a used shipping containers sell for a price range of N450,000-N600,000 (Naira) for the 40ft by 20ft while the 20ft by 20ft sell for N300,000 - N380,000 (Naira) depending on the year of manufacture). The attraction also to these components is the ability to use them as modular systems, being an advantage for building social housing units as alternative to housing shortage in Lagos state. However, as innovative and sustainably friendly shipping containers can be, they have their downsides. At Archdaily, Pagnotta (2011) writes:

Reusing containers seems to be a low energy alternative, however, few people factor in the amount of energy required to make the box habitable. The entire structure needs to be sandblasted bare, floors need to be replaced, and openings need to be cut with a torch or fireman's saw. The average container eventually produces nearly a thousand pounds of hazardous waste before it can be used as a structure.

He also argues that to make an adequate sized space, multiple boxes need to be combined, which again, requires energy. This he says is because dimensionally, an individual container creates awkward living/working spaces. Taking into account added insulation, you have a long narrow box with less than eight foot ceiling. Alter (2011), in his concluding thoughts in his article, *Does Shipping Container Architecture Make Sense?*, stated that thinking of the future of shipping container architecture, does not bring happy thought, because according to him, shipping containers have globalized the production of just about everything except housing, because houses are bigger than boxes. However this can be argued if seen as a module of a system which can be assembled to create practical spaces rather than just a box. While there are certainly striking and innovative examples of architecture using cargo containers, Pagnotta (2011), finally concludes that it is typically not the best method of design and construction, but it is however a design method that should not be ignored and if employed where desperately needed like in developing country, could bring comfort to countless lives. Shipping container homes makes sense where resources are scarce, containers are in abundance, and where people are in need of immediate shelter such as, developing nations and disaster relief. This description is a perfect scenario of the challenges facing the Lagos Metropolis in terms of housing shortage. The paper argues that though shipping container homes have certain downsides, these downsides cannot out weigh the challenges of providing housing for the teeming population in Lagos Metropolis, by employing this innovative building method as an alternative to reducing housing shortage for residents of the city, while still looking for more affordable and practical methods of providing houses.

Shipping containers as sustainable housing structures in Europe and America.

Many structures based on shipping containers have already been constructed, and their uses, sizes, locations and appearances vary widely across Europe, Asia and America.

In 2006, Southern California Architect Peter DeMaria, designed the first two story shipping container home in the U.S. as an approved structural system under the strict guidelines of the nationally recognized Uniform Building Code (UBC). This home was the Redondo Beach House, and it inspired the creation of Logical Homes, a cargo container based pre-fabricated home company. In 2000, the firm Urban Space Management completed the project called *Container City I* in the Trinity Buoy Wharf area of London. The firm has gone on to complete additional container-based building projects, with more underway. In 2006, the Dutch company Tempohousing finished in Amsterdam the biggest container village in the world: 1,000 student homes from modified shipping containers from China (Cookson, 2009). Figure 3 shows pictures of the student hostels in Amsterdam.



Fig.3: Keetwonen (Amsterdam student housing)

Source: www.tempohousing.com/projects/keetwon

Also the Dordoy Bazaar is a large wholesale and retail market in Bishkek, Kyrgyzstan. It is one of Asia's greatest public market places, built of double-stacked shipping containers. Typically, the lower container is used as a shop, while the upper one is used for additional storage. It is estimated that there are some 6,000 to 7,000 containers in the bazaar. This Asian Bazaar can be seen in figure 4. Other examples of shipping container houses can be seen in figure 5, (Container house in Puma City) and 6 (Container social housing).



Fig.4

Source: Rotschild, 2009



Fig. 5

Source: Herzog, 2011.



Fig. 6

Source: Push, 2011.

From observation, it can be seen that there is a total contrast with the level of finishing of container homes built in Asia, Europe and America as compared to those existing in Lagos state, Nigeria. Most containers shelters whether used as offices, construction site office or homes are still crudely and poorly executed. This is because most constructions are carried out by road side welders (metal work artisans) who are not well experienced and lack the technical skill to deliver such high level of finish and detailing. Also most builders and architects in Lagos are still oblivious of sustainable practices and therefore not interested in engaging in projects like container homes. We can see as the paper progresses examples of the stage and level of finishing of shipping containers currently being used for shelter and storage purposes in Lagos.

RESEARCH METHOD

A case-study approach was adopted involving personal observation, photography taken during field trips and a scoped systemic literature review of archival materials, publications focusing on the Lagos Metropolis and housing issues, as a secondary data, while also reviewing relevant literatures relating to containers as architectural components for solving housing shortage. Questionnaires were drafted, printed and circulated to sample opinions and perception of 200 professional within the age range of 25-65 years, who practiced in the Building Industry, on the introduction of shipping container architecture into the Lagos market as a way of providing housing in Lagos State.

DISCUSSION & FINDINGS

Below is a chart that illustrates the information gathered and documented after several questionnaires were passed to selected people to fill. 200 questionnaires were distributed to selected professional in the building industry including bankers and financiers, to sample their opinion on the introduction of shipping containers as an alternative for solving housing shortage in the Lagos Metropolis. 4 professional categories were chosen; Architects, Urban Planners, Engineers and Financiers/Bankers who financed housing projects. Each category had 50 questionnaires filled out. We asked them if they were for or against the use of shipping containers as houses. Below is a table documenting the number of people for or against the choice of material for building and their reasons summarised.

Table 1: Questionnaire Results on sampled opinions

N o.	Professional category	For shipping container homes	%	Against shipping container homes	%
1	Architects	36	72%	14	28%
	Reasons	Innovative, cost effective, sustainable		Not cost effective, required specialised work men, drastic change of construction material and method	
2	Engineers	42	84%	8	16%
	Reasons	Cost effective, structurally sound , good modular units		General bias about its credibility to provide optimum comfort, due to insulation challenges	
3	Urban planners	16	32%	34	68%
	Reasons	optimum land use management		Conflict with present building code regulations	
4	Housing Financiers	21	42%	29	58%
	Reasons	Cheaper to facilitate		Bias about its level of acceptance by end users	
	Total	115	57.5%	85	42.5%

Source: Author, 2012.

A total of 115 (one hundred and fifteen) professionals were in support of the innovative shipping container being used for building accommodation, that is 57.5% of the 200 selected professional who participated in the survey. While 85 (eighty-five) professionals were against the proposal to promote the use of containers for residential homes, that is 42.5% of the 200 selected professional who participated in the survey.

About 80% of the 115 professional who were for the innovative solution were between the ages of 24-45years while 20% fell between the ages of 45-65years. It was observed that the younger generation welcomed the new idea more than the older professionals who were biased about its functionality and argued that it was not a practical solution to solving housing shortage in the Lagos Metropolis. Figure 7 and 8 illustrates these results.

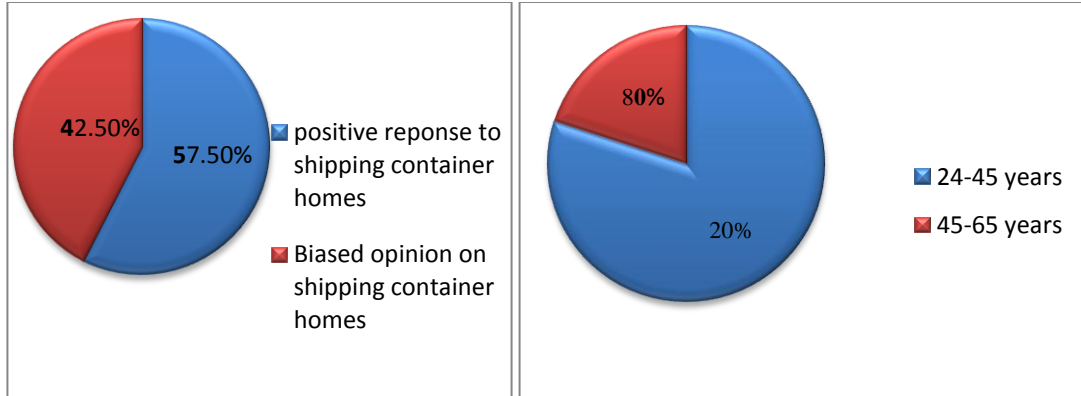


Fig. 7: Percentage of professionals for and against shipping container homes. **Source:** Author, 2012.

Fig. 8: Age demography of professionals who participated in survey.

It was also observed that shipping containers were already being used for various purposes like site offices, temporary storage and in some cases accommodation by the urban poor. Photograph were taken and documented for the purpose of this research paper. The containers used by the urban poor were usually at deplorable states and found in slums scattered within the Lagos metropolis. Figure 9, 10, 11 and 12, illustrates some of the ways these containers are being used presently in Lagos Metropolis.



Fig. 9: Restaurant **Fig. 10:** Construction site office **Fig. 11:** Post Office **Fig. 12:** Shelter

This method of construction is already being proposed in Lagos State. For now only 2 (two) known firms are pursuing the realisation of this innovative method of construction for the provision of shelter in Lagos state. These findings are briefly listed below:

- The Global Pathway Limited Firm, located in the United Kingdom, is versed in the durability and versatility of portable storage containers. The company plans on harnessing these qualities to expand availability to housing in Lagos State, Nigeria. The managing director of Global Pathway Limited is collaborating with the Real Estate Developers Association of Nigeria (REDAN) and Container Space Nigeria Limited, to introduce modular homes in Nigeria (<http://www.storagecontainer.com>, 2011).

- The University of Lagos is in discussion with Global Pathway Limited to plan the construction of student flats. The versatility of the units will allow more Nigerian's an opportunity to own homes and attend college.
- Tempohousing is a leading project developer using modular solution in different parts of the world, and are presently in Nigeria,Lagos state.Partnering with a Nigerian entrepreneur Dele Ijaiya-Oladipo of Ampersam Network Associates.Tempohousing intends to introduce and adapt the Tempohousing technology from Holland, to meet the ever increasing demand for housing in Lagos state,Nigeria. A factory is being built in ikeja, Lagos state in preparation to providing alternative modular housing units using the ISO shipping containers. Figure 13 shows a container being built at the Ikeja factory.

One major challenge encountered using an ISO shipping container for housing in the tropical region is the general discomfort caused by heat absorption of the steel box. In temperate regions many of these prefab and shipping container homes focus on passive heating and cooling. But in warmer climates, such as Africa and Central America, construction requires a different tactic – insulating from the heat and providing lots of natural ventilation to help cool. Tempohousing Nigeria is presently using a material known as Polyurethane Foam as an insulating material. However, the paper argues that there are cheaper and more organic insulating materials that could reduce the overall cost of construction of the container homes. Clay -sawdust compact dry building panels which are usually produced as flat panels are cheaper and better eco-friendly materials that can be locally sourced. Clay insulating panels are already being produced and available for eco-conscious builders and designers to use in building project around the world. Though the basic components of the insulating panels are abundant in their raw state in Lagos, they however are not easily sourced locally as finished products and must be imported. This on-going research hopes to investigate the viability of producing such insulating materials for shipping container homes and also proposes manufacturing panels that are made in moulds similar to the corrugated profile of the ISO container. Figure 14 shows some illustrations of proposed clay insulating panel profiles using a mould similar to the corrugated profile and a cross section of an insulated container.

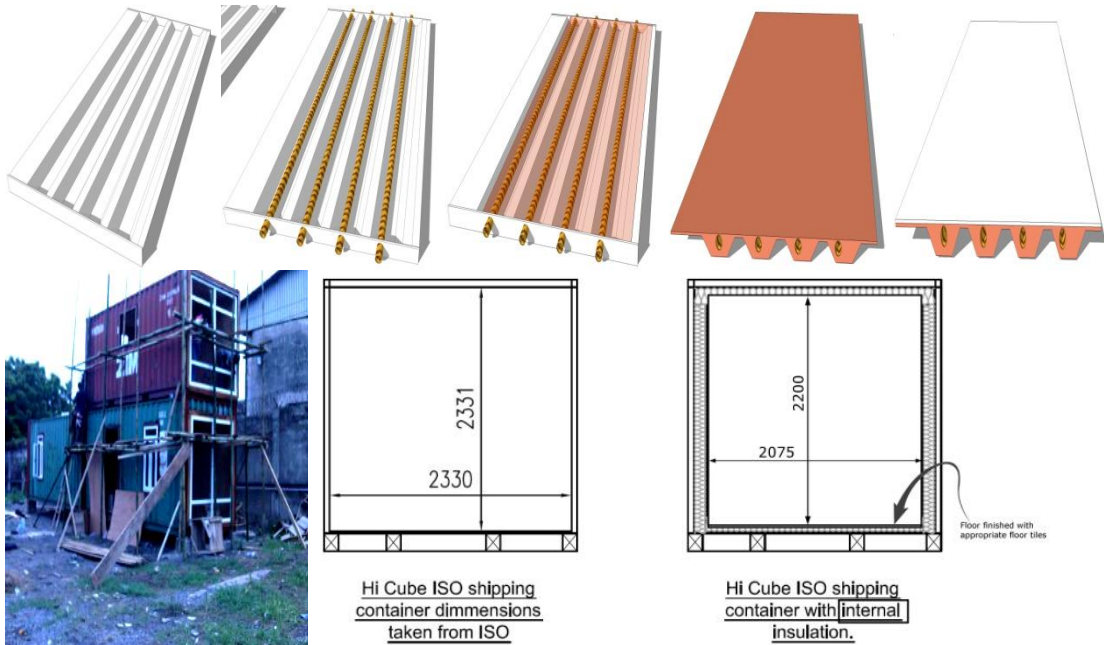


Fig. 13

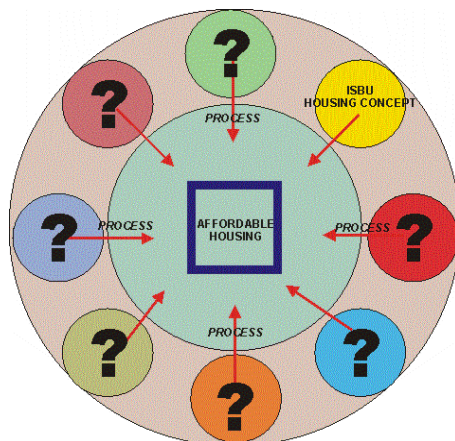
Fig. 14

RECOMMENDATIONS

For effective sustainable housing delivery, private and public developers should shift from over dependency on imported materials to the use of local materials that are cost effective and recyclable. In order to provide adequate housing for the Lagos population, Kabir Yari, the Managing Director of Urban Development Bank of Nigeria stated that the government must develop a good social housing policy. He defined social housing as a housing option for low to medium income persons (Adeyemo, 2012). Social housing can be actualised using the ISO shipping containers as recyclable building components. If embraced, and awareness is properly created towards all stakeholders, this would go a long way in curbing the acute housing shortage in Lagos. Other recommendations are briefly listed below;

- Public-Private Partnership should be properly executed and incentives towards employing innovative and sustainable form of construction should be encouraged.
- Building code regulations should be modified to achieve sustainable results.
- Real Estate Developers Association of Nigeria REDAN ,and other building industry professional Associations to sensitise professionals and general public on the alternative method of sustainable building.
- School curriculums/trainings should be re-visited to include sustainable programs.
- More case-study descriptions of successful sustainable projects should be shown to the public

CONCLUSION



All the programs embarked upon by the Lagos State government and its different agencies are aimed at regenerating the urban fabric, sustaining environmental quality and increasing housing supply. These efforts are ideal, but they seems not to be proportionally coordinated within the context of increasing accessibility to homes for the low-income earners. While, the houses for the upper income segment of the society has never been in short supply, housing for the poor has remained a vexed issue with various government

Fig. 15 programs unable to meet the deficit recorded in this segment (Oshodi, 2010). Building material is believed to have constituted 55% to 65% of total cost of construction input. But available record has shown that shipping containers as building materials cut the cost of construction of unit homes by 50%, and has a potential for enhancing mass housing development, but regrettably stakeholders have not embraced them. In conclusion, Shipping containers (ISBU unit), are one out of so many sustainable approach options to providing affordable housing in Lagos State. There is therefore no absolute solution to providing the required amount of affordable housing globally and in Lagos state. However, one can only strive to improve the present status of housing shortage by embracing and encouraging the adoption of every sustainable, innovative and affordable housing alternative being

showcased, so as to ease the housing shortage in Lagos and also globally. Figure 15 shows a model explaining this statement.

REFERENCES

ADEMILUYI, I.A. and RAJI, B.A. (2008) Public and private developers as agents in urban housing delivery in Sub-Saharan Africa: the situation in Lagos state. *Humanity & Social Sciences Journal*, 3 (2), pp.143-150.

ADEYEMO, A. (2012) *Government seeks private investors' help in providing housing* [WWW]. Available from: <http://234next.com> [Accessed 8/01/2012].

AGENCY REPORTS (2011) West Africa containerised cargo up by 364%. *Leadership*, 7th Oct, [WWW]. Available from: http://www.leadership.ng/nga/articles/6174/2011/10/07/west_africa_containerised_cargo_364.html [Accessed 10/12/2011].

ALTER, L. (2011) *Design / Modular Design : Does shipping container Architecture make sense?* [WWW]. Available from: <http://www.treehugger.com/modular-design/does-shipping-container-architecture-make-sense.html> [Accessed 17/11/2011].

COOKSON, R. (2009) Hotel changes the landscape of building. *Financial Times*.

HERZOG, A. (2011) [WWW]. Available from: <http://www.flickr.com/photos/ari-herzog/> [Accessed 17/11/2011].

IGBINOBA, R. (2009) *The state of Lagos housing market*. Lagos: Roland Igbinoba Real Foundation for Housing and Urban Development (RIRFHU).

INTERMODAL SHIPPING CONTAINERS AND ARCHITECTURE.

[WWW]. Available from:

<http://www.residentialshippingcontainerprimer.com/home> [Accessed 22/10/2011].

OSHODI, L. (2010) *Housing, population and development in Lagos* [WWW]. Available from: <http://www.residentialshippingcontainerprimer.com> [Accessed 22/10/2011].

PAGNOTTA, B. (2011) *The pros and cons of cargo container Architecture* [WWW]. Available from: <http://www.archdaily.com/160892/the-pros-and-cons-of-cargo-container-architecture/> [Accessed 22/10/2011].

PUSH, M. (2011) [WWW]. Available from: <http://www.flickr.com/photos/mr-push/> [Accessed 22/10/2011].

ROTSCHILD, I. "Tour de Dordoi" - Photos and essay on Dordoi Bazaar. *The Spektator Magazine*, 3, pp. 20-22 .