

APPLICATION OF ICT TO RESOURCE AND DISASTER MANAGEMENT

*Ayo C. K., Adeboye A. B., and Gbadeyan J. A.
Covenant University,
Ota, Nigeria.*

Abstract

Expansion works such as road expansion and location of new facilities had attracted huge compensations for demolished houses, farmlands and facilities, thus making the cost of future developments in the built environment very prohibitive. A number of urban cities in Nigeria are proposing Mega City Projects which call for sustainable physical planning and property management in order to minimize cost.

This paper proposes the application of information and communication technology (ICT), particularly the use of modeling and visual reality to sustainable physical planning and property management with a view to carrying out future expansion works with reduced compensation cost. Also, the paper considers the development of a Mobile Ad Hoc Network (MANET) for disaster response and management within the built environment.

Keywords: ICT, MANET, GIS, Modeling, Visual Reality, Facility Management, Disaster Management, Facility Location, and Built Environment.

1. Introduction

The concept of sustainable development has been largely missing in our design culture. Building structures are usually at the discretion of the land owners and individuals who can buy and erect whatever structure of choice. Experience has shown that in Nigeria, the planned areas in the country are largely the Government Reservation Areas (GRAs).

However, taking a cue from the developed economies, Europe, United Kingdom, South Africa etc all the streets and structures are well planned and governments, through the mortgage firms, are central to the acquisition of homes.

There is the need to be futuristic in the planning, design and construction of buildings. Ogunlana (2006) presented sustainable buildings as a major consideration in building construction in the 21st century through the cycle of planning, design and construction. The National Institute of Building Science (NIBS) opined that sustainable designs would lead to avoidance of resource wastage, depletion of energy, water and raw materials. Prevention of environmental degradation caused by facilities and infrastructure throughout their life cycle is observed to be capable of creating a built environment that is safe, conducive, comfortable and productive (NIBS, 2005).

Generally, the built environment professionals through the use of advanced

technologies such as the geographic information system (GIS), Visual Reality (VR) and Global Positioning System (GPS) can optimize site potential, energy use, protect and conserve water, optimize operational and maintenance practices (NIBS, 2005).

Environmental development in the area of expansion works such as road widening and location of new or re-location of existing facilities was identified to have been attracting enormous compensations for demolitions and alterations making the cost of development exorbitant. As a number of urban cities in Nigeria are proposing mega city projects, there is the need for sustainable physical planning and property management in order to minimize cost in this area of physical and human development.

All these developments could be shaped by the role played by disaster risk as observed by Human Development Report (HDR) of the United Nations Development Project (UNDP, 1999). It has also been observed that disaster risk has been a concern of regional works not only in Nigeria but all over the world as expressed (UNDP, 1999 & UNDP, 2002). The main reason for reducing disaster risk, which is a challenge to development, is to identify the relationship between human development and disaster because the objective of development itself is to create an enabling environment for people to enjoy long, healthy and creative lives.

The rest of the paper is arranged as follows: section 2 presents the objectives of the paper, section 3 presents related works, section 4 presents ICT and disaster management, section 5 presents the development issues on the evolving Mega

2. Objectives of the research

The objectives of this paper is to present the application of ICT particularly the Internet, GIS, GPS, Visual Reality and Modeling to achieve sustainable physical planning and property management with a view to carrying out future expansion works with reduced compensation cost as well as to develop an effective

3. Related Works

Anumba (2006) presented Wireless Technologies, Web Services, Semantic Web, Agent-based Technologies and Context-aware Computing as emerging technologies that have potentials to foster collaboration within a distributed construction environment in the face of globalized and complex construction projects where the various subcontractors are separated by space and time.

Ayo et al. (2006) presented the role of technology, particularly ICT in making the built environment safe for mankind. The paper presented the use of Computer-Aided-Design (CAD) – the use of computer in drafting and design; GIS – an information system that provides spatial information that helps in locating facilities – roads, sewage, structures etc; Visual Reality – a system that enables professionals visualize a modeled structure with a view to making predictions concerning usage in reality; and Smart Building – a system that integrates technology into structures to effectively automate and regulate heating, ventilation and air-conditioning (HVAC), lighting, access etc.

According to Liu et al. (2008), the advent of digital camera and mobile phones with camera offers the possibility of making photographs more accessible by publishing them online or sharing them using flickr. Flickr is a social networking site like Facebook that allows its members to store, sort, search and share photos and images via the Internet. This helps in information sharing in disaster management.

City syndrome as well as the dredging of River Niger (resource management), section 6 presents the recommendations while the conclusion is presented in section 7.

communication system through the Mobile Ad Hoc Network (MANET) to help out in disaster response and management within the built environment. Finally, the paper presents some scenarios of the involvement of the Mega city development in Nigeria as well as the impact of the dredging of the Niger River on the neighboring towns and cities.

Barry (1967) proposed the Air Survey method while Uttarwar (2001) proposed the application of GIS and Remote Sensing in urban planning, implementation and monitoring urban projects for Rohini and Dovarko project in New Delhi. The new multi-criteria method by means of multi-dimensional scaling technique was also developed in Nijkamo (1980).

Furthermore, it is observed that developments in ICT have impacted positively on the entire life cycle of a structure and the built environment. ICT and the Internet have the potentials to foster closer link between the participants in the building process as well as their activities and knowledge (Sariyildiz, 2010). The integration of the communications technologies has brought enormous possibilities to users. Through the Laptop, Palmtop, and Cell phones mails can be sent all over the world, particularly to persons in disaster areas for safety.

The 21st century has become spaceless and timeless, through the use of GPS. Anybody could be reached anywhere and at anytime. ICTs are used as partners in terms of knowledge integration, decision support and artificial intelligence. They can also be valuable and reliable friends in solving fuzzy or not clearly defined problems.

In an emergency situation, the GIS-based information tools allow disaster managers to mobilize right resources to the right location within the shortest response time. It offers the most versatile platform for decision support by providing multilayer geo-referenced information on all the available facilities and sites (Mohanty et al, 2010).

4. ICT and Disaster Management

Various disasters occur in different nations of the world at different occasions beyond national and international borders irrespective of the developed, developing or the least developed status of the country. Within the last decade, the world witnessed the Tsunami, earthquakes, hurricanes, cyclones, droughts and several other natural disasters. Neither man nor technology could prevent their occurrences but their impact can be managed significantly through the ICT (APT-ITU, 2005). ICT plays a very important role in early disaster prediction, communicating and disseminating disaster information to residents, and ensuring a speedy communication system after the disaster to both government and non-government agencies for relief materials.

Through ICT and in particular the Internet, GIS, remote sensing, satellite-based

communication links, effective disaster risk reduction measures can be implemented (Mohanty, et al., 2010).

The Indian Experience

The unique geo-climatic conditions of India have made it highly vulnerable to natural disaster. In India, 54% of landmass is prone to earthquakes, 40 million hectares of landmass is prone to floods, 8000 km of Coastline is prone to cyclones and almost 68% of the total geographical area is vulnerable to drought. The occurrence of Tsunami in 2004 left a devastating blow on the country (Mohanty, et al.2010). Complete prevention of natural disaster is beyond human capabilities but the involvement of the state-of-the-art technology and communication technology systems are panacea for implementing a reliable disaster prevention measures.

The Indian’s model is presented in figure 1.

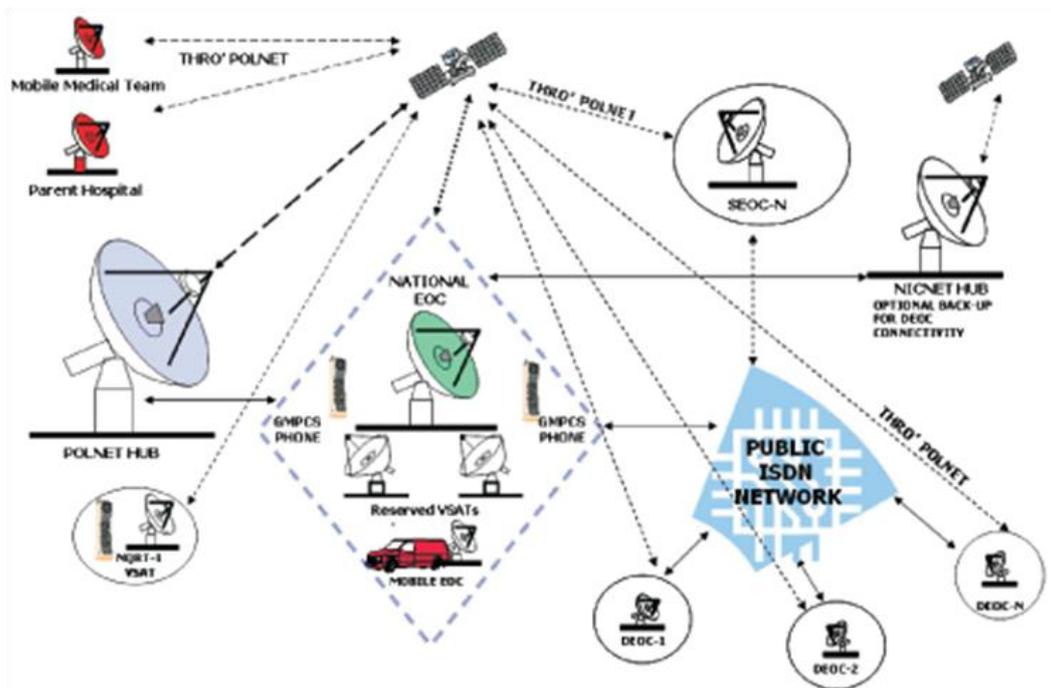


Figure 1: Proposed Indian National Emergency Communication Plan [Source: Mohanty, et al., 2010]

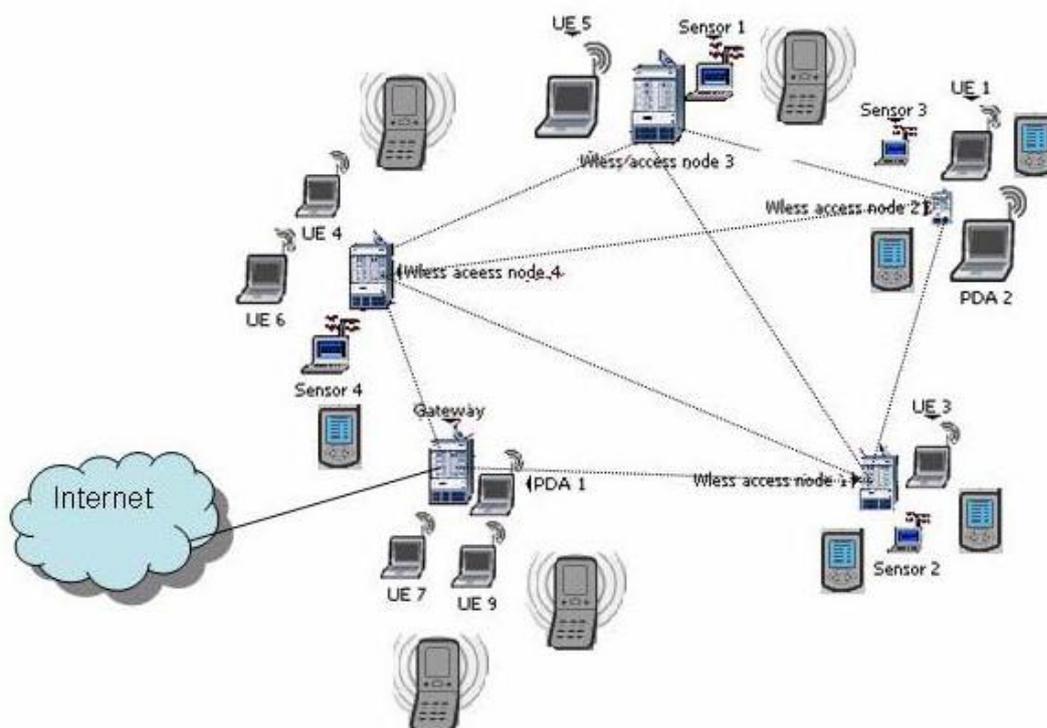


Figure 2: MANET-based Disaster Response and Management System
[Source: Adapted from Dilmaghani, et al. 2008]

The Nigerian Experience

There are available statistics about some zones in Nigeria that are prone to these natural disasters and there is a GIS-based system that contains the spatial information about Nigeria in general. However, the level of integration and usage is what cannot be readily ascertained.

Nigeria established the National Emergency Management Agency (NEMA), and was saddled with the primary responsibility of coordinating and facilitating disaster management efforts in Nigeria with a view to reducing loss of lives and property and to protect lives from hazards (Shaba, 2009). The specific responsibilities include:

- Disaster preparedness and mitigation;
- Notifying, activating, mobilizing, deploying staff and setting up the necessary facilities for response;
- Evaluating and assessing disaster damage and requests;
- Managing Disaster Management funds;
- Public Information and Enlightenment; and
- Formulating policy/guidelines for Disaster Management in the country.

Currently, Nigerian is known to be one of the fastest growing telecoms Nation in the world with about 76 million connected lines, which is about 50% of the entire population of the country (Akwaja, 2010).

5. Developments of Mega City and Dredging of the River Niger

The United Nations defined a megacity as a metropolitan area with a total population of more than 10 million people. Some definitions also set a minimum level for population density (at least 2,000 persons/square km) (Wikipedia, 2010). Bugliarello (1999) opined that megacities are strictly a phenomenon of the developing world but should be of concern to the developed world for obvious reasons: explosive population growth, massive infrastructural deficit, pressure

Thus, through the Mobile Ad-Hoc Network (MANET), we propose a distributed communication system for disaster management as shown in figure 2.

A Mobile Ad Hoc Network, MANET, is a collection of wireless mobile devices (nodes) that are equipped with a short range radio interface (Bluetooth and Wi-Fi). Mobile devices in a MANET can dynamically connect to each other within one another's transmission range, without any preexisting fixed network infrastructure. MANET provides a quick, self-configurable and inexpensive communication infrastructure for email, text communication and instant messaging in order to enable all the parties involved to interact continuously.

This model in figure 2 is highly appealing because it is self configuring and independent on infrastructure inherent in the connecting devices. It does not require preexisting infrastructure and it is used extensively all over the world for disaster management (Rao and Prasad, 2010) and for the US Coast Guard (Straw, 2011). In Nigeria, however, the model can be used as a messaging system in disaster zones to reduce the damaging consequences.

This architecture fosters seamless communication among wireless devices, laptops, cell phones etc. in a disaster zone. The advantage of the mesh topology is to ascertain that communications can continue unhindered even when a particular location has been affected by the hazard.

on land and housing, environmental concerns, scarcity of capacity and health to mention a few.

Lagos State is considered Africa's emerging model of a mega city. The State government has accepted this status and has set ambitious and achievable goals to realize the dream (Sawyerr, 2010). While some major business districts (Ikeja, Victoria Island) are expected to metamorphosed into the picture shown in figure 3 by the year 2020/25, the State is expected to embark on new towns with well-planned features



Figure 3: A Visualized Ikeja Business District for 2020/2025
[Source: Adapted from Shaba, 2009]

This ambition calls for sustainable development with massive investments in infrastructure such as road networks, power supply, water supply, transport system, health system, etc. The most economical way is to start the plan now, because it is cheaper to make reservations for road networks, relocate owners of ancient buildings, develop water/energy supply and sewage system to match the new look of the city and the expected population.

The dredging of the River Niger is most likely to have a rapid transformation of the

coastal cities to mega cities. Consider figure 4, an envisioned Lokoja bridge or re-planned Third Mainland bridge. This scenario is likely to play out arising from rapid developments in Lagos Island or Victoria Island.

The ongoing dredging of river Niger in Nigeria from the Atlantic Ocean to the Federal capital, Abuja, which is nearing completion, will open up a lot of the coastal towns and villages to development. Some of them will eventually evolve into mega cities as well.



Figure 4: Visualized Third Mainland /Lokoja Bridge in 2020/25
[Source: Adapted from Shaba, 2009]

Similarly, figure 5 represents the envisioned Sea ports in Lokoja (Kogi State), Niger State and Kaduna. These are possible development issues and the built

environment professionals should put on their thinking caps to contribute to these emerging trends



Figure 5: Visualized Lokoja, Niger and Lokoja Sea ports
[Source: Adapted from Shaba, 2009]

Furthermore, figure 6 shows an envisioned Abuja township by 2030/50. As beautiful as these scenarios may appear, there are major challenges which bother on local contents. Hence we may begin to ask ourselves the following questions:

1. What is the technical competence of Nigerian professionals in this respect?

2. Is Nigeria to rely on foreign experts and technologies?
3. Are the current academic curricula able to prepare the youths for the challenges ahead?
4. Is Nigeria able to formulate a framework or actionable plan to achieve all these to the maximum benefits of Nigeria?



Figure 6: Envisioned Abuja Township in 2030/50
[Source: Adapted from Shaba, 2009]

7. Recommendations

The mega city phenomenon requires concerted efforts in planning, modeling and visual reality. Thus, it is important to make future projections in terms of the implications of road expansions and location of facilities at reduced cost. The human capital requirements can also be developed with an invigorated education system.

The following are some recommended actions for future expansion works:

- Reservation can be made to reduce the amount of compensations to land/building owners.
- Government should institute development plans (Vision 2025) to start now.

8. Conclusion

We conclude that the use of advanced technologies such as the geographic information system (GIS), Visual Reality (VR) and Global Positioning System (GPS) can optimize resource management. The mega city phenomenon is a reality but requires proper planning for effective management of funds as well as production of the required human and material resources. The attendant benefits of appropriate resource management tools include: avoidance of waste, job

- Provisions should be made for energy, water, roads and various layouts presented.
- The Public, Private, Partnership (PPP) initiative is suggested for optimum result.
- A review of the academic curriculum to match our envisioned world.
- Retraining of the current built environment professionals to deliver on expectations.
- An increased use of ICT tools within the built environment professional.
- Development of an effective communications system to help in disaster management

creation, less dependence on foreign experts and improved economy.

Also, this paper presents the use of MANET to provide a quick, self-configurable and inexpensive communication infrastructure for email, text communication and instant messaging in other to enable all the parties involved to interact continuously.

Most of the environmental hazards may not be preventable: earthquake, hurricane, flood, acid rain, volcanic ash etc but appropriate technologies can be

employed to make accurate forecast and predictions, as well as engaging MANET for speedy dissemination of information to reduce the amount of casualties.

Future developments and expansions require concerted efforts from government, professionals and the academia. Appropriate recommendations

References

- Anumba C. J. (2006): "Information and communication Technology support for Globalization in the Built Environment", Being a keynote address delivered at the 2006 International Conference on The Built Environment: Innovation Policy and sustainable Development, pp xxi – xxiii.
- Ayo, C. K & Gbadeyan, J. A. (2006): "The Role of Technology in the Built Environment", *The Proceedings of the Built Environment*, pp. 446-451.
- Akwaja Chima (2010): Nigeria Telecom Investment boost GDP by 7%, *Financial Standard*, Vol. 10, No. 505, pg16.
- APT-ITU (2005) Meeting on Role of ICT for Disaster Reduction, 28 February 2005, Bangkok, Thailand, Access date: April, 2010, Available at : <http://www.itu.int/wsis/docs2/pc3/plenary/apt-itu-disaster-relief.pdf>
- Barry, M.G. (1967) Air Survey Method: Their Application to Physical Planning, *The Town Planning Review*, Vol. 38 No.2 pp135-150, Liverpool University Press
- Bugliarello George (1999): Megacities and the Developing World, publication of the National Academy of Engineering, Volume 29, Number 4 - Winter 1999, <http://www.members.nae.edu/nae/bridgecom.nsf/weblinks/NAEW-4NHMPU?OpenDocument>
- Dilmaghani R. B and Roa R. R. (2008): A Wireless Mesh Infrastructure Deployment with Application for Emergency Scenarios, *Proceedings of the 5th International ISCRAM Conference*, pp 484 - 494
- were made, which include: increased use of ICT tools, involvement of the Public, Private Partnership initiatives, making reservations for future developments in our plans and designs and to make effective use of the ubiquitous mobile devices for disaster management among others.
- Liu S. B. Palen L., Sutton J., Hughes A. L., Vieweg S. (2008). In search of Bigger Picture: The Emergent Role of Online Photo Sharing in Times of Disaster. *Proceedings of the 5th International ISCRAM Conference*. USA, pp149.
- Mohanty Sujit, Karelia H. and Issar Rajeev (2009): ICT for Disaster Risk Reduction- The Indian Experience, Accessed date: April 2009, Available at: www.ndmindia.nic.in/WCDRDOCS/knowledge-manageme.pdf
- Nijkamo, P. (1980) *New Multi-Criteria Method for Physical Planning by Means of Multi-Dimensional Scaling Techniques*, Paper presented at IFAC- Symposium on Water and Related Land Resource Systems, Cleveland, Ohio.
- Ogunlana S. O. (2006): "Sustainable Buildings: Where we should be heading", Being a Lead Paper presented at the 2006 International Conference on The Built Environment: Innovation Policy and sustainable Development, pp xiv – xxx.
- Rao K. Venu Gopala and Prasad G. Shyama Chandra (2010): Instant Disasters / War Zone Communication Management Through Manet: TBR, *Advances in Computational Sciences and Technology*, ISSN 0973-6107 Volume 3 Number 3 (2010) pp. 269–276, © Research India Publications, <http://www.ripublication.com/acst.htm>
- Sariyildiz Sevil (2010): ICT Influence on Spatial Planning, Building and the Built Environment, Access date: April 2010, Available at: <http://cumincades.scix.net/data/works/att/6375.content.pdf>
- Sawyer Stella (2010): Driving the Investment Train, *Tell Magazine*, No 17, May 3rd, 2010, pp44-45.

Shaba Halilu Ahmad (2009): National Disaster Management in Nigeria, Accessed date: April 2009, Available at: ochaonline.un.org/OchaLinkClick.aspx?link=ocha&doc/

Straw Joseph (2011): MANET Makes an Impression, The Magazine, [available online] <http://www.securitymanagement.com/article/manet-makes-impression-007555>

UNDP (1999) El Estado de la Region Human Development Report

UNDP (2002): Building Competitiveness in the Face of Vulnerability Human Development Report

UNDP (1999) El Impacto de un Huracán Human Development Report

Uttarwar, P.S. (2001), Application of GIS and Remote Sensing in Urban Planning, Implementation and Monitoring of Urban Projects: Case Study of Rohini and Dwarko Project, New Delhi, GISdevelopment.net