Enhancing Small and Medium Enterprises (SMEs) in Africa through Service Oriented Software Engineering (SOSE)

Emmanuel Okewu
Centre for Information Technology and Systems
University of Lagos
Lagos, Nigeria
okewue@yahoo.com

Abstract—**Experts in African development believe that small and medium businesses form the engine room of the continent's economic growth and development. This spectrum of businesses, to all intents and purposes, currently provides productive engagements for about 80% of Africans. Despite widely acknowledged contributions to the survival of the continent, adequate records have not been kept about this segment of the economy. The apparent dearth of statistics makes it difficult for entrepreneurship stakeholders such as investors, researchers, financiers, government and consultants to effectively and efficiently articulate and orchestrate a growth plan for them. This study relied on the doctrine of inclusive innovation and development to design and build an Automated System for Small and Medium Enterprises (ASSME) that avails information for these businesses to continue to grow in influence and importance. The researcher used service-oriented software engineering (SOSE) approach and against the backdrop that Nigeria is a microcosm of Africa, the study focused on the country as a testbed for implementing the web-based solution. The research methodology includes requirements engineering, modelling of the new system using universal modelling language (UML), implementing the proposed solution using Microsoft SharePoint development platform and finally, evaluating results. In the final analysis, a practical and usable n-tier enterprise application emerged. It will aid regulatory agencies like SMEDAN (Small and Medium Enterprises Development Agency of Nigeria) in gathering and coordinating information as well as availing same to entrepreneurship stakeholders in the Small and Medium Enterprises (SMEs) sector for their respective growth-enhancing interventions.**

Index Terms*— *Africa, Economic growth and development, Entrepreneurship, Service-oriented software engineering, Small and medium enterprises

I. INTRODUCTION

Small and medium enterprises (SMEs) have been considered as the engine of economic growth and for promoting equitable development. The sector has grown in popularity in recent memory as catalyst for inclusive economic empowerment that deliberately target the vulnerable segment (women, the poor, unemployed, the disabled, among others) of society with a view to given them economic voice. The chief merit of the sector is its employment potential at low capital cost. The labour intensity of the SME sector is much higher than that of the large enterprises, positioning it as a nursery for entrepreneurship, often driven by individual creativity and innovation. Towards providing an enabling environment for SMEs to thrive, a number of government programmes have been put in place to improve basic services, infrastructure and housing facilities for the rural population, extending access to credit, farm inputs and creating employment [1].

In Africa, a huge chunk of initial financing for SMEs is derived from personal savings of the operators themselves and from formal financial institutions, while additional financing comes mainly from informal sources. This is not surprising as the SMEs activities revolve around the poor who cannot afford loan from formal institutions. SMEs initiatives are targeted towards the poor, and covers all kinds of business activities, including petty traders, artisans, market women, plumbers, food sellers, farmers, housewives, cattle rearers, hair dressers, tailors, barbers, and groundnut sellers [2,3]. This illustrates that, as they evolve, SMEs are financed increasingly by the informal financial institutions. It also brings to fore the complementary relationship between the formal and informal financial institutions, with both providing resources to SMEs. In principle, African SMEs have been known to make valuable contribution to the economy, though not quantifiable. However, a worrying concern is the fact that studies have shown that, by their nature, these enterprises have insufficient access to formal financial institutions. Consequently, they rely more and more on their own or friends' and relatives' savings, and on informal financial institutions for investment capital. This limits the rate of growth of the SMEs. And this expansion constraint is worth investigating. It is an established fact that the lack of adequate information on their activities has made formal financial institutions and other stakeholders to show apathy towards them. Hence, the need to put information system in place for the rapid development of the sector. This is the motivation for this research study.

This paper reports a study of the use of service-oriented software engineering (SOSE) in building a solution that provides online real-time information for the

SME sector in Africa. The study designed and developed an Automated System for SMEs (ASSME) using Nigeria as test bed. The work empirically investigated the impact of online real-time exchange of information among SME stakeholders on the development of the sector. It equally x-rayed the use of SMEs as a vital tool for inclusive development through the inclusive innovation ideology. The author observed that not many reports on empirical application of automated system for SMEs transformation in Africa have been found in the literature. As a contribution, this work seeks to enrich the existing body of knowledge in the use of SMEs for inclusive development by reporting on a unique and practical experience of implementing automated information system in SMEs governance in Nigeria. This work is significant against the backdrop that it is rare to find reports of empirical studies of application of cutting-edge and technically sophisticated automated information system based on service-oriented software engineering that originates from the African region.

The remainder of this paper comprises the following: Section 2 gives the background of study and related work; Section 3 presents the methodology and the selected case study; section 4 focuses on results and discussions; and finally, the paper is concluded in section 5.

II. Background and Related Work

A. African SMEs Sector

The capacity of African countries to favourably compete in the global SMEs market is a function of their ability to innovate and apply the relevant mechanism to SMEs industry and productive sectors. The urge to propel and sustain the development and growth of this sector demands serious investment in the generation of knowledge that meets the yearnings of our society, fosters stability and sustains growth and development in tandem with the basic international standards in development goals such as the Millennium Development Goals (MDG) with focus on the eradication of global poverty as its prime mandate [2]. The introduction of an automated system for information capturing, storage and dissemination is certainly one of the viable ways of enhancing the sector.

A large percentage of the African population survives on informal labor. The vulnerable group, particularly the untrained youth are presently finding it difficult to find stable formal employment. There is no gainsaying the fact that the prevalence of this untapped informal sector creates great risk, which can result in economic and political instability as evidenced recently in some Northern Africa and Arab States. This underscores the need to put measures in place that bring together investors, entrepreneurs, policy makers, government representatives and consultants who are actively engaged in SME development. Information sharing has proven overtime to be one of such measures. And its use in facilitating initiatives like the African SME Expo which brings together business owners and decision makers at interval from Africa and the rest of the world for meaningful deliberation on SMEs growth and development is commendable.

B. Innovation Systems, Inclusive Innovation and Inclusive Development

Technology engenders new ways of doing things and this popularizes the concept of innovation systems. On the other hand, inclusive innovation defines the growing role of technology in bring about all-round development. When technology is deliberately used to harness the potentials of citizens, particularly the vulnerable groups who are normally kept out of development mainstream, we have inclusive development [4,5]. Hence, there is a thin line between inclusive innovation and inclusive development. Practically, inclusive innovation and development is the means by which new goods and services are produced by those who have been excluded from the development mainstream; particularly those living on lowest incomes. From the technology standpoint, technologies for the economically challenged such as low-cost mobile phones, mobile services, telecentres, better seed varieties, vaccines, etc are included. The application of software to enhance activities of SMEs in Africa as proposed by this research is an example of inclusive development initiative since the bulk of the players in Africa's SME sector are low-income earners.

C. Service-oriented Software Engineering(SOSE)

Service-oriented Software Engineering (SOSE) is a software engineering methodology focused on the development of software systems by composition of reusable services (service-orientation) often provided by other service providers. Since it involves composition, it shares many characteristics of component-based software engineering, the composition of software systems from reusable components, but it adds the ability to dynamically locate necessary services at run-time. These services may be provided by others as web services, but the essential element is the dynamic nature of the connection between the service users and the service providers [6,7].

There are three types of actors in a service-oriented interaction: service providers, service users and service registries. They participate in a dynamic collaboration which can vary from time to time. Service providers are software services that publish their capabilities and availability with service registries. Service users are software systems (which may be services themselves) that accomplish some task through the use of services provided by service providers. Service users use service registries to discover and locate the service providers they can use. This discovery and location occurs dynamically when the service user requests them from a service registry [8,9].

Figure 1 shows the service-oriented architecture on a web service platform.

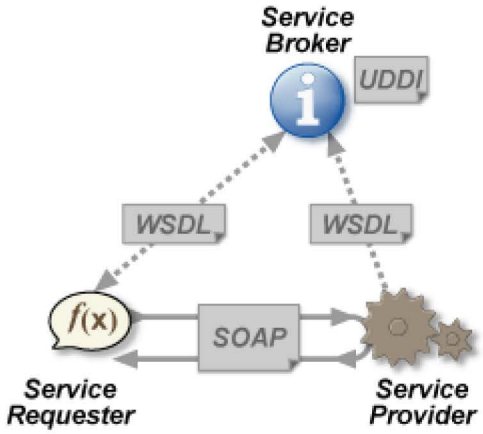

Fig. 1. . Service-oriented architecture (Source: *en.wikipedia.org/wiki/Web_service*) downloaded February, 2015

As illustrated above, in this web services architecture, the service provider sends a WSDL (web service description language) file to a directory named UDDI (Universal Description, Discovery and Integration) . The service requester contacts UDDI to know the provider for the data it needs, and then it contacts the service provider using SOAP (Simple Object Access Protocol). The service provider validates the service request and sends structured data in an XML (extensible markup language) file, using the SOAP protocol. This XML file would be validated again by the service requester using an XSD file. Generally, UDDI outlines which software system should be contacted for which type of data. In the event a software system needs a particular report/data, it would go to the UDDI and find out which other system it can contact for receiving that data. Once the system to be contacted is known, SOAP is used to make the contact. In the first instance, the service provider system would validate the data request by referring to the WSDL file. Thereafter, it processes the request and send the data under the SOAP protocol.

D. Related Work

Some of the previous efforts that are related to this work in the literature are presented as follows.

Box [10] shared the Kenyan experience of developing policies for financing small-scale industries. He suggested that the characteristics of the informal financial market or its structures could be used to develop small-scale enterprises in Africa. His assertion is consistent with current micro-financing initiatives in various African countries that target small-scale businesses. Various African government embarked on micro-finance scheme in view of its strength which lies in its simplified operations coupled with the promptness in loan procurement, both of which generally characterize the operations of the informal financial institutions which endear them to SMEs as opposed to the formal financial institutions. The study did not however state why funding of SMEs by formal financial institutions was relatively difficult. But a likelihood is that adequate information needed by these institutions about SMEs they plan to support may not be available. The provision of SMEs' information online real-time is the main motivation for this work.

According to Anyanwu [1] and Ogwumike [11], government showed concern for poverty reduction in Nigeria indirectly by launching many programmes. The programmes included the River Basin Development Authorities (RBDA), the Agricultural Development Programmes (ADP), the Agricultural Credit Guarantee Scheme (ACGS), the Rural Electrification Scheme (RES), the Rural Banking Programme (RBP) and Operation Feed the Nation (OFN) set up in 1977 among others. However, most of them could not be sustained as many of them failed due to diversion from the original focus, lack of political will and commitment, policy instability and insufficient involvement of the beneficiaries in these programmes. Though their works did not center on the use of SOSE to facilitate growth of SMEs as instrument for poverty alleviation, it underscored the fact that overtime, efforts have been geared towards inclusive development that centered around mainstreaming the less privileged in national development.

In their contributions, Egware [12] and Ogwumike [13,3] identified major factors hampering the success of government efforts to mitigate the level of poverty through the funding of SMEs. Among others, the factors include poor coordination, absence of a comprehensive policy framework, excessive political interference, ineffective targeting of the poor leading to leakage of benefits to unintended beneficiaries, and overlapping functions which led to institutional rivalry and conflicts. Though this study fell short of mentioning that SOSE approach could be used to enhance information access to SMEs sector stakeholders, it nonetheless alluded to the fact that SMEs could be used to mitigate poverty.

International Finance [14] posited that Small and Medium sized Enterprises (SMEs) are important drivers of growth in economies across Sub Saharan Africa, accounting for up to 90% of all businesses in these markets. To support SME growth and competitiveness, the International Finance Corporation (IFC) developed a holistic approach that tackles challenges faced by SMEs and the approach encompasses four building blocks: conducive business environment; provision of affordable access to localized and customized business management information, interactive tools, and training; providing access to new markets; and facilitating access to finance. By piecing these four solutions together in a coordinated fashion, IFC is playing a critical role in enhancing SME competitiveness across Africa. Nevertheless, the study was silent on the role of software application in enhancing SMEs.

Effective States [15] focused on creating secure states that are more effective at, and committed to, delivering inclusive development. One of the strategies being implemented is the engagement of the vulnerable segment of the society through micro, small and medium enterprises (MSMEs). It however did not specify how information system could be used to facilitate inclusive development through SMEs.

European Network [16] conducted a security risk assessment of cloud computing technologies from 2010 t0 2012 aimed at giving advice to SME's on the most important risks in adopting cloud computing technologies, as well as ways to address those risks. The study looked at the perspective of SME end-users of cloud computing infrastructures and applications (either current users or those considering adoption) and was based on a survey of the actual needs, requirements and expectations for cloud computing infrastructures. Though this study linked SMEs with computing technology, it did not explore the development of an application for the sector using SOSE approach.

In a nutshell, it could be seen from the reviewed literature that none of the previous studies had focused on the implementation of an Automated System for SMEs in an African context using SOSE approach. This is the main motivation for this work.

III. METHODOLOGY - AUTOMATED SYSTEM FOR SMALL AND MEDIUM ENTERPRISES (ASSME)

The study used Nigeria as a test bed. This is against the background that it has the largest economy in Sub-Saharan Africa and findings here can, to a large extent, be representative of economic realities on the African continent. The proof of technology was done using Microsoft Sharepoint while the underlying theoretical framework used was service-oriented software engineering. Guided by the software architecture process, the study progressed through activities of gathering architectural requirements, designing architecture to validating the service-oriented architecture

A. Architectural Requirements

The researcher gathered requirements and summarized the cross-cutting functional requirements of the proposed ASSME solution in Table 1.

TABLE 1. CROSS-CUTTING FUNCTIONAL REQUIREMENTS

Requirement ID	Requirement	Brief Description
R01	Add SMEs information	The system shall allow authorized users to add SMEs information to the database
R02	Access SMEs information	The system shall allow authorized users to access SMEs information from the database
R03	Edit SMEs information	The system shall allow authorized users to edit SMEs information on the database
R04	Delete SMEs information	The system shall allow authorized users to delete SMEs information from the database

B. Architectural Design

The deployment diagram for the proposed solution is shown in Fig. 2.

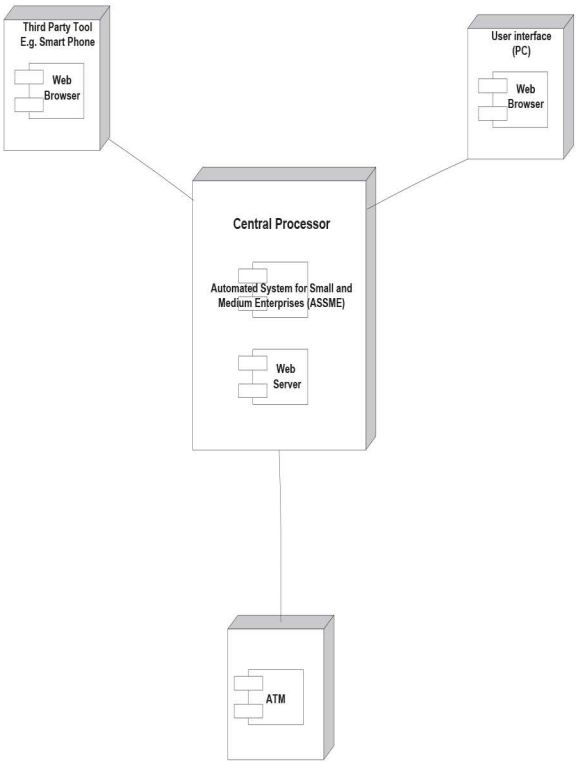

Fig. 2 ASSME deployment diagram

The ASSME algorithm design is as follows:

```
Procedure addSMEsServicesInfo()
  smesServicesInfo ← " "
  while (not endOfSMEsServicesInfo())
  smesServicesInfo ← addInput()
return(smesServicesInfo)

Procedure accessSMEsServicesInfo()
  while (not endOfSMEsServicesInfo ())
  getInfo(smesServicesInfo)
return

Procedure editSMEsServicesInfo()
  while (not endOfSMEsServicesInfo ())
  getInfo(smesServicesInfo)
  editSMEsServicesInfo()
return(smesServicesInfo)

Procedure deleteSMEsServicesInfo()
  while (not endOfSMEsServicesInfo())
  getInfo(smesServicesInfo)
  deleteSMEsServicesInfo()
return(smesServicesInfo)
```

The ASSME software architecture pattern is presented as n-tier architecture and the visual overview is shown in Fig. 3.

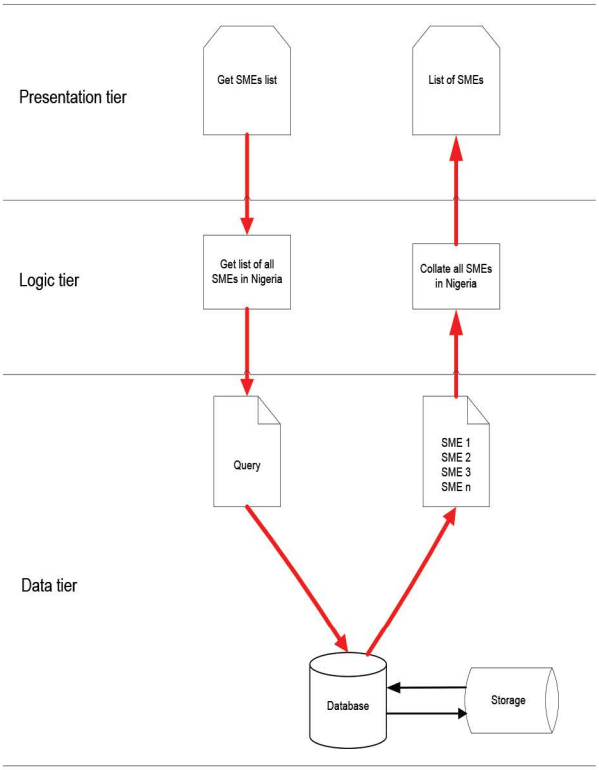

Fig. 3 Visual overview of the 3-tiered ASSME architecture

In this instance of the ASSME architecture, they are three layers, hence n = 3 and we have a 3-tier architecture as explained in the Table 2 below.

TABLE 2. ASSME ARCHITECTURE EXPLAINED

SN	Tier	Explanation
1.	Presentation tier	The top-most layer of the application is the user interface. Its key function is to translate tasks and results to something the user can understand.
2.	Logic tier	This layer articulates the application, processes commands, take logical decisions and evaluations, and performs calculations. It equally moves and processes data between the two surrounding layers.
3.	Data tier	At this level, information is stored and retrieved from a database or file system. The information is then passed back to the logic tier for processing, and then ultimately back to the user.

C. Architecture Validation

To verify and validate the ASSME architecture, a prototype was developed using Community Site component on the Microsoft SharePoint web-based development platform and tested. As the name suggests, the Community Site component facilitated online real-time conversation between SME stakeholders. Test scenarios were presented where service users (requesters) sought for information from the service providers housed in the service registry. To underscore the dynamic collaboration philosophy of SOSE which encourages real-time exchange between information users and providers, the prototype ensured that information was provided on real-time basis. This confirmed that Microsoft SharePoint is a web-based enterprise development tool that supports service-oriented software engineering. Put in another fashion, service users were able to access service providers warehoused in the service registry of Microsoft SharePoint.

IV. RESULTS AND DISCUSSION

To measure outcomes of this study objectively, the author used software experiment. The researcher also evaluated possible threats to obtained results.

A. Result of Software Experiment

The test bed allowed simulated web-based interaction between SME stakeholders. Not only was information freely shared, it was achieved on real-time basis. The implication is that government, entrepreneurs, financiers, consultants, and others with stakes in the SME sector can have access to information on the sector with ease. This fulfills the goal of accelerating development of the sector through information accessibility and availability. It should also be emphasized that as SME activities expand, more of the less privileged and vulnerable segment of society can be productively engaged thus strengthening inclusive development and overall socio-economic development.

Snapshots of the ASSME prototype experiments are shown in Fig. 4, Fig. 5 and Fig. 6 below.

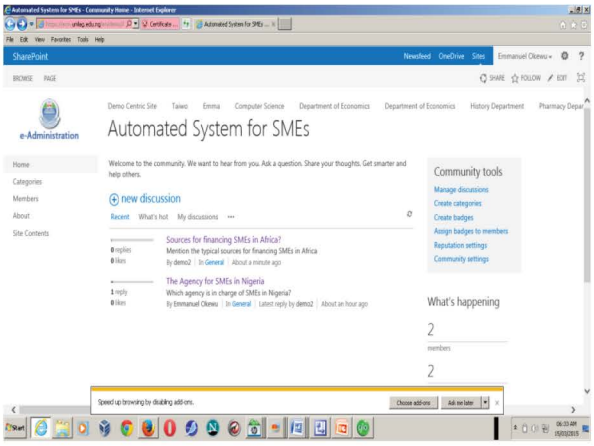

Fig. 4. The home page for Automated System for SMEs (ASSME)

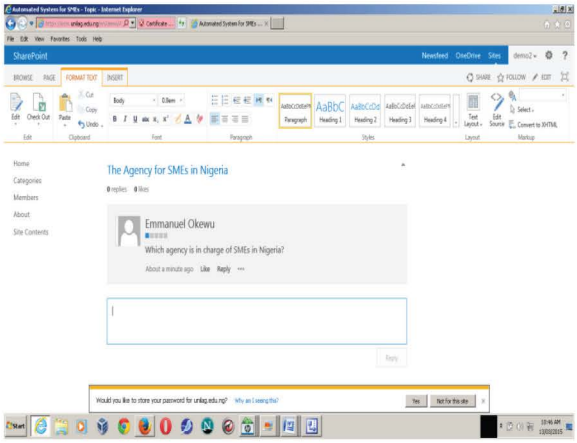

Fig. 5. A simulated user posting question seeking to know the agency responsible for SMEs in Nigeria

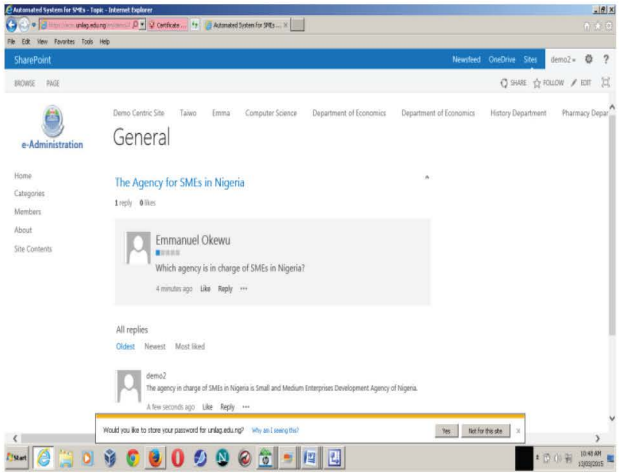

Fig. 6. A simulated user responding to the question on agency responsible for SMEs in Nigeria

B. Evaluation Threats

There are possibilities that an expanded evaluation of the different modules of the proposed solution (ASSME) could give new insights. Nevertheless, the subjects that participated in the survey have the required practical knowledge of Nigeria's SME sector. They equally had sufficient practical engagements with the application. Hence their observation is an objective assessment of how technology could be used to enhance inclusive development through information-driven SME sector. It follows that their views can be taken seriously.

Furthermore, the fact that only a limited number of people were involved in testing the prototype could in a sense limit the statistical significance of the outcome. However, the result of the experiment clearly indicates that robust web-based dialogue ensued between simulated SME stakeholders. Since the main objective of the study is to ascertain that technology could bridge the information gap between SME stakeholders and provide sufficient data on SME activities, the outcome is considered to be a good result. At this juncture in the project, the main objective is to have a sense of how ASSME can stimulate citizens participation in inclusive development through heightened SME activities. As a result, despite the constraint of using a limited number of evaluators, there is adequate ground to infer that the proposed solution could accelerate activities in the SMEs sector thereby providing increased opportunities for non-mainstream citizens to participate in entrepreneurial initiatives for overall socio-economic growth and development. We can thus generalize that service-oriented software engineering is effective for enhancing SMEs in Sub-Saharan Africa.

V. CONCLUSION

This study used innovative system (ASSME) and inclusive development to address the socio-economic challenges of Africa. This was achieved by targeting the SMEs sector as a tool and mechanism for transforming the lives of citizens through entrepreneurial initiatives. SMEs and their stakeholders need information for optimal decision making and ASSME has demonstrated that technology can address this information need in a timely and sufficient fashion. Using SOSE as proof of concept and Microsoft SharePoint for proof of technology, this study showcased the capability of technology to bridge the information gap between SMEs stakeholders, thereby boosting their confidence in the sector. This will lead to more investment in the sector with more citizens productively engaged.

REFERENCES

[1] C.M. Anyanwu, "Micro-finance Institutions in Nigeria: Policy practice and potentials", Paper presented at the G24

[2] Workshop on "Constraints to Growth in Sub- Saharan Africa," Pretoria, South Africa, November 29-30, 2004

[3] R.O. Olorunnimbe, and S. Adejobi, "Globalisation and Poverty Alleviation Strategies:the Nigeria Experience", in Geography and the Millennium Development Goals: Translating Vision into Reality in Nigeria, ANG 50th Annual Conference at Universityof Calabar 25th-28th August. pp613-624, 2008

[4] F.O. Ogwumike, "An Appraisal of Poverty Reduction Strategies in Nigeria": CBN Economic & Financial Review VOL. 39 N0.4, 2002.

[5] S.R. Arnstein, "A ladder of citizen participation", Journal of theAmerican Institute of Planners, 35(4), 216-224, 1969.

[6] C. Foster and R. Heeks, "Conceptualising inclusive innovation: modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers", European Journal of Development Research, 25(3), 333-355, 2013.

[7] H. Cervantes and R.S. Hall, "Technical Concepts of Service Orientation." Chapter 1, pp. 1-26 in Stojanović, Zoran and Dahanayake, Ajanthap. Service-oriented software system engineering: challenges and practices. Idea Group Inc. (IGI), 2004. ISBN 978-1-59140-428-6.

[8] H.P. Breivold and M. Larsson, "Component-Based and Service- Oriented Software Engineering: Key Concepts and Principles" in Software Engineering and Advanced Applications, 2007. 33rd EUROMICRO Conference on, ISBN 978-0-7695-2977-6

[9] Z. Stojanović, A Method for Component-Based and Service Oriented Software Systems Engineering. Doctoral Dissertation, Delft University of Technology, The Netherlands. ISBN 90-901910-0-3

[10] E. Okewu, and O. Daramola, "Component-based Software Engineering Approach to Development of a University e-Administration System", IEEE 6th International Conference on Adaptive Science and Technology (ICAST), 2014.

[11] R. Box, (1983) "Policies for financing of small-scaleindustries: Kenyan experience", in N. Molenaar, M.S. El-Namaki and M.P. Van Dijk (eds) Small-Scale Industries Promotion in Developing Countries, The Netherlands, 1983

[12] F.O. Ogwumike, "The Effects of Macrolevel Government Policies of Rural Development and Poverty Alleviation in Nigeria" Ibadan Journal of the Social Sciences, 1(1), 85 – 101, 1995.

[13] L. Egware, "Poverty and Poverty Alleviation: Nigeria's Experience". In Poverty Alleviation in Nigeria, Selected Papers for the 1997 Annual Conference of Nigerian Economic Society, 1997.

[14] F.O. Ogwumike, "Poverty Alleviation Strategies in Nigeria". In Measuring and Monitoring Poverty in Nigeria, Proceedings of the Seventh Annual Conference of the Zonal Research Units of CBN, 1998.

[15] International Finance Corporation, World Bank Group, 2015

[16] The Effective States and Inclusive Development Research Centre, The University of Manchester's Institute for Development Policy and Management.European Network and Information Security Agency, 2013.