Thesis By

OLUSESAN MICHAEL AWOLEYE

UNIVERSITY, ILE-IFE, NIGERIA

A STUDY OF PRODUCTION AND INNOVATION CAPABILITIES IN SELECTED INFORMATION AND COMMUNICATIONS TECHNOLOGY CLUSTERS IN NIGERIA

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CERTIFICATION

This is to certify that this research work was conducted by **Olusesan Michael Awoleye** in the African Institute for Science Policy and Innovation (AISPI), Faculty of Technology, Obafemi Awolowo University, Ile-Ife, Nigeria; and was supervised by Professor M. O. Ilori and co-supervised by Professor T.O. Oyebisi both of AISPI.

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Co- Supervisor

Prof. O.O. Jegede **Date: ……..**
Director, AISPI and Chief Examiner

DEDICATION

This work is dedicated to the Almighty God who is the Father of the fatherless; He has been all-in-all to me and my family. To Him be all the glory.

And to the memory of my beloved biological father and mother, Late Mr James Adeoye AWOLEYE who was a Principal Nurse at the Health Centre(HC), Obafemi Awolowo University until his death in 1983 and Late Mrs Comfort A. Awoleye, who was also a Ward Maid until her retirement in 2001 at the same hospital (HC).

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Michael Awoleye

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ABSTRACT

The study examined the production capabilities existing in selected ICT clustered firms in Nigeria and determined the nature and extent of innovations possessed by the firms. It also investigated factors influencing the building of production and innovation capabilities of the ICT firms in the clusters and established the impact of clustering on business performance of the firms. This is with a view to designing policy framework for facilitating innovativeness in the Nigerian ICT clusters.

The study employed survey design and was carried out using both primary and secondary data sources. A multistage sampling technique was used to select a total of 400 firms from ICT clusters from Abuja, Lagos and Port-Harcourt. Primary data were collected through structured questionnaire administered on founders of the selected firms. The questionnaire elicited information on issues such as firm's production and innovation capabilities; types of innovations; sources of information for innovation activities; internal and external factors affecting production and innovation activities and impact of clustering on business performance of the firms. Personal observations and interviews were also used to obtain more information on the activities in the clusters. Secondary data were sourced from official documents such as reports, journals and textbooks. The data were analysed using descriptive and inferential statistics.

The study revealed that about 15% of the ICT firms in the clusters had been involved in product manufacturing such as computer cloning, power packs modification, computer casing design and fabrication among others. About 57% and 22% had monthly production up to 20 and 40 computers on the average, respectively.

These firms had adopted traditional quality control (94%) and total quality management (23%). About 65% and 63% of the firms were involved in marketing and organisational innovations, respectively. These firms had generated 148, 382, 498 and 396 product, process, organisation and marketing innovations, respectively between 2011 and 2013. Most of the innovations were either new or significantly improved products or services. The study further showed factors that significantly influenced the building of production and innovation capabilities. This include qualification of marketing manager ($\beta = 30.66$, $\rho < 0.01$), suppliers of materials ($\beta = 22.16$, $\rho < 0.01$), qualification of owner ($\beta = 16.17$, $\rho < 0.01$), competition ($\beta = 13.76$, $\rho < 0.01$), innovation expenditure ($\beta = 16.17$, $\rho < 0.01$), age of business ($\beta = 6.97$, $\rho < 0.01$) and percentage of engineers ($\beta = 1.11$, $\rho < 0.05$). The following factors significantly contributed to business performance: resource spillover ($R^2 = 14.4\%$), cooperation and linkages ($R^2 = 11.5\%$), availability of financial resources ($R^2 = 11.4\%$), inter-firm resource sharing ($R^2 = 10.6\%$), increased performance ($R^2 = 8.36\%$) collaborations ($R^2 = 8.3\%$) and information sharing ($R^2 = 7.7\%$). The study also designed policy framework for facilitating innovativeness around effective linkage and collaborations between the clusters and knowledge institutions, standardisation and promotion of quality assurance as well as provision of cluster knowledge management system.

The study concluded that production and innovation capabilities in ICT clusters in Nigeria could be improved through provision of adequate human resource development, financial and technology support services and improved working environments among others.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Around the globe, the concern of improving national economic performance is paramount to every government. They attempt to achieve this by intensifying effort on academic research and its transfer to industry; they also facilitate the application of this research by domestic firms (Kodama and Suzuki, 2007). The dynamics of competitiveness and globalisation as propelled by technological change has also repositioned the way people think and live today. The amount of knowledge that a country has acquired and put to use has been adduced to the basis of her productivity and economic growth (Kim, 1998; Spielkamp and Vopel, 1999). The transfer and use of information now play an important role in the effectiveness of innovative systems and their potential to advance economic performance.

The concept of innovation capability (IC) is the ability to create new and useful knowledge (Kim, 1997; Ilori, 2006). It is further defined as the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of firms and their stakeholders (Lawson and Samson, 2001). Innovation capability thus represents a tool that induces the process of bringing firms together to tap new sources of knowledge and technology (Guinet, 2002). It also involves translating the acquired knowledge and technology into entirely new (Mytelka, 2000) or an improved (OECD, 2005) products and processes. Further concepts of Innovation Capability reveals that if a firm is to 'stand tall' in global competitiveness, external knowledge is essential (Cohen and Levinthal, 1990). The mobilisation of external sources for technological learning is christened 'learning by interacting' (Abereijo *et al.,* 2007). This suggests that companies cannot 'go it alone'

and expect success. Competitiveness now depends on complementary knowledge including technologies acquired from other firms and institutions (Ilori and Irefin, 1997; Cassiman and Veugelers, 2002). The ability to in-source externally developed technology or ideas underpin firm's absorptive capacity which cannot be underplayed in this context (Cohen and Levinthal, 1990; Cassiman and Veugelers, 2002; Liao *et al.*, 2009). Innovation Capability is further described as an embodiment of 7 key elements which are: (i) Learning capability which is the capacity to identify, assimilate and exploit existing, internal knowledge and competence essential for a firm's competitive success, (ii) R&D capability refers to a firm's ability to integrate R&D strategy, project implementation, product portfolio management and R&D expenditure, (iii) resource allocation capability is the firm's ability to mobilise and expand its technological, human and financial resources in the innovation process, (iv) manufacturing capability refers to the ability to transform R&D results into products, which meet market needs, (v) marketing capability indicates the capacity to publicise and sell products on the basis of understanding consumer's current and future needs, customer's access approaches and competitors' knowledge, (vi) organising capability is the capacity to constitute a well-established organisational structure; and (vii) strategic planning capability is the capacity to identify internal strengths and weaknesses and external opportunities and threats (SWOT) (Oyebisi, 2001; Yam *et al.*, 2004).

Knowledge flow and heterogeneity of firms and organisations tend to receive more prominence in innovation system literature which emphasises network of actors jointly creating, adapting and diffusing knowledge (Freeman, 1987; Lundvall, 1992; Ilori, 2006). Innovation has played a vital role in country's development, much more, where it is harnessed with adequate knowledge and skills.

1.2 Statement of the Research Problem

Economic viability of small-scale production has the ability to contribute to employment, income creation, innovation; productivity and competitiveness (Romijn and Albaladejo, 2002; Porter, 1990; Becattini, 1989.) Activities in ICT clusters are expected to hold promising potentials as agents of industrial regeneration. This is a major element in the quest of building a knowledge-driven economy (Bamiro, 2006). Innovativeness influences business performance and this may vary across firms based on organisation's place in the value chain. Firm's strength and disposition to opportunities and threats around them could also impact productivity. Oyebisi (2001) notes that enterprises need to be aware of their business environment/settings and hence recommended that firms should scan their environment to take business opportunities and to identify possible threats that may emanate from competitors.

A number of studies have provided empirical evidence in the USA and Europe that clustering is an important driver of economic growth (Blien *et al.,* 2006; De Lucio *et al.*, 2002; Combes, 2000; Glaeser *et al.,* 1992; Hendersonet *et al.,* 1995; Henderson, 1997). In low income economies, especially in Africa, studies on the effects of clusters on firm's performance and industrial development are particularly scarce. Where available, it primarily comes in form of case studies with small coverage of study. For example, Zeng (2008) conducted a desk research on comparative analysis of clusters in Africa and identified some capabilities in the clusters. He reported the capability of natural endowments to producing cut flowers in Kenya, fishing in Uganda and wine in South Africa. Also the Kamukunji metal works in Kenya, Nnewi auto parts and Ikeja Computer Villages in Nigeria. The Suame manufacturing and vehicle repair clusters in Kumasi, Ghana have also been noted to leverage on tacit knowledge of the indigenous entrepreneurs among other strengths (Zeng, 2008).

Oyelaran-Oyeyinka (2006) reported that most of the entrepreneurs in the ICT cluster in Ikeja came purposely to take advantage of the unprecedented growth of ICT businesses in the cluster. He also noted that the entrepreneurs started their businesses with funds from their own savings, friends and relatives. The study also shows computer assembly process is the main technological process taking place in the cluster. The components and parts merchandise take place also in the cluster provides the required input for the computer assembly (cloning) process. It was further reported that 70% of the operators sourced their components from the leading countries in micro-electronics around the globe. The total sum of these sources was put at about 800 suppliers scattered abroad (Bamiro, 2006; Oyelaran-Oyeyinka, 2006). This company had operational assembly capacity of 200-350 computers per day. However, some of the components were fabricated abroad to the company's design, which enabled them to make the Zinox brand. There is no recent information about what has happened to this collaboration, the data collected earlier may have been outdated. Whereas, innovation survey is expected to be repeated every three years (OECD, 2005), this is one of the reasons for this study.

In the computer village study, the cluster impact was reported to have created both direct and indirect employment. The total direct employment was estimated at 5,000 to 6,000 with an average of 10 staff per firm. The cluster also provides a platform for knowledge acquisition and diffusion for apprentices, street operators as well as opportunities for industrial work experience students (Oyelaran-Oyeyinka, 2006). The previous studies of ICT clusters in Nigeria (Bamiro, 2006; Oyelaran-Oyeyinka, 2006) have only used the conventional indicators to measure innovation output of firms and have failed to leverage on the new indicators as posited by OECD (2005).

Considering the dynamic nature of technological activities in the ICT clusters, there is a need for regular periodical assessments. The information obtained at the Ikeja Computer Village may have become obsolete. In addition, more ICT clusters have emerged in various parts of the country after the study.

Developing countries are still depending on technologies and knowledge developed in the developed world especially in the area of production and development of electronics. The experience of Japan, Korea and China suggests that developing countries also have strong potentials for innovation and technological capabilities. Technological learning in many developing countries is in a growing stage and learning from experience of these economies is important for development especially in the ICT clusters in Nigeria. Heavy reliance on importation of computers, components and peripherals is contributing to making the cluster sensitive to macroeconomic variables such as foreign exchange and import duties (Zeng, 2008).

1.3 Research Questions

The relevant questions that guided this study are:

1. What production capabilities exist in selected ICT clusters in Nigeria?
2. What is the extent and nature of innovations in ICT clustered firms in Nigeria?
3. What are the factors responsible for innovation performance of the firms in the ICT Clusters?
4. Does clustering of firms influence business performance in the clusters?
5. How would policy framework enhance the performance of the ICT clusters in Nigeria?

1.4 Objectives of the Study

The general objective of this study is to assess the innovation capability of firms in selected ICT clusters in Nigeria.

The specific objectives are to:

i. examine the production capabilities existing in selected ICT clustered firms in Nigeria;
ii. determine the nature and extent of innovations possessed by the firms;
iii. investigate factors influencing the building of production and innovation capabilities of the ICT firms in the clusters;
iv. establish the impact of clustering on business performance of the firms;
v. design a policy framework for facilitating innovativeness in the ICT clusters.

1.5 Significance of the Study

This study investigated production capabilities in ICT clusters in Nigeria. It determined the type of innovations adopted by enterprises and the number of innovations carried out by the firms. It also examined the factors responsible for innovation performance in the ICT-clustered firms and showed evidence of the impact of clustering on the firm's business performance. In addition, it presented a policy framework which provided a guide for the possible role of government through her relevant agencies, and the role of private firms, knowledge institutions and other stakeholders, such as: financial institutions, suppliers, customers, among others. The framework thus guides the interaction among the key elements of cluster innovation system through policy to enhance productive capacity within the ICT clusters in the country.

1.6 Contributions to Knowledge

The study provided information on production and innovation practices in ICT clustered firms in Nigeria. It has contributed to the understanding of the factors which are responsible for the building of production and innovation capabilities for gaining

competitive advantage. It also added to the body of knowledge on the impact of clustering on firm's business performance in the context of Nigeria. A robust policy framework for facilitating innovativeness in ICT clustered firms was thus generated by the findings.

1.7 Operational Definition of Terms

(i) Innovation: This is the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.(OECD, 2005).

(ii) Production Capabilities: This is personal and collective skills, production knowledge and experiences embedded in physical agents and organisations needed for firms to perform different production tasks as well as to adapt and undertake in-house improvements across different technological and organisational functions.

(iii) Product Innovation: Introduction of a new or a significantly improved good or service into the market.

(iv) Process Innovation: Introduction of a new or significantly improved production process, distribution method, or support activity for goods and services.

(v) Organisational Innovation: The implementation of new or significant changes in firm structure or management methods that are intended to improve firms' use of knowledge, the quality of firms' goods and services or the efficiency of work flows.

(vi) Market Innovation: The implementation of a new marketing concept or strategy that differ significantly from the firm's existing marketing methods

which have not been used before.

(vii) **R&D Intensity**: The percentage of total revenue allocated to R&D or ratio of Total R&D expenditure to total revenue (sales).

(viii) **Sales Performance:** This is a measure of the sales amount due to technologically new or improved product/processes as a change of total sales between 2011 and 2013 in the ICT clustered firms in Nigeria.

(ix) **Sales Turnover** is defined as the total market sales of goods and services include all taxes except value added tax.

(x) **Policy**: Policy is a projected course of action of an individual, firm or government within a given environment to provide solutions to problems and opportunities for the future in an effort to reach a goal or realise an objective to guide future decisions.

(xi) **Productivity**: The ratio between the quantity index of gross output (sales turnover) and quantity index of combined input (total R&D investments).

(xii) **Innovation Expenditure:** Spending on activities to support and implement production or process innovations.

(xiii) **Innovation capability:** skills and knowledge needed to effectively absorb, master, and improve existing technologies and to create new ones (Lall, 1992).

(xiii) **Absorptive Capacity:** Abilities of firms to recognize the value of new information assimilate it and apply it to commercial ends, which is critical to their innovative capabilities (Cohen and Levinthal, 1990).

(xiv) **Human capital** is the stock of knowledge, habits, social and personality attributes, including creativity, embodied in the ability to perform labour so as to produce economic value.

(xv) **National Innovation System (NIS):** The network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies (Freeman, 1987).

(xvi) **Cluster:** Geographical and sectoral agglomeration of enterprises operating in the same industry (Guilani, 2005).

(xvii) **Innovative firm**: Is one that has introduced an innovation during the period under review. The innovation(s) need not have been a commercial success.

(xviii) **Technological Capability (TC):** The ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies (Kim,1997).

CHAPTER TWO

LITERATURE REVIEW

2.1 The Concept of Innovation

The Oslo manual defines innovation as

"...the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD, 2005: 46)."

Innovation is also defined as the process by which firms master and implements the design and production of goods and services that are new to them irrespective of whether they are new to their competitors, customers or the world (Mytelka, 2000). This was defined in the developing country's context. The concept of innovation performance comes into play as a measure of innovation output. The innovative performance of an economy depends on how individual institutions and actors (e.g. firms, research institutes, and universities) perform in isolation and how they interact with each other as elements of a collective system of knowledge creation and use, and on their interplay with social institutions (Oyebisi *et al.,* 1996 and OECD, 1997). Without adequate development of these actors and institutions in the domestic and regional settings, the innovation system remains underdeveloped and anaemic (Juma *et al.,* 2005). Table 2.1 therefore puts in perspective the analytical building blocks of systems of innovation and industrial clusters framework (Oyelaran-Oyeyinka and McCormic, 2007). Lundvall and Johnson (1994) introduced a different set of distinctions: know-what, know-why, know-how and know-who. *Know-what* refers to knowledge about 'facts', here, knowledge is close to what is normally called information - it can be broken down into bits. *Know-why* refers to knowledge about

Table 2.1: Systems of Innovation in Clusters

Level of analysis	Cluster concept and innovation systems	Focus of analysis: Clusters	Focus of analysis: System of innovation
National level (macro)	Industry group linkages in the economic structure	Specialization patterns of a national/regional economy Need for innovation and upgrading products and processes in mega-clusters	National level actors (organizations and individuals) Knowledge bases and institutions Linkages between actors
Branch or industry level (meso)	Inter- and intra-industry linkages in the different stages of the production chain of similar end product(s)	Benchmark analysis of industries Exploring innovation needs	Sectoral analysis of actors, knowledge bases, linkages and institutions
Firm level (micro)	Specialized suppliers around one or a few core enterprises (inter-firm linkages)	Strategic business development Chain analysis and chain management Development of collaborative innovation projects	Firm level core capabilities for production and innovation Collaboration capabilities

Source: Oyelaran-Oyeyinka and McCormick (2007).

principles and laws of motion in nature, in the human mind and in society. This kind of knowledge has been extremely important for technological development in certain science-based areas such as chemical and electric/electronic industries. To have access to this kind of knowledge will often make advances in technology more rapid and reduce the frequency of errors in procedures of trial and error. *Know-how* refers to skills, such as the capability to do something. It may relate to the skills of manual workers, but actually plays a key role in all activities in the economic sphere. The businessman judging the market prospects for a new product or the personnel manager selecting and training the staff have to use their know-how. It would also be misleading to characterise know-why as science-related and know-how as being for practical people. One of the most interesting and profound analyses of the role know-how is actually about how the advanced scientist makes research on the basis of personal skills (Lundvall, 2000). However, not all know-why knowledge is scientific. In everyday life, when interpreting what is happening, models of causality that have very little to do with science are applied by ordinary people. Know-how is typically a kind of knowledge developed and kept within the border of the individual firm or the single research team. But as the complexity of the knowledge base is increasing co-operation between organisations tends to develop. One of the most important rationales for the formation of industrial networks is the need for firms to be able to share and combine elements of know-how. Similar networks may be formed between research teams and laboratories. This is one reason why *know-who* becomes increasingly important. There is general trend towards a more composite knowledge base where a new product typically combines many technologies. Any technology is rooted in several different scientific disciplines and coupled with dynamics of technological change is crucial to have access to different sources of knowledge (Ilori

and Irefin, 1997). Know-who involves information about who knows what and who knows to do what. But it also involves the social capability to co-operate and communicate with different kinds of people and experts.

2.1.1 Innovation Process

Innovation process refers to how technologies are developed and put into economic use. This process could be divided into three broad overlapping stages viz: invention, innovation and diffusion (NACETEM, 2010). Invention is thus described as generation of idea or creation of a new technology (Mytelka, 2000) for the first time or improvement of an existing technology (OECD, 2005). This could be on entirely new or a combination of existing technologies (Hauser, 1998). Innovation refers to the first time a product or process becomes available for practical use and is commercially exploited. Product innovation refers to the introduction of a new product while process innovation involves the use of a new production process to produce the same product (Jones and Lall, 1998). After innovation, diffusion takes place. This is described as the spread and adoption of an innovation among members of a social system over time. Diffusion of a new technology in a society often leads to the phenomenon of technology spill over where the technology is used for a new thing other than it was initially designed. Thus technology diffusion may result in using and recombining new technologies in novel ways, thereby exerting influence on technological opportunities (Pyka, 1997). Ilori (2006) identified seven phases of innovation, these are: idea generation, screening of ideas, research and development, business analysis, prototype development, test marketing and commercialisation. Idea generation has been described as a search for new ideas through brainstorming, attribute listing and need identification. Origination of ideas is common to R&D departments of organisations and from specific market needs (Ilori and Irefin, 1997).

The former description of ideas source is sometimes referred to as technology push and the latter, referred to as demand pull (Ilori *et al.,* 2000; Diyamett, 2004). Whatever the source of the ideas, screening of the ideas is also important. Screening thus entails evaluating all the ideas with a view to identifying and concentrating on those with greater potential for success. During R&D phase, the idea on paper or in the laboratory is translated into a physical product, process or service. Business analysis phase thus identifies product features, estimate market demand and product profitability and assigns responsibilities for further study of the product feasibility. When the process reached the prototype stage, the laboratory output is scaled up and small scale production is attained, this is produced at pilot stage. The last stage of these processes is commercialisation. Here, full-scale production and marketing programmes are perfected and the product is launched into the market. These 7 stages have been categorised into 3 phases viz: pure research, technology development, production and marketing.

The seven stages or three phases in the innovation process have been presented as step-by-step approach, which proceeds in a linear and static manner, with a phase commencing after a preceding phase has been completed.

2.1.2 Types of innovation

A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Product innovations can utilise new knowledge or technologies, or can be based on new uses or combinations of existing knowledge or technologies. The term “product” is used to cover both goods and services. Figure 2.1 further depict the relationship that

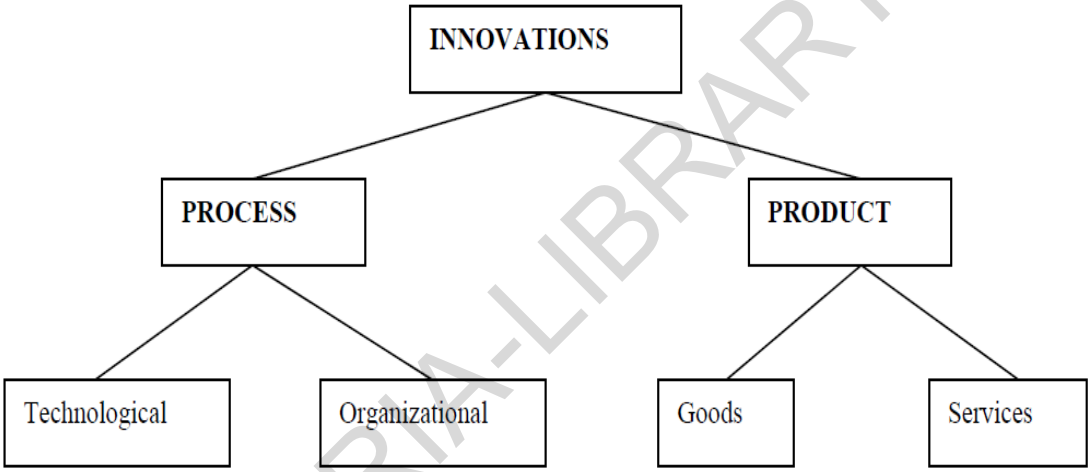

Figure 2.1: Taxonomy of Innovation

Source: (Diyamett, 2004)

exists in the taxonomy of Innovation which shows the importance of products and processes. Product innovations include both the introduction of new goods and services and significant improvements in the functional or user characteristics of existing goods and services. New products are goods and services that differ significantly in their characteristics or intended uses from products previously produced by the firm. On the other hand, a process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Process innovations can be intended to decrease unit costs of production or delivery, increase quality, or production or deliver new or significantly improved products. Marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. Marketing innovations are aimed at better addressing customer needs, opening up new markets, or newly positioning a firm's product on the market, with the objective of increasing the firm's sales (OECD, 2005). Organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. Organisational innovations can lead to increase in firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labour productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies.

Organisational learning depends on practices and routines, patterns of interaction both within and outside the firm, and the ability to mobilise individual tacit knowledge and promote interaction. Such learning can be encouraged through careful design of practices, routines and relationships, or through a more flexible,

organisation in which individuals are encouraged to develop new ideas and ways of doing things (OECD, 2005).

2.2 Innovation Survey Indicators

A number of studies have been carried out in the context of both developed and developing nations which explain the innovation process and how the social and economic environment affects innovation performance. Salazar-Acosta (2006) reported that not all the results and recommendations of the studies have penetrated the public policy sphere. Hence, it is expedient for policy makers to be armed with relevant information gathered from appropriate instruments and measures. There have been demands for indicators that explain and characterise innovation processes (Djellal and Gallouj, 1999; Holbrook and Hughes, 2001; Salazar and Holbrook, 2004). Some of the most frequent claims are: Innovation surveys are biased towards the manufacturing sector, high-tech firms, the private sector, and successful firms. There are problems associated with industrial classifications some of which are: how to characterise the degree of novelty, who is the best candidate to respond to survey request in the industry, the adequacy of use of patents records as innovation indicator among others. A number of survey manuals have been provided in the attempt to proffer solutions to some of these concerns and to also guide quality assessment of innovation performance. These Innovation manuals have emanated over time based on the needs of different regions and levels of development. This became prevalent at the instance of governments' interest on innovation which was dated back to the 1960s (Carney and Ryan, 2010). The OECD (1997) thus began to carry out innovation surveys since 1980s for different countries. Prior to this time, many laboratories have collected data in different capacities and use diverse methodologies without any standard or unified way for such innovation studies or measurement

(Carney and Ryan, 2010). Studies have mostly relied on patents and R&D data, the OECD thus championed the course for the paradigm shift in the measurement of innovation activities in the 1990s rather than innovation outputs which characterised earlier surveys in the 1970s (Beyhan *et al.*, 2002; Godin, 2002).This was aimed towards standardising the measures of innovation. Some of the manuals that emerged relative to this are: the Oslo, the Bogota, Frascati, Community Innovation Survey-CIS, the NESTA Innovation Index and a few others. This thesis therefore adopted the use of the Oslo manual.

2.3 The Oslo Manual

The evolutionary trend of Oslo manual is dated from the first edition in 1992 which focused on Technological Product and Process (TPP) innovation with application to manufacturing. The main goal of introducing this manual was to standardise data collection methodology (Peeters and Pottelsberghe, 2003). The manual provides guidelines on how to conduct innovation surveys with provision for different innovation indicators and methodological considerations. Furtherance to this, in 1993 EUROSTAT and OECD launched a standardised questionnaire that was to be used in EU countries. The questionnaire was christened the Community Innovation Survey (CIS). In 1997 the second edition was published and it covered the service sectors. A more comprehensive edition was put together in 2005 which included an additional chapter titled “innovation linkages”. The edition also addressed non-technical innovations such as the marketing and organisational innovations. These revisions have made the OSLO manual an established guide for macro scale surveys that seek to examine innovations in the business sector (Carney and Ryan, 2010).

2.4 The Community Innovation Survey (CIS)

The CIS is an instrument to collect data on innovation activities in enterprises that is, on product innovation (goods or services) and process innovation (organisational and marketing aspects). The CIS is the main instrument for collecting systematic and empirical information about innovation activities in European enterprises. The CIS was an important source and basis for innovation policy in Europe. Results of the CIS help to analyse and understand the effects of innovation on the economy, for example on competitiveness, employment, economic growth and on trade patterns. The CIS is conducted every four years until 2005 when it became more regular and the frequency changed to once every two years. The CIS was conducted for the first time in 1992, while the second (CIS2) took place in 1997, CIS3 in 2001; CIS4 took place in 2005, CIS5 2007, CIS6 in 2009, while CIS7 took place in 2011, which is the most recent survey till date. Data collection was conducted in the Member States, either by their statistical offices or by research institutes that have been appointed for this task. The methodology of the CIS was based on the "Oslo manual". The fourth version of CIS (CIS4) was expected to contribute to a better understanding of the "non-technical" aspects of innovation, such as management techniques.

2.5 Developing a Knowledge-based Economy

A quality infrastructure contributes to the capacity of National Innovation System (NIS) to absorb and diffuse knowledge and technologies, and therefore to the success of development strategies aiming at productive activities that yield higher economic returns. Bringing and adapting more effective production processes or technologies to new contexts is the most elementary form of innovation. However this is especially relevant in societies that lack the capacity to create new-to-the-world

technologies and processes. Besides, once the national producers are capable of incorporating the knowledge that is created by national and international innovative actors, the benefits associated with better processes and technologies are effectively spread throughout a country's productive systems. Moreover, as this knowledge is used by a higher number of agents, this shall lead to more innovations than could be expected if only a reduced amount of players would have access to it.

Quality infrastructure can serve as a means to enable local firms to comprehend and integrate new technologies and processes, thus enhancing the technological upgrading of firms and facilitating their entrance into new economic activities. This is a vital step in order to strengthen the innovation capability of a society. To continuously support the development of value chains that imply a higher number of partnerships, levels of trust between firms, and complexity in terms of the production processes, Government policy plays an important role. On the creation of platforms for discussion and creation of standards, a government can orient economic actors and the elements of quality infrastructure into a specific research direction that is supportive of those that are considered the strategic economic sectors. The gradual formation of such innovative markets leads to the production of goods with higher value added, and helps economies to advance into sectors that face less international competition.

Economies with high exposure to a reduced number of production activities by giving or foreign markets are more vulnerable to a few commodities and respective international prices, availability and cost of inputs and the economic situation in the targeted foreign markets. Quality infrastructure can be used in order to support local companies to support the diversification of the economic activities by giving technical

support to local companies to join new sectors, and to improve the integration of the local economy in global value chains and markets (Wipplinger *et al.,* 2006).

2.5.1 Learning Processes and types of Knowledge

There are two types of knowledge: formal and non-formal, while the latter is sometimes referred to as experiential knowledge, the former is attained in a planned and ordered manner, usually mostly through education. Formal knowledge is usually obtained in an institution with the award of a certificate at the end of the training. Non-formal knowledge is learning acquired by doing. It is usually acquired in a traditional setting, where learning is acquired by apprenticeship. Oyelaran-Oyeyinka (2004) reported that knowledge of production is largely tacit and rely on skills of workers which is referred to as know-how (Table 2.2). The author further reiterated that skills draws on know-why is based on particular procedures or routines. Lundvall (2000) further described tacit knowledge as a bundle of information that is largely innate. It is most times in built from practice and accumulated experience. For instance, learning that takes place between an apprentice and a master. Nelson and Winter (1982) noted that much of the tacit knowledge in firms is transformed into organisational routines. By the word routine, it is explained in the concept of apprenticeship that the master personifies the routines and determines the culture and the rate of transferring the skills to learners. The developing countries alike have been urged to formulate effective ways to promote local knowledge institutions (Stiglitz, 2000; Oyelaran-Oyeyinka, 2004).

For every economy aspiring to industrialise need to promote and strengthen local knowledge institutions (Oyebisi *et al.,* 1996) to drive the local learning process and to promote science and technology (Ilori *et al.,* 2002); this has been noted to be

Table 2.2: Learning Processes and Types of Knowledge

	Know-What	Know-Why	Know-How	Know-Who
Knowledge Type	Codified	Codified	Tacit	Tacit
Sources	Facts & Information	Scientific principles and laws	Skills acquired through experience	Developed and maintained through personal contacts in research groups and production networks
Transfer Processes	Formal joint venture patents	Formal Books, journals	Non-Formal Formal Learning – by practicing/production design Reverse engineering Apprenticeship	Non-Formal Networking, face-to-face contacts, joint research/production; exchange of personnel; professional association, Apprenticeship
	Digital libraries Formal Institutions (schools)	Digital libraries Formal Institutions	Workplace Research and Training Centres	Workplace Research/Training Centres

Source: Oyelaran-Oyeyinka (2004)

critical for economic development (Iwuagwu, 2011). This is one of the main motivations for this research, as cluster studies have been identified as a potential catch-up strategy to expedite economic development in developing countries.

2.5.2 Technological Learning and Capabilities

Knowledge has been predicted by Drucker (1965) in the effort to replace traditional factor of production. Technological knowledge is not shared equally among firms, nor is it easily imitated by or transferred across firms. Transfer necessarily requires learning because technologies are tacit, and their underlying principles are not always clearly understood. Thus, to gain mastery of a new technology requires skills, effort and investment by the receiving firm, and the extent of mastery achieved is uncertain and necessarily varies by firm according to these inputs. Furthermore, firms have more knowledge of their "own" technology, less about similar technologies of other firms and very little about dissimilar alternatives, even in the same industry. They operate, in other words, not on a production function but at a point, and their technical progress, building upon their own efforts, experience and skills, is (to varying degrees) "localised" around that point (Atkinson and Stiglitz, 1969). The extent to which firm-level technological effort and mastery occur may vary by industry, by size of firm or market, level of development or by trade/industrial strategies pursued. Firms also differ in terms of innovative capabilities, that is, there are different degrees of technology accumulation and efficiencies in the innovative search process.

2.5.2.1 Investment Capabilities

These are the skills needed to identify, prepare and obtain technology to design, construct, equip, staff and commission a new/expanded facility. They determine the capital costs of project, the appropriateness of the scale, product mix,

technology and equipment selected, and the understanding gained by the operating firm of the basic technologies involved (which, in turn, affect the efficiency with which it later operates the facility).

For example in a survey of auto mechanics in Southwestern Nigeria, it was reported that the investments of master mechanics ranged between 6.5 US dollars and 3,250 US dollars at the start of the business. About 60% started work with an amount ranging between $6.5 and $130. It was discovered that about 96% had invested amounts not exceeding $650 for the establishment of their workshops while only a paltry of 4% invested in excess of $650 but not above $3,250. Thus, it was concluded that the majority of the mechanic workshops fell within the small/medium scale business using investment categorisation (Oluwale *et al.*, 2013). Also another study showed that about 40% of small scale enterprises studied in Ibadan invested between $6.5 and $32.5 initially while those which invested above $130 were just a meager 5.50%. Thus it can be inferred that low initial capital outlay is characterise of small scale enterprise in Southwestern Nigeria (Omisakin, 1999).

2.5.2.2 Production Capabilities

The skills involved in both process and product engineering as well as the monitoring and control functions of the same. These range from basic skills such as quality control, operation, and maintenance, to more advanced ones. Such as: adaptation, improvement or equipment “stretching,” to the most demanding ones of research, design, and innovation. They cover both process and product technologies as well as the monitoring and control functions included under industrial engineering. The skills involved determine not only how well given technologies are operated and improved, but also how well in-house efforts are utilized to absorb technologies bought or imitated from other firms on the significance of research and development

for assimilating external innovations (Cohen and Levinthal, 1989; Ilori, 1994; Ilori *et al.,* 2002).

Oyelaran-Oyeyinka (2006) reported the formation of an alliance that exist in by two Nigerian companies and one foreign firm to form Zinox Technologies. This company since has been involved in computer production and supply to the Nigeria computer market. Other evidence of production capacity was reflected by the development and deployment of local currency (Naira) enabled keyboard. Another keyboard which is capable of handling 3 major Nigerian languages was also championed by OMATEK Company which also belongs to the cluster as well (Oyelaran-Oyeyinka, 2006).

2.5.2.3 Linkage capabilities

These are the skills needed to transmit and receive information, skills and technology to and from raw material suppliers, subcontractors, consultants, service firms and technology institutions. Such linkages affect not only the productive efficiency of the enterprise (allowing it to specialise more fully) but also the diffusion of technology through the economy and the deepening of the industrial structure, which is essential to industrial development. The significance of extra market linkages in promoting productivity increase is well recognized in literature on developed countries (Cohen and Levinthal, 1989). Lall (1985) develops and applies the linkage concept in a development setting.

2.6 Human Capital Development and Competitiveness

The literature records that Human capital (HC) emanates from the notion that humans possess skills and abilities that can be improved and as such can change the way in which people act (Dakhli and De Clercq, 2004). Neo-classical Solow growth

theory reiterates the place of H**C** in economic development. It assumes the level of output in an economy is determined by the amount of labour and fixed capital that interacts within a framework of technology available to it. This theory explains long-run economic growth by looking at capital accumulation, labour or population growth, and increases in productivity. HC is embodied in the skills, knowledge, and expertise that people have; it has been seen as an important source of competitive advantage to individuals, organisations, and societies. Although Ilori *et al.*(2000) referring to the era of industrial revolution reported a contrary opinion and recap the place of machines to human labour in gaining competitive advantage in enterprise. Gimeno *et al*. (1997) for example found positive association between the overall level of human capital as measured by education, work experience and economic performance at the firm level. The effect of human capital on innovation at the country level also has been established by Bourdieu (2011) who opined that different forms of capital can be converted into resources and other forms of economic payoff. Researchers have validated this assertion of resource conversion process at individual level. The argument is premised on the fact that people who are more educated have gathered enormous skills and knowledge and are better able to contribute to the overall well-being of the of the society (Stewart and Ruckdeschel, 1998; Hanushek and Woessmann, 2012; Hanushek, 2013; Pellegrino *et al*., 2013).

For instance, authors have argued that the overall stock of knowledge and skills in a society or region may enhance its overall competitiveness (Dakhli and De Clercq, 2004). These skills, competences and capabilities that are accumulated in humans are difficult to imitate. For a country aspiring to strengthen its innovation capabilities towards knowledge driven economy, it is important to make human capital development a priority.

2.7 Knowledge Spillover

Knowledge spillover is indirect transfer of knowledge which may occur through backward and forward linkages when firms provide training and technical assistance to their local environments (Oyebisi and Agboola, 2003) such as: suppliers, subcontractors and customers. Other authors reported that spillovers occur only through backward linkages, that is, from foreign firms to their local suppliers in upstream industries, but not horizontally within industries (Javorcik, 2004; Blalock and Gertler, 2004; Kugler, 2006). Knowledge spillovers can also be viewed from two different perspectives, namely knowledge inflows and knowledge outflows (Iammarino and McCann, 2006). Regarding knowledge inflows, one may say that all firms regard knowledge inflows positively. However, unintentional knowledge outflows can have both positive and negative effects on the firm. The private effect of an unintentional knowledge outflow on the owner firm is a leakage of its valuable intellectual capital and intangible asset, and this would always be viewed negatively Grindley and Teece, 1997). On the other hand, the potentially positive effect of an unintentional knowledge outflow is the public good aspect of knowledge (d'Aspremont *et al*., 1998). This would be important in situations where local knowledge outflows contribute to a virtuous cycle by strengthening the knowledge base of the location, thereby making it more attractive for other innovation-bearing firms, leading to larger knowledge inflows in the future. Empirical studies thus show the various perspectives of knowledge spillover. For example, Abereijo (2010) reported that the presence of research and development activities performed by foreign firms in the host country can enhance the extent of knowledge spillovers from foreign to domestic multinational firms. This is premised on the fact that local workers and engineers working the in the research and development unit of foreign

firms gain a greater amount of knowledge than workers in foreign firms that do not perform research and development in the host country. Hence, this knowledge obtained by these engineers, may further diffuse to domestic firms through work-related discussions, job turnover, and forward and backward linkages.

Authors have suggested that for spillovers to arise, local firms need to have significant absorptive capacities that allow them to reap benefits from the knowledge possessed by other firms (Cohen and Levinthal, 1990; Abereijo, 2010). Although the extent by which knowledge is acquired will be dependent on the availability of skills and technical competencies and on the magnitude and nature of innovative activities performed by domestic firms.

However, studies around the concept of knowledge spillover and geography concur that knowledge spillovers tend to be geographically bounded within the region where new economic knowledge was created (Agrawal 2001 and 2011).

2.8 Network Collaboration

Strong network cohesion supports generation and diffusion of knowledge as emphasised in literature (Freeman, 1991; Lundvall, 1992). Interactions are means through which interactive learning, information and technology are exchanged or jointly exploited for the purpose of productive activities. Hence, interactions among firms, institutions, and government and business associations are likely to stimulate the process of innovation and business performance (Oyebisi *et al.,* 1996). With the fur, it is hypothesized that firm's systematic interactions are important for firm's performance. This may come through vertical and horizontal linkages, or information contracts, membership in formal and informal associations and collaborations. The importance of clustering is also discussed as another medium that can promote new product development, make diffusing of new technologies possible by facilitating

information exchange and joint problem solving between firms in an industry and sometimes in different industries (Mytelka and Farinelli, 2000; Saxenian, 1991).

2.9 Size as Possible Influencing Factor of Firms' Performance

The importance of firm's size on its ability to compete and to influence innovation and business performance in and around agglomerated firms is established in literature. This result on how firm size can impact the reception of agglomerative spillovers complements the Rosenthal and Strange (2003) findings. Big firms may be at an advantageous position in terms of performance primarily on account of their ability to mobilise productive resources and other services that are either external or internal to a firm (Gachino, 2007). This is possible in the large firms because of their access to certain skills information and credit facilities. Also they can accumulate specialised manpower as a result of their continuous training while on-the-job. Other advantages possess by large firms are having more networks with individuals and institutions that provide training, technical information and technical services, which are important inputs in the technological capability process. On the contrary, because small firms have inadequate resources to improve their technological capabilities the result is weak absorptive capacity, low spillover occurrence, reduced learning and innovation (Abereijo, 2010).

2.10 Clusters Concept and Technology Agglomeration

Cluster which is central to this work fits into the innovation systems framework given its systemic, networking features as well as reliance on institutions as sources of dynamism (Oyelaran-Oyeyinka and McCormic, 2007). Schmitz (1992) defines cluster by two key attributes viz: geographical/spatial distribution and sectoral dimension. A cluster is thus defined as a geographical and sectoral agglomeration of

enterprises (Schmitz, 1992) operating in the same industry (Guilani, 2005). A cluster is a geographic concentration of interconnected companies and institutions in a particular field (Porter, 1998). The activities in the cluster include suppliers of specialised inputs such as components, machinery and services and providers of specialised infrastructure (Porter, 1991). Industrial economists have deliberated on the benefits derivable from agglomeration of firms and have argued that by concentrating the economic factors of production, clusters compound the payoffs (Ahn *et al.*, 2009). Ahn *et al.* (2009) further observed that the advantages are presented in marginal costs as a result of harnessing the resources as well as spill-over effect from the interactions of the firms. Other authors have also buttressed this argument in different directions. For example, Audretsch (2001) suggested that entrepreneur clusters provide knowledge spill-over, create diversities among participating firms and increased number of enterprises. Ahn *et al.* (2009) posited that geographical agglomeration reduces time and cost of transaction. The type of businesses that the firms do together in the cluster must be related in a particular field, for example ICT, biotechnology and pharmaceutical. Traditional clusters or induced clusters are known to emanate from firms engaging in the same or related business. Proximity is key and a number of advantages have been adduced to this. The theory of agglomeration is thus known to complement the cluster framework by suggesting that the performance of one firm is influenced by the other due to collocation of the firms (Ahn *et al.*, 2009). Some of these advantages have been attributed to knowledge, skilled labour, innovation, input spillover among others. A Geographic proximity facilitates exchange of skills and ideas which in the end impact overall productivity. Knowledge transfer in this environment is usually tacit and since such knowledge is antecedent to competitive advantage. The proximity brings about regular face to face interactions which

facilitate effective knowledge transfer (Desrochers, 2001; Pinch *et al.,* 2003). Many clusters include governmental and other non-governmental institutions such as universities, agencies, vocational training providers, trade associations that provide training, education, information research and technical supports are presented in figure 2.2.

2.10.1 Clusters and Local Economic Development

Clusters are agglomerations of companies and other organisations engaged in the production of a set of related goods and services e.g., the firms that design shoes, produce the rubber sole, develop the machinery needed to assemble the shoes, and the training institutions that prepared skilled workers (Porter, 1998). A large body of empirical evidence illustrates that firms based in clusters perform on average better, especially in times of crisis (Schmitz, 2000). Clusters can be important drivers of local economic growth and development (Becattini, 2004).

The firms and organisations that form clusters interact and engage in cooperative initiatives, which allow them to become more competitive than they would be if they operated individually (Porter, 1998).

By working together, sharing some of their resources, and interacting with different types of public and private sector organisations, even very small enterprises can become globally competitive. Clusters facilitate coordination and cooperation economies, which help businesses, overcome their resource constraints, for example by gaining better access to credit or benefitting from a common brand (Piore and Sabel, 1984). Clusters also support innovation. Companies and research laboratory operating in isolation can invest large sums in research and development (R&D), pushing technological change. However, unless their research team access ideas and

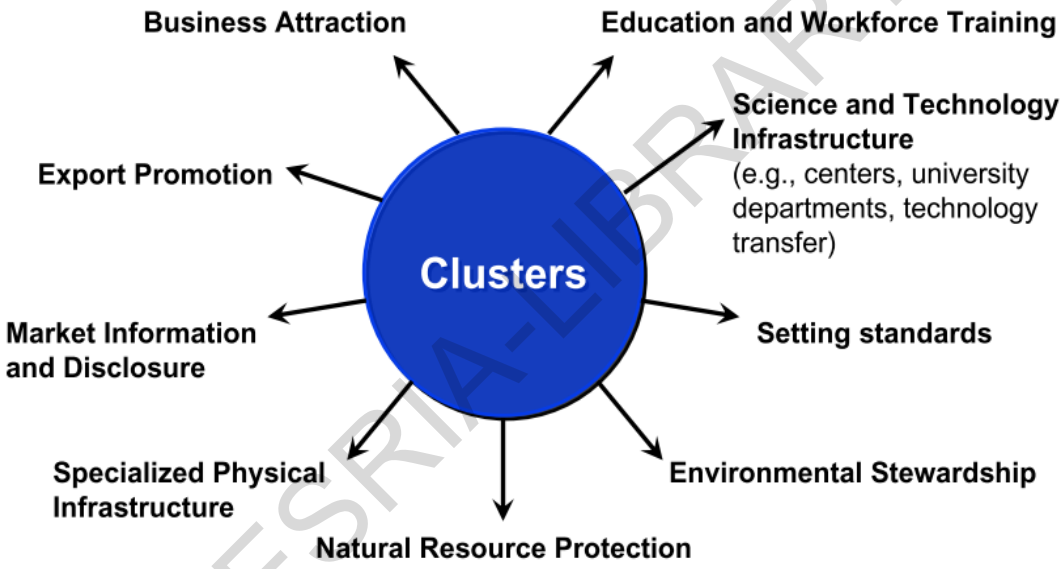

Figure 2.2: Cluster Environment

Source: Porter (1990)

inputs from other organisations, the extent to which they can innovate will be limited they will suffer from the limitations of closure (Bell and Albu, 1999).

The cross-fertilisation of ideas and the exchange of knowledge across organisational barriers are core towards improvement of innovative processes. A competitive cluster facilitates these phenomena by providing foci for organisations to exchange knowledge as well as mechanisms to support innovative initiatives, such as venture capital funds specialising in high-tech start-ups and incubators (Audretsch and Feldman, 1994). After all, some of the most admired companies in the world, such as Apple and Microsoft, started as micro enterprises. They develop and become global leaders not only because of the genius of their founders, but also thanks to the network of venture capitalists, clients, suppliers and advisors with whom they interacted in Silicon Valley the most talked about cluster in the world. Clusters help in attracting capital and skills investors and skilled labourers are likely to move to agglomerations where there are opportunities in their field. If a cluster grows, it generates skilled jobs and wealth (Porter, 1998). A competitive cluster also generates exports and links with other specialised clusters located in different areas, evolving from being a local agglomeration into a hub part of a larger globally integrated production network (Saxenian, 2006).

2.10.2 Information Flow and Innovation in Clusters

Firms sometimes are involved in a variety of different types of networks and structures such as strategic alliances, subcontracting arrangements, joint ventures, interlocking directorates, associations, cross-ownership etc. Each of these networks facilitates access to various different forms of information and knowledge and affects business and innovation performance (Ahuja, 2000; Bell and Zaheer, 2007).

One explanation for the geographical concentration of innovative activities is that knowledge that develops in a cluster circulates more easily within that industrial district, but its transfer outside the district is much more difficult (Dahl and Pedersen, 2004). Geographic proximity facilitates the exchange of knowledge, especially tacit knowledge between firms and their employees (Bell and Zaheer, 2007). Knowledge transfer is equally important for clusters in dynamic, high-tech sectors (Capello, 1999; Chiu, 2009), as well as in traditional, mature, low technology intensity sectors (Bell, 2005; Krätke, 2002). The difference between these transfers is in the benefits that firms can extract from that knowledge: radical product innovations, in the high-tech sectors; gradual product and process innovations, in the mature sectors (Capello, 1999; Krätke, 2002). Damanpour (1991) considered that product innovations are new products or services, introduced to meet the needs of an external user or a market, and process innovations are new elements introduced into an organisation's production or service operations. Although many studies analyse the relations help between innovation management and inter-firm networks, few studies have closely examined how ties of a strictly non-informational nature (such as social networks of friendship or cooperative trust) facilitate the transfer of innovative knowledge (Tsai, 2001; Tsai and Ghoshal, 1998; Yli-Renko *et al.*, 2001). Several studies have argued that social ties are channels for the flow of information and resources, so they have a significant effect on innovation capability (Batjargal, 2003; Moran, 2005; Tsai and Ghoshal, 1998; Bell and Zaheer, 2007).

Knowledge circulating within the cluster network is not of equal benefit to all firms (Tallman *et al.*, 2004). The literature has shown that the central position of firms in the network and the structure of the ego network of each firm can affect its performance and more specifically, its innovative performance (Bell, 2005; Chiu,

2009). Thus, on the one hand, literature has shown how firms with more central network positions benefit to a greater extent from knowledge flowing through the network and from improved innovation performance (Bell, 2005; Chiu, 2009; Takeda, *et al.,* 2008). Nevertheless, the research also points out that this result is contingent upon certain variables, such as the nature of the network under study and the type of innovative performance (Rowley *et al.*, 2000; Walker *et al*., 1997).

2.10.3 Innovative Clusters

Clusters may not necessarily be innovative but it can be transformed to an innovation system through sustained policy support (Hall *et al*., 2005). Although the process of policy learning is heuristic and the strengthening local actors may take time and require explicit investment in learning. Innovative Clusters therefore has been described as strong inter-firm interactions and sectoral specialisation (Nadvi, 1994). The driving forces of cluster formation are: high rate of learning, networking and dense network of formal and informal institutions (Becattini, 1990*;* Saxenian, 1991; Oyelaran-Oyeyinka, 2006). Traditional sectors have been noted in advanced countries to have transited from low technology sectors into successful innovative clusters, which are becoming an environment of attraction for new technology, skilled personnel and research investment.

Countries have therefore leveraged on clusters of innovative firms, as a driver for growth and employment (Krugman 1991; Markusen and Venables 1999), especially in USA and Europe (Glaeser *et al.,* 1992; Henderson *et al.,* 1995). Though competition exists among the firms in the clusters but yet they cooperate (Porter, 1998). Cooperation has increasingly become a requirement for success in clusters, it offers a way to improve economic performance and reduce costs. This can be achieved if new knowledge and technology could be introduced either by induction

(Oladeji, 1998) or acquired cheaply outside the firm rather than produced in house. Moreover, it creates greater opportunities for learning, enables risks and R&D costs to be shared and facilitates flexibility. It also has the tendency to reduce time-to-market for new products and processes (Guinet and Pilat, 1999).

2.10.4 Types of Agglomeration in Clusters

Economic activity tends to agglomerate in certain places at certain times. There are four main types of agglomerations as shown in Figure 2.3. The first type of agglomeration relates to general economies of regional and urban concentration that apply to all firms and industries in a single location (so-called urbanization economies), emanating from lowered transportation costs and the efficiency of large-scale operations of the agglomeration as a whole. These are the forces that lead to the emergence of larger manufacturing belts and metropolitan regions. City agglomerations attract a wide range of economic activity. More important cities, particularly capital cities, represent political power and markets for public projects, and are therefore attractive targets for headquarter functions of large corporations.

The second agglomeration type involves economies that relate to firms engaged in similar or linked business activities, leading to the emergence of industrial districts. Such districts constitute a base for flexible production systems that can meet the demands of volatile markets (Piore and Sabel, 1984). In both cases, agglomeration economies have their roots in processes whereby linkages among firms, institutions and infrastructure within a geographic area give rise to economies of scale and scope; development of general labour markets and pools of specialised skills; enhanced interaction between local suppliers and customers; shared infrastructure; and other localised externalities. Agglomeration economies are believed to arise when such links either lower the costs or increase the revenues (or both) of the firms taking part

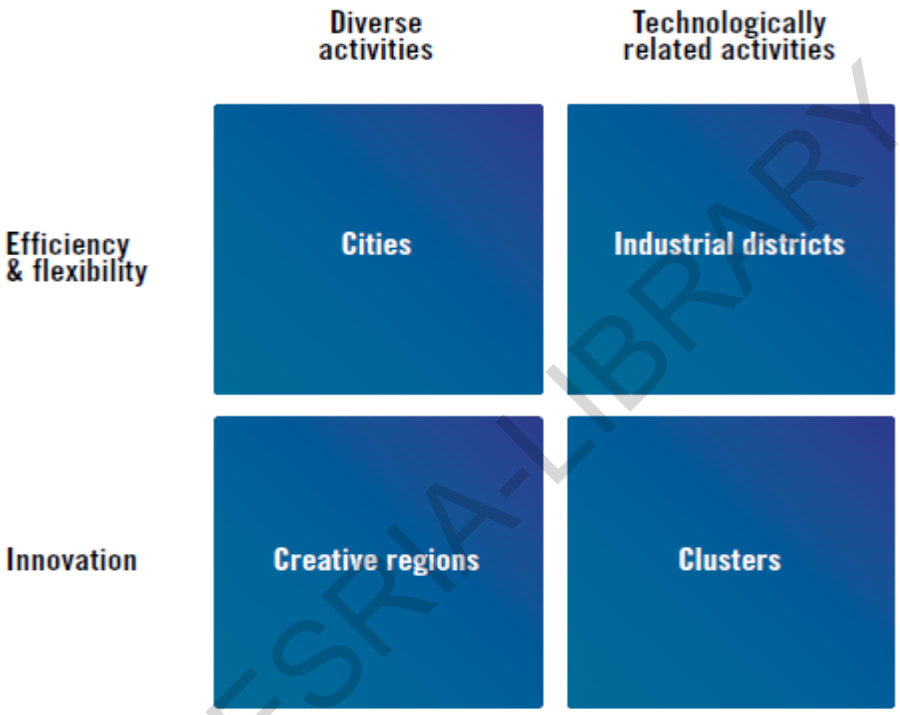

Figure 2.3: Four Types of Agglomerations

Source: Malmberg *et al.* (1997)

in the local exchange. The formation of agglomerations will be particularly intense where linkages and flows tend to be small-scale, unstable and unpredictable, and hence subject to high transaction costs (Scott, 1983, 1988).

In addition to these two types of agglomerations, which can be explained mostly by efficiency gains and flexibility, two other types of agglomerations can be explained as centres of knowledge creation and innovation. The first type is referred to as clusters, where sustained competitiveness is based on capabilities that are linked to a particular location (Porter, 1990; 1998). Clusters are not seen as fixed flows of goods and services, but rather as dynamic arrangements based on knowledge creation, increasing returns (Krugman, 1991) and innovation in a broad sense. In line with this view, more recent research approaches have come to focus on the importance of innovation as a means of trying to explain the emergence and sustainability of agglomerations. Thus, clusters are made up not only of physical flows of inputs and outputs, but also include the intense exchange of business information, know-how, and technological expertise, both in traded and un-traded forms. Several studies have confirmed knowledge externalities in clusters (Audretsch and Feldman, 1994; Jaffe *et al.,* 1993). Many types of firms and organisations constitute the set of actors on the "cluster stage". Here six main types have been identified, viz: firms, financial actors, public actors, universities, organisations for collaboration and media. The fourth type of agglomeration relates to knowledge creation and creativity in a region without any sectoral boundaries. While Porter's main concern has been the existence and reproduction of clusters of technologically related firms, there are corresponding attempts to analyse the learning abilities and creativity of regional and urban agglomerations of the general type. Instead of specialisation and spatial clustering of related industries, emphasis is placed upon the presence of a regional variety of skills

and competencies, where the often-unplanned interaction among different actors can lead to new and sometimes unexpected ideas and creative designs, products, services and business concepts (Florida, 2002; Johannisson, 1987; Andersson, 1985).

2.10.5 Cluster Dynamics and Competitiveness

Clusters involve the level of dynamism and amount and quality of linkages between cluster actors, and external linkages to international markets. Variables such as level of networking, factor mobility and general dynamism differ enormously across clusters. If the quality of resources differs within a region, so too does the flexibility with which the pieces can be assembled and reassembled. Dynamic clusters create the foundation for sophisticated strategies and act as a driving force behind upgrading and innovation among incumbent firms. In summary:

(i) Firms in dynamic clusters develop strategies and routines across the value chain, engendering new capabilities in a process of prestigious backyard rivalry.

(ii) Firms in clusters tend to share many activities through cooperation, e.g., swapping technology, components or products. Clusters facilitate both horizontal and vertical (buyer-supplier) cooperation within a setting of a "common language", trust and high social capital.

(iii) Firms in rich clusters can operate more efficiently, drawing on specialised assets, suppliers, and buyers with short lead times. Critical resources and capabilities often do not exist within the firm but are accessible through networks inside the cluster.

(iv) Firms in clusters can achieve higher levels of knowledge creation and *innovation*. Knowledge spillovers and close day-to-day interaction between buyers, suppliers and organisations lead to incremental improvements, which

are in turn the foundation of both technical (product and process improvements) and non-technical (business model improvements) Innovations. Furthermore, both types of innovations tend to diffuse quickly within clusters (Ilori and Irefin, 1997).

(v) Clusters offer an environment where different resources (individuals, technologies, capital, etc.) can quickly be reshuffled and restructured (spin-offs, labour mobility transferring skills across organisations etc), allowing for new and better economic combinations of skills, capital and technology. The need for changing the strategy or "recipe" of the firm can quickly be accommodated within a cluster. The rate of new business formation tends to be higher in dynamic clusters. Start-ups are reliant on close interaction with suppliers and buyers. The cost of failure is typically lower within a cluster where many alternative opportunities exist.

(vi) Clusters in many cases offer lead markets where sophisticated buyers encourage and cultivate technology development and innovation in close interaction with suppliers.

The outcomes of firms, as manifested in the output of goods and services, will vary from cluster to cluster. To be certain, cars from Japan will compete in the global marketplace with cars from Germany or the U.S., and increasingly, Japanese-built cars in the U.S. will compete with U.S. cars built in Mexico. But global markets are one thing and local clusters quite another. Cars from one cluster will "taste" and "smell" differently than cars that hail from another. They will cater to different consumer tastes; they will exhibit differences in cost levels, quality, features, energy efficiency and so on.

2.15.5 Clusters and firm innovativeness

Firms in clusters may have better access to information than other firms (Bianchi and Bellini, 1991; Porter, 1990; Pouder and St. John, 1996). This may result from direct cluster effects as well as network processes underlying the cluster (Bell, 2005). Thus, the total effect of clusters on innovation may mostly be indirect and partially influenced by network positions. The effect of clusters on innovation that operate independently of network effects will arise partially because there is common knowledge available to members of the cluster that is not consciously transmitted among them or is transmitted via chance meetings between executives that are fostered by geographic proximity (Saxenian, 1994b). Common knowledge is augmented and reinforced by public information sources, such as the local media or universities (Porter, 1998; Saxenian, 1994b). Over time, the common knowledge forms a cluster level of absorptive capacity (Cohen and Levinthal, 1990). The ability to understand and exploit this cluster level absorptive capacity is enhanced by the common lineage and heritage of the firms in the cluster and their executives. Specifically, firms in clusters often share lineage to a common parent firm, such as the many firms in Silicon Valley directly or indirectly related to Fairchild (Saxenian, 1994a). More broadly, executives in geographically proximate firms share a common background and understanding (Paniccia, 1998). This common lineage and heritage will enable executives to understand information they may share when they 'run across each other' in chance settings (Saxenian, 1994b). Firms in clusters will have better access to common knowledge than geographically remote firms. Thus, they tend to search locally for information used in innovation (Almeida and Kogut, 1997; Jaffe *et al.,* 1993). Additionally, the geographic proximity of firms in the cluster enhances direct observation of competitors (Burt, 1987; Pascal and McCall, 1980). A

firm that observes others may try to mimic them and inadvertently generate innovation. Such inadvertent innovation may operate even in the absence of direct network ties, when the imitator cannot simply contact the other firm to learn more about an innovation, but must rely on cues from observing the other, increasing the likelihood of mutation and innovation. Firms outside the cluster (remotes) would have access to neither the cluster common knowledge nor the ability to directly observe their rivals, so would not be able to use these conduits for innovation (Powell *et al.*, 1996).

2.16. Clusters in United States of America

Gamuts of selected clusters in the United States has been mapped by Porter (1998) relative to the field as well as their region in the country as depicted by Figure 2.4. For example the financial cluster in New York, the media cluster in Hollywood, the IT cluster in Silicon Valley, the automotive cluster in Detroit and others.

2.16.1 The Silicon Valley Cluster in California

Silicon Valley has become the symbol of one of the most dynamic and successful high-tech regions in the world, the example of which has been followed by many regions around the world. The story of Silicon Valley starts with Stanford University and the University of California at Berkeley during World War II, when the Federal Government sought the development of high technology weaponry at top US universities.

The research during the war was carried out in R&D units set up within the universities but physically separated from the campuses for security reasons, e.g., Lincoln Laboratory at MIT. Later on, these research laboratories were made more

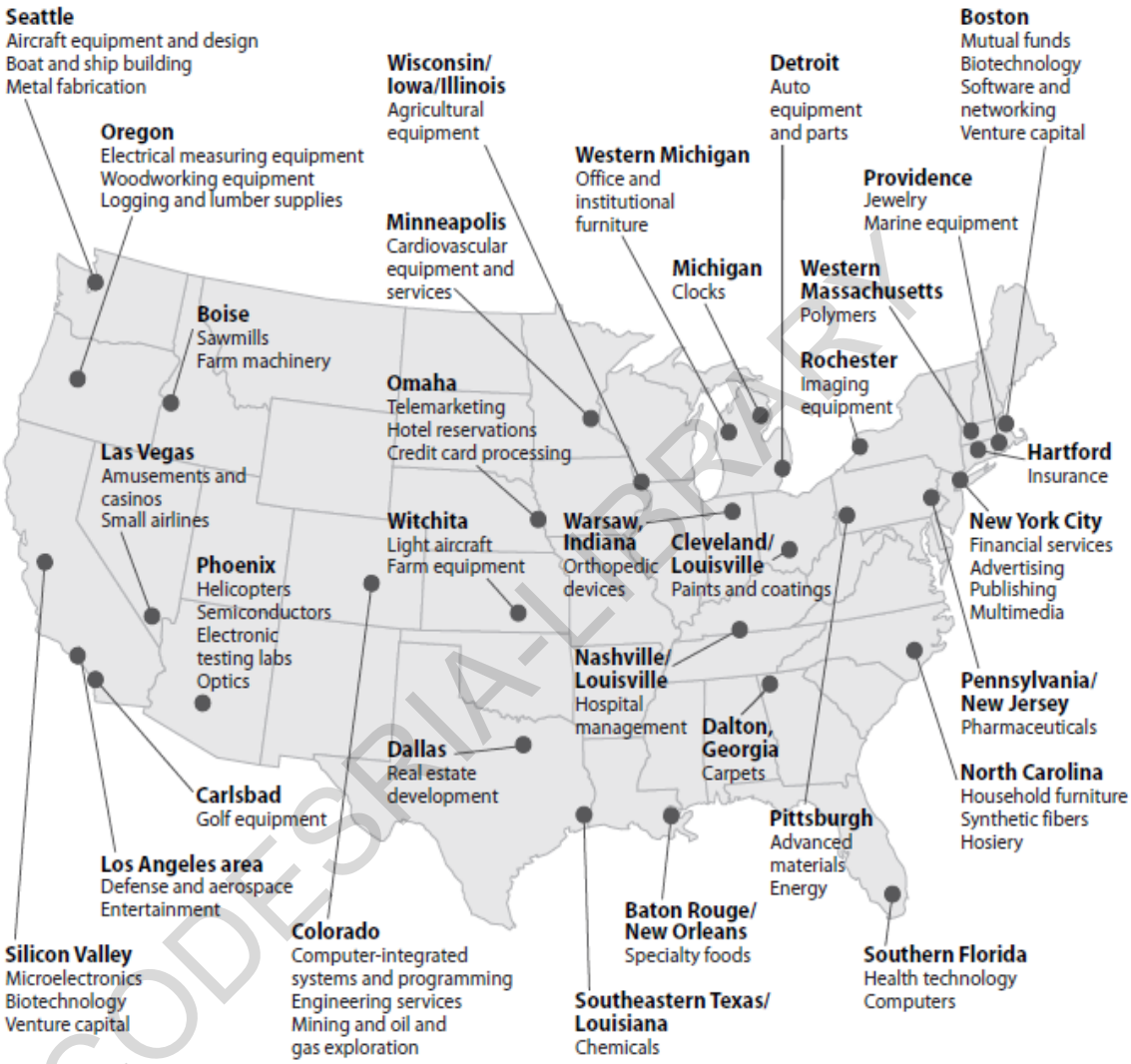

Figure 2.4: Sample Selections of US Clusters

Source: Porter (1998)

independent of their universities and began to function as businesses, yet with government contracts playing a key role (Saxenian, 1994b). It was widely considered by many subject related authors, that the creation of Fairchild Semiconductor was the crucial catalyst in the development of the Silicon Valley. The company became the training platform for technological entrepreneurs, e.g., their cooperation and sharing of experience. In several cases their business relationships was a continuation of universities (Saxenian, 1994b).

Second import in the event of Silicon Valley's history was the creation of the Stanford Industrial Park in 1951. It was the first technology and science park in the world. The Industrial Park became an attractive location for start-ups, specialised laboratories, offices and production facilities. One of its first tenants were Varian Associates, Hewlett-Packard, Eastman Kodak and Lockheed. By 1960 the technology park grew up to 40 companies (Hulsink *et al*., 2007). Whereas, the high-tech employment of Silicon Valley increased from 17,000 in 1960 to 268,000 in 1990 (Saxenian, 1994b). The growth was fueled by the emergence of the venture capital industry that replaced the military as the leading source of financing for Silicon Valley start-ups. In her 1994 book, Regional Advantage: Culture and Competition in Silicon Valley and Route 128, Saxenian reports that "cooperation among Silicon Valley's venture capital community was always tempered by the reality of intense competition". "Competition in computing was increasingly based on the ability to add value-to identify new applications and improvements in performance, quality and service rather than simply on lower cost" (Saxenian, 1994b).

Another important event, strengthening the role of region as a leading scientific and hightechnology centre in the world was the establishment of NASA Research Park. It has enlarged the investment pools, technical infrastructure and skill

base of the Silicon Valley by attracting new engineering talent into the region. Silicon Valley's success story and milestones as shown in Figure 2.5 made the cluster an attractive place for people and firms from all over the world. In 2000, more than half a million engineers, scientists, managers and operators in industries ranging from electronic components to computers were employed in the high tech firms in Silicon Valley. In 2000-2002, The Silicon Valley region generated about 23,000 net new firms. Almost half of all firms in Silicon Valley was started in the five years starting experienced a boom period (peaked in 2000 at $34.5 billion) followed by a bust between 1998 and 2003. In 2003, after a smooth growth, venture capital investment from 1998 to 2002. Its geography extends across 30 cities, including San Jose, the third-largest city in California, and parts of four counties; Santa Clara, San Mateo, declined by 80% to $6.7 billion.

Alameda and Santa Cruz. The economy of Silicon Valley is connected with other Similar trend has occurred regarding the rate of employment. Between 2001 and 2004 Silicon Valley lost 16% of its jobs.

2.16.2 Structure and Types of Collaboration Networks

This sense of community that existed, since the early history of the Silicon Valley, among the business and technical people enabled the firms to solve technical problems more easily and rapidly than their counterparts elsewhere. Saxenian (1994b) demonstrates how decentralised regional network-based system emerged in Silicon

Valley influenced the region's competitive advantage (in comparison with the independent firm-based system represented by Route 128). In a network-based industrial system region is organised to adapt continuously to fast changing markets and technologies. The system's decentralisation encourages the pursuit of multiple

1930's	Encouraged by Prof. Frederick Terman, William Hewlett and David Packard start a company to produce their audio-oscillator.
1937	Stanford professor William Hansen teams with brothers Sigurd and Russell Varian to develop the klystron tube.
1946	The Stanford Research Institute is founded.
1951	Stanford Industrial Park is established.
1952	IBM locates a key research facility to the valley.
1956	William Shockley founds Shockley Transistor Corporation to produce semiconductor-based transistors. In 1958, engineers from Shockley Transistor found Fairchild Semiconductor.
1958	NASA moves a research facility to the valley.
1968	Gordon Moore and Robert Noyce found Intel.
1976	Steve Wozniak teams with Steve Jobs to form Apple Computer and build the first microcomputer.
1982	The Stanford University Network is the catalyst behind the founding of Sun Microsystems.
1993	Stanford Professor Jim Clark hires Mark Andreesen to found Mosaic Communications, predecessor to Netscape Communications Corporation and the browser that made the Internet an everyday tool.
1994	Jerry Yang and David Filo, graduate students at Stanford University, start a directory of websites, later on transformed into Yahoo.

Figure 2.5: Silicon Valley Milestones

Source: Saxenian (1994b)

regional economies in California, the nation and the world. Silicon Valley continues to reinvent itself and shift to new areas. In 2005, six of top 10 U.S. cities for patents were located in Silicon Valley (Venture, 2007). Venture capital investment has technical opportunities through spontaneous regroupings of skills, technology, and capital; its production networks promote a process of collective technological learning (Saxenian, 1994b).

Cooperation among Silicon Valley firms took various forms, e.g., from cross-licensing and second-sourcing arrangements to technology agreements and joint ventures. Agreements were made between firms participating in the same market, between suppliers and customers, and between firms wishing to share financial risk. Some agreements were short-term and others lasted for many years. As Saxenian (1994b) reports the success of technical people who left career jobs to become entrepreneurs, made it easier for others to take the risk of starting their own companies. The frequent changes of jobs in the Silicon Valley necessitated and re-enforced the community of relationships that existed. There was also more of a willingness to invest in startup companies. Often those providing the venture capital were the successful entrepreneurs of the past. The office complexes on Sand Hill Road near the Stanford campus became a major centre of venture capital. Saxenian quotes Wilf Corrigan, the founder of LSI Logic, who expresses it in terms of people thinking of themselves as working for Silicon Valley rather than a particular company. Region's culture shaped the regional industrial system – industrial structure and corporate organisation, and vice-versa regional industrial system influence the local culture (labour market behaviour and attitudes toward risk-taking). Brown and Duguid (2000), while investigating knowledge networks in Silicon Valley, concluded that small groups working closely together, sharing insights and judgment, both

develop and circulate knowledge inevitably as part of their practice." They have referred to this phenomenon as communities of practice (Brown and Duguid, 2000). For example, regional institutions such as: universities, business associations, local governments, as well as professional societies and other forums that created and sustained social interaction in a region and its innovative culture. Some of the most active of them are the following: Silicon Valley Community Foundation, Joint Venture: Silicon Valley Network, Sustainable Silicon Valley, The Churchill Club, etc. The main goal of these organisations is to gather leaders from business, government, the universities, and the non-profit sector to think how to promote actions that encourage social inclusion, equality of opportunity and regional growth.

2.16.3 Cooperation with University and Local Government

Silicon Valley is one of the most highly-educated regions in the country, with 40% of its population with at least a Bachelor's Degree. Despite the region's own well developed educational infrastructure over half of its Science and Engineering talent was born abroad. In 2000, this group constituted 49%, and by 2005, it expanded to 55% of the region's science and engineering occupations. Foreign-born talent in Silicon Valley represents roughly three-times the national shares in and in all occupations (Venture, 2007).

The contributions of region's universities to Silicon Valley success took different forms, starting from the faculty and students' employment, R&D funding, talent attraction and development through startup company generators, business assistance services and special initiatives and policy leadership. The phenomenon of Silicon Valley was originated above all as bottom-up social and business networks, with the leading role of Stanford University in shaping the social and intellectual capital of the region. Having played a role in the birth of Silicon Valley, Stanford

presently offers educational, professional excellence and consulting services for many of Silicon Valley's firms. Many of the current initiatives are hosted under Stanford Entrepreneurship Network, such as: Stanford Technology Ventures Program, Center for Entrepreneurial Studies, BASES, Office of Technology Licensing, Stanford Biodesign Network, Stanford School of Medicine, Stanford School of Law, Society of Women Engineers, Asia technology Initiative and others.

2.16.4 Venture Capital

Silicon Valley has been traditionally very strong in attracting venture capital investment. In the last observed year 2007 venture capital (VC) investments were up almost 11%, comparing totals from the first three quarters of 2006 and 2007 (Venture, 2007). This is the most positive trend since the dotcom boom. For the first time Silicon Valley may be able to receive 30% of the nation's total venture capital funding. The top two destinations of the VC investment have been observed in energy and in medical devices. Also telecom and software equipment continues to attract the most investment. Major portion of venture capital investment originates from the U.S., with a small share of the local venture capital financing. The year of 2000 was exceptionally fruitful in drawing the nationwide investment capital to the Valley.

2.16.5 R&D Tax Incentives in California

The federal and state governments use business tax credits to promote R&D. In 2006, at least 32 U.S. states offered credits for company-funded R&D. Federal R&D tax credit reached an estimated $5.5 billion in 2003 compared with all-time high of $7.1 billion in 2000. California offers a 15% credit on research (12% until 2000) and 24% for university research. The California R&D Credit reduces income or franchise tax. The company can qualify for the credit if it paid or incurred qualified

research expenses while conducting qualified research in California. The company receives 15 percent of the excess of current year research expenditures over a computed base amount (minimum of 50 percent of current year research expenses). Manufacturing and Research Equipment Credit reduces the state's corporate franchise tax, and can be used to reduce the sales tax on the acquisition of qualified property. Taxpayers are entitled to 6% of the amount paid for equipment placed in service in California (Landabaso, 2000).

2.17 ICT Clusters in Europe

ICT clusters in Manchester, the Hague and Helsinki are discussed, in order to have a glimpse of the behaviour of ICT clusters in Europe.

2.17.1 ICT Cluster in Manchester

The city of Manchester is the capital of England's North West region. About 440,000 people reside in the capital. The heart of the greater Manchester has a population of 2,578,000. Manchester, the cradle of the industrial revolution, has to cope with severe economic restructuring as production in the manufacturing sector started to decline from the late 1960s onwards. The city has also experienced severe problems which are common to those many other major industrial cities in Europe and the US. Between 1975 and 1990, Manchester lost over 100,000 manufacturing jobs. In the same period the service sector created many jobs, however, most of these new jobs did not go to the people displaced by the job losses in manufacturing.

For years, the economic performance of the greater Manchester area has been below UK and European averages in terms of Gross Regional Product and higher in unemployment rates. From this perspective, the Manchester City Council views the ICT sector as a new and desperately needed source of urban wealth and employment.

The city of Manchester is the principal centre of ICT activity in the North West region of England. The cluster is diverse, and contains electronic components and networks of systems hardware manufacturers, software developers, internet service providers, Internet developers and, ICT consultancy businesses among others. Most firms predominantly operate for the regional market, but in some respects, the cluster has a function that supersedes the regional dimension. For instance, the region hosts some of leading ICT firms' European headquarters. The size distribution shows that there are several very large firms, as well as around 1,000 of smaller ICT firms active in software development, Internet services and telecommunications. The number of firms also in the cluster has been rising rapidly in the last few years, as is reflected in the development of the Manchester Business Park2. In the region of the North West, 30,000 people are employed in the ICT sector (Van Winden, 2000) a substantial part of them are in Manchester. The major assets of the Manchester cluster are its universities. The region accommodates 4 universities, with a total student's population of 77,316. In 1997, the four universities produced about 1,000 graduates in computer science and IT and another 2,300 graduates in engineering and technology related disciplines (Van Winden, 2000)

2.17.2 ICT Cluster in Hague

The Hague With 445,000 inhabitants is the third largest city of the Netherlands and is the capital of the Dutch national government. It hosts virtually all the national ministries, as well as foreign embassies and other foreign institutions. The city's goal is to become a strong ICT/telecom city. This is part of its general strategy to attract more international private business. The Hague was the headquarters of telephone service providers, among which the headquarters of Dutch market leader – and former state monopolist, which has been in the Hague for many years. The fastest

growth was realised in the last half of 1990s, with the arrival of the mobile communications service providers such as Ben and Dutchtone since 1998. These firms owned by foreign companies, probably found the Hague as an attractive location because of its nearness to political decision makers, ministries, and the telecom regulation body relevant for the telecom sector are located in the Hague. The Hague has also attracted technical equipment firms such as Alcatel, Siemens and Nokia albeit, mainly functioning as sales outlets and customer services centres. Other well-known players are Amazon, the American e-bookstore, that has recently opened its European headquarters which serves as the call and logistics control centre for the European market. Another North American Internet-firm in the Hague is Map quest which is a leader in interactive geographic information systems. These companies choose to locate in the city of the Hague for its international atmosphere and the availability of ICT staff. The ICT educational facilities in the region include the Haagse Hogeschool and the Delft Technical University. There are many branches of ICT consultancy companies along the Hague highway. The cluster also hosts some small and young firms active in software development Internet business, e-commerce and so on. The adjacent cities of Delft and Zoetermeer also hosts a lot of ICT activity. A certain specialisation of ICT activities can be observed. The headquarters of many new media and ICT firms are located in the Hague. This may be because of the city's urban atmosphere and the presence of many potential customers. Zoetermeer hosts mainly software and IT consultancy firms. The city's main attraction is its accessibility from all parts of the Country. Delft is home to the Technical University which has a "natural" attraction as R&D centre in the field of ICT. It hosts a rich variety of small and medium sized ICT firms of which some of them are concentrated in the commercial business-centres.

2.17.3 ICT Cluster in Helsinki

Helsinki has a population of 532,000 and is by far the largest city in Finland. The region's economy is strongly dominated by the service sector. Some 80% of employment in the country falls into service category. Manufacturing is much less important, in particular compared to other sectors in Finland's average. Finland is a very advanced country when it comes to the production and application of state-of-the-art telecommunication services and new media services. As at 1998, it has the highest penetration rate of mobile telephones in the world, exceeding 50%. A reason for the high penetration rates of new communication devices, low prices and the success of Finnish telecom service and equipment producers may be due to the early liberalisation of the Finnish telecom market. Helsinki is the principal ICT cluster in Finland. This firm is famous for its development and production of mobile telephones. With a global market share of 21%, it is a true world leader in the field. Nokia has grown tremendously during the last few years. The firm employs 7,000 people in Helsinki, 22,000 in Finland, and 42,000 world-wide (Van Winden, 2000).

There are very many smaller firms in the Helsinki region active in ICT. Many of them have some links to Nokia, as suppliers of parts, components, software or other services. Other customers of these firms are buying new media services mainly for the purpose of corporate communication, internal communication and advertising. Besides, foreign equipment manufacturers have establishments in Helsinki. Eriksson, the Swedish competitor of Nokia employs over 1,000 people in the Helsinki region. Another important category of players in the cluster are the providers of telecom services, such as telephone companies of different kinds and sizes, internet providers and others. The largest among them are Sonera and Finnet Group. The research and

educational infrastructure in Finland is also well developed, with a technical university, a university of art and design and other universities and polytechnics.

2.18 ICT Clusters in Asia

2.18.1 ICT Cluster Development in Taiwan

The Taiwanese ICT electronic manufacturing cluster emerged from the outsourcing by American producers during the 1980s (Amsden and Chu, 2003), whereas the Indian clusters developed when Silicon Valley firms began outsourcing programming and other services to reduce their costs during the 1990s (Athreye, 2005). As of 2012, several of the global companies that dominate the ICT industry originated in emerging market clusters: the Taiwanese firm Foxconn, which produces the likes of the Apple IPhone and IPad, is one of the largest players in the industry, employing an estimated 800,000 people in 2010; the Indian firms Tata Consulting Services, Wipro and Infosys, have become some of the top providers of outsourced information technology services in the world; Acer, a Taiwanese computer manufacturer, moved from being a subcontractor of components to develop its own brand of personal computers. Taiwan has experienced a remarkable structural transformation and rapid diversification towards electronics and electrical machinery since the 1980s after an early phase of specialisation in labour-intensive clothing. During the 1990s Taiwan achieved great success in the electronics industry, and especially in the information technology (IT) area. In 1998, the value of domestic and foreign production of the Taiwanese IT industry was over US$ 30 billion and ranked third in the world for the production of computers, following the US and Japan.

2.18.2 Growth and Distribution of China's ICT industry

China's ICT industry has experienced rapid growth since the 1990s. However, it received little attention until recently. There were few ICT manufacturing

enterprises before 1991, but the number grew during the 1990s and there was a dramatic increase in the period 2000-04 (Figure 2.6). The temporal development of the ICT service sector is different from that of the ICT manufacturing sector. There were very few firms in the service sector before the 1990s, but during the period 2000-04 there were nearly five times as many start-ups in this sector as there had been in the 1990s (Figure 2.6). The recent growth of China's ICT industry has been boosted by the state policies and guidelines that have been introduced at different stages. To understand the evolution of China's ICT industry, it is necessary to examine the changing political context, particularly the organisation structure and state policies pertaining to science and technology (S&T). After the foundation of the PRC in 1949, the Chinese Communist Party (CCP) committed itself to building up a centrally controlled economic system. Under the influence of the former Soviet Union, R&D activities were initially separated from industrial enterprises and restricted only to institutions established and supported by the state within the planned economy.

This not only suppressed initiative among industrial and commercial enterprises but also impeded the commercialisation and application of research output. Because of the unstable domestic and international environment prevalent at the time, S&T activities were concentrated in the fields of the military, defense and national security. An ideology that undervalued technological knowledge and the incentive to innovate severely constrained S&T development.

In 1985, a reform of the S&T system was launched to strengthen the linkage between the market mechanism and R&D capability. In 1992, during his "southern tour," Deng reiterated the principle that "S&T are the primary driving productive forces. " In 1995, it was formally announced that the S&T system would be further improved to accelerate technological innovation.

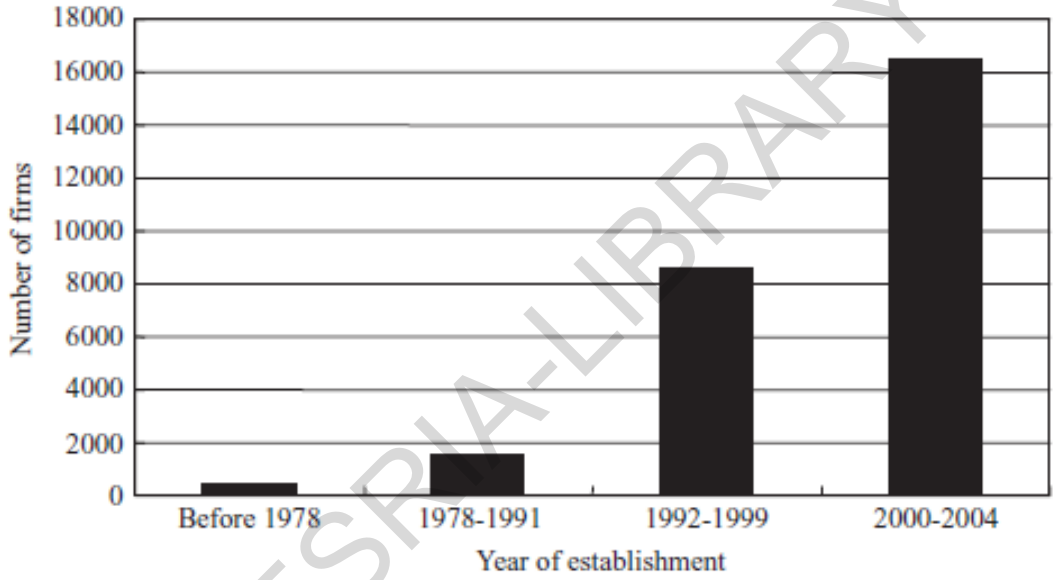

Figure 2.6: ICT Manufacturing Start-ups at Different Stages

Source: National Bureau of Statistics, 2004

The ninth (1996-2000) and tenth (2001-05) five-year plans reflected China's dedication to long-term S&T development. Considering its limited resources of capital and talent, China decided to focus on the ICT industry.

2.19. Clusters in Africa

Clusters are known to occur in many forms each of which has its own specific developmental trajectory as well as its organisation and different waves of militating challenges. Some clusters do originate spontaneously and unplanned through agglomerations of enterprises and other actors. Others are sometimes induced or created by public policies. Induced clusters range from technolpoles, industrial parks to incubators and export processing zones (Zeng, 2008). Zeng (2008) identified some basic elements that led to the formation of these clusters, these are: (i) natural endowments (ii) proximity to major local markets and infrastructure, (iii) closeness to local entrepreneurs with tacit knowledge and basic skills in trading, design or manufacturing (iv) market push and, (v) government intervention.

2.19.1 Natural endowments

In Figure 2.7 Kenya cut flower, Uganda fishing and South Africa wine were identified as major natural resource based clusters. It was reported that, the cluster in Kenya leveraged on favourable climate as they are endowed with a diverse range of temperatures coupled with well distributed yearly rainfall. Availability of land, fresh water resources, gives the country a unique advantage. In the case of the Ugandan fishing cluster, it was noticed that Lake Victoria which is the biggest lake in the whole of African continent gives the country the edge (Zeng, 2008).

Cluster	Country	No. of firms	Firm size (no. of employees)	Products	Markets	Major Challenges
Lake Naivasha	Kenya	24 (large firm)	250-6000	Cut flower	Domestic & exports (mainly Europe)	Resource depletion and environmental pollution
Kamukunji	Kenya	+2000	1-2	Metalwork	Domestic	Low barriers to entry and over-congestion of micro enterprises; weak linkages with knowledge institution; and weak infra. support
Lake Victoria	Uganda	17 (fishing plants)		Fish production & processing	Domestic & exports (mainly Europe)	Falling fish stock and EU quality crisis
Mwenge	Tanzania	2,200	15-20 (average)	Handicrafts	Domestic & limited exports	Lack of financing; weak firm capacity; and weak public institutions and infrastructure
Keko	Tanzania		2-130	Furniture	Domestic & limited exports	Weak public institutions and infrastructure; lack of technological support & access to finance
Nnewi	Nigeria	85	< 12 (average)	Auto parts	Domestic & limited exports	Asian competition and poor public goods
Otigba	Nigeria	+5000	8 (average)	Computer hardware	Domestic & exports (mainly West Africa)	Lack of capital, especially long-term financing; weak infrastructure support; and vulnerability to foreign exchange and import duties
Suame Magazine	Ghana	+9000	5-10	Manuf. and Vehicle repair	Domestic & limited exports (West Africa)	Lack of effective dissemination of R&D results to firms; and inadequate
Mauritian textile & clothing	Mauritius	260	170 (average)	Textile & clothing	Domestic & international	Increasing labor costs; enhanced international competition; low productivity
South Africa Wine	South Africa	+340 (wine farms)		Wine	Domestic & international	Lack of effective marketing/branding strategy and expertise; financial constraints for small producers
Western Cape	South Africa	327	103 (average)	Textile & clothing	Domestic & international	Increasing labor costs; enhanced international competition; lack of innovation both in product and process

Figure 2.7 Clusters in Africa

Source: Zeng (2008)

2.19.2 The Proximity to Major Local Markets and Infrastructure

Zeng (2008) listed the characteristics of the clusters studied (Figure 2.7), for example the Otigba computer village in Nigeria is located within Ikeja, the industrial capital of Lagos state. The Suame cluster in Ghana is located in Kumasi, the capital city of the Ashanti region and a very important and historical centre of Ghana. The Kamukunji cluster in Kenya is located in Nairobi, which is the capital of Kenya. The lake Naivasha cluster is also near Nairobi and the Jomo Kenyata International Airport. The Nwenge cluster in Tanzania is located in the capital of Dares Salaam and the Keko cluster is located near the Chag'ombe Road. Western Cape cluster is located in the Cape Town metropolitan area. All of them are located close to the market and infrastructure.

2.19.3 Local Entrepreneurs with Tacit Knowledge

Most business in the clusters were reported to have been started by traders, traditional craftsman, artisans, carvers, flower farmers etc who have inherited the knowledge and the skills through their families, kingship ties and local apprenticeships. For example, in the case of Kamukunji metal work in Kenya, Nnewi auto parts and Ikeja Computer Villages in Nigeria. The businesses mostly started with trading, repairing and gradually evolve to assembling and manufacturing activities. The Suame manufacturing and vehicle repair clusters in Ghana evolved from manufacturing simple tools to a more sophisticated metal product.

2.19.4 Market Push

Most of the clusters were responding to market needs, mostly local needs except the fishing and cut flower cases that have market extension beyond the border of the producing countries. The metal products were initially made to meet household

consumption and agriculture while computers were produced as a result of ICT demand from the local people (Zeng, 2008).

2.20 Clusters in Nigeria

In Southwestern Nigeria some industrial clusters are found around Oluyole industrial estate in Ibadan, Otta, Ilupeju and Apapa wharf in Lagos state. There are others located between Kano and Kaduna in the Norther part of Nigeria. In the Eastern part, some industrial clusters were located in Onitsha, Ugheli, Nnewi, Port-Harcourt and Warri (Akinbinu, 2003). It was noted that these clusters were induced and have some essential infrastructure but was devoid of extensive collaborative arrangement comparable to what exist in Europe and other developed economies (Akinbinu, 2003). Nevertheless, they were reported to have strong cooperation among themselves. For example, Oyelaran-Oyeyinka (1997) reported that there are trading cooperation, intense competition, entrepreneurial dynamism and trust among the SMEs within the Nnewi industrial clusters. It was found that activities in the Nnewi cluster have led to several products manufacturing. For example, the production of motor cycle parts and components, cables and hoses, motorcycle engines, roller chains, automotive filters, exhaust systems and others. This is an area in which Nnewi firms have overtime developed considerable skills and technical capabilities (Boladale, 2006). Although over 80% of the firms are SMEs and are fully owned by Nigerians.

Obembe (2013) also reported that in the plank markets in Ibadan (Bodija and Sango) and Akure, there exists some clustering of carpenters and furniture manufacturing workshops purposely to access purchase of cheap materials. Oyelarlan-Oyeyinka (2006) reported the activities of the ICT cluster in Nigeria, he observed that between 2002 and 2003 the total number of Information Communications Technology

(ICT) firms in Ikeja Computer Village in Lagos were about 2,500. The cluster did not only serve the Nigerian market alone, but also serves a few other African nations (Oyelaran-Oyeyinka, 2006). About 55% and 15% of the operators of firms in the cluster were graduates of universities and polytechnics respectively, while 20% were technicians and the remaining 10% were unskilled traders (Oyelaran-Oyeyinka, 2006). About 3,500 enterprises were present in the cluster in 2003 and employed over 6,000 workers. At the end of 2004, the cluster comprised 5,000 enterprises which employed about 10,000 workers. The level of cooperation among the firms was also found to be almost total; as 97% of the firms indicated that they cooperated and collaborated on the level of subcontracting and on usage of industrial association usage (Oyelaran-Oyeyinka, 2006).

2.21 Clustered Firm Advantages

Firms that participate within a cluster have the advantage of better productivity compared to non-participants. This is because they have better access to sourcing of inputs, information, technology and needed institutions; co-ordinating with related companies and measuring and motivating improvement (Porter, 1998). For example, there is better access to existing pool of specialised and experienced employees in a vibrant or innovative cluster. This will thus lower some certain overheads such as search and transaction cost of recruiting. Clusters have always been attraction for best brains and talented people from other locations (Amiti and Cameron, 2007; Porter, 1998). This is evident in the Silicon Valley, California, the United States of America.

The Venture (2013) showed that ethnic composition in the Silicon Valley cluster reveals that 37% were White and Non-Hispanic, 30% were Asia, 27% were Hispanic and 2% were of African descent. The rest (4%) were of other ethnic

categories. It also reveals that Science and Engineering talents expanded by 4% in Silicon Valley and by 8% in the U.S. proximity also improved and lower the cost of communications. It also makes it easier for suppliers to provide support services in the Silicon Valley. Access to information flow is also germane in clusters as extensive market, technical and competitive information accumulates within a cluster and members will have first-hand access to it. The community ties and inter-personal relationships within the cluster foster trust and free flow of information (Thompson, 2006). The level of specialisation in the cluster also constitutes a driver for economic performance. If a region has a low level of specialisation in an industry, productivity will definitely be lower than in regions with higher levels of specialisation spread across many industries. This is also in support of the debate in literature regarding the benefits derivable from co-location of firms. Bobonis and Shatz (2007) suggested that strong clusters receive more foreign direct investment than weaker ones.

2.22 Growth Impact of ICT Clusters in Nigeria

Before the liberalisation of the telecommunication industry in Nigeria, the teledensity stood at less than 2% which is about 500,000 telephone lines for a population of 120 million. The liberalisation spurs the business activities in the ICT clusters, thereby leading to increased sales and improved business performance. The teledensity has now reached a mark of 81.9% as at January, 2013 with a total of 114.7 million subscribers. This growth is unprecedented as the teledensity soared from 1.89 in 2002 and 24.16 in 2006 (NCC, 2014). Thus, the total Internet use in Nigeria has put the rate of diffusion of the Internet at 28.4% in Africa, which is higher than what obtains in South Africa (17.4%), Cameroon (5.0%) and Mozambique (4.3%) put together (World Internet Users Statistics, 2012).

Considering this rate of adoption of ICTs in Nigeria as orchestrated by the boom in electronics market (mobile devices and computer systems), one will not hesitate to infer that this will have significant translational effect on the economy. To gain access to the Internet, mobile devices or computer systems are used. Majority of these electronic devices are sourced/purchased in Nigeria's ICT clusters. Data about activities in ICT clusters in Nigeria is particularly scarce, although we have data about other ICT activities. Few examples are computer and Internet use among students (Jagboro, 2003; Jegede and Adelodun, 2003; Awoleye and Siyanbola, 2006), among teachers (Awoleye, *et al.*, 2008; Jegede *et al.*, 2007; Jegede, 2008) and for adult education (Akande and Jegede, 2004). Nevertheless the available data on ICT clusters are therefore reported. Between 2002 and 2003 the total number of Information Communication Technology (ICT) firms (shops) in Ikeja Computer Village in Lagos stood at 2,500. The cluster did not only serve just the Nigerian market alone, but also serves a few other African nations, according Oyelaran-Oyeyinka (2006). About 55% and 15% of the operators of the cluster are graduates of University and Polytechnic respectively, while 20% are technicians and the remaining 10% are unskilled traders (Oyelaran-Oyeyinka, 2006). About 3,500 enterprises were present in the cluster in 2003 and employed over 6,000 workers. At the end of 2004, the cluster comprises 5,000 enterprises which employed 10,000 workers. The level of cooperation among the firms was also found to be almost total; as 97% of the firms indicated that they cooperated and collaborated on the level of subcontracting and on the note of industrial association usage (Oyelaran-Oyeyinka, 2006).

2.23 Theoretical Framework

The theoretical basis of this work is premised on Marshallian theory of externalities. The theory focused mainly on the externality concerns of firms in knowledge spillovers between firms in an industry (Marshall, 1890). This theory thus

contends that knowledge is predominantly sector-specific and hence local or regional specialisation will foster entrepreneurship which leads to growth in newly founded and incumbent firms. The externalities theory further adds that intra-regional spillover effects occur alongside agglomeration effects due to labour market pooling and input sharing (Feser, 2002; Rosenthal and Strange 2001). This further explains that the concentration of an industry in a city helps knowledge spillovers between firms (Ilori and Irefin, 1997), and therefore has the tendency to impact the growth of that industry and of that city. A good example would be production of computer chips in Silicon Valley (Arthur 1990). Through spying, imitation and rapid inter-firm movement of highly skilled labour, ideas were quickly disseminated among neighboring firms. The theory also predicts, like Schumpeter (1942) that local monopoly is better for growth than local competition, because local monopoly restricts the flow of ideas to others and so allows externalities to be internalized by the innovator. When externalities are internalized, innovation and growth speed up. Porter (1990) also argues that knowledge spillovers in specialised geographically-concentrated industries stimulate growth.

The theory of Resource Base View (RBV) is concerned with competitive heterogeneity among firms and the way they reach and sustain competitive advantage to determine firm's performance. According to the RBV, a firm is a bundle of tangible and intangible resources and capabilities, and the root of differences is based on proprietary heterogeneous resources (Penrose, 1995). RBV's core ideas are resources, competences and capabilities. Some authors have defined complementary terms, such as strategic resources (Barney, 1986); core competences (Prahalad and Hamel, 1990); dynamic capabilities (Teece *et al.*, 1997). In this research work therefore firm's capabilities are measured by some inputs, while firm's performance is represented by average sales turnover between 2011 and 2013.

2.24 Innovation capability framework

Factors internal to the firm include first of all, the knowledge and skills brought into the firm by the entrepreneur(s) and workforce, which they obtained through earlier experience. Firms require an adequate stock of technically qualified manpower to absorb new technologies, modify them, create and transfer new technological information, particularly scientists and engineers. The inability to recruit high quality technical staff can be a serious constraint on subsequent growth (Hoffman *et al.*, 1998). Firms can further enhance their human capital stock over time through (formal and informal) internal staff training. Another major internal activity is 'learning-by-doing' through involvement in R&D both as a formally organised activity (Malerba, 1992; Cohen and Levinthal, 1989) and as informal technological efforts. Interaction with suppliers, customers, public assistance agencies, industry associations, foundations and the like, can provide missing external inputs into the learning process which the firm itself cannot (easily) provide. Interaction may take place for the purpose of gathering information about technologies and markets, and also for obtaining various other inputs to complement the internal learning process, such as external staff training, parts and components, consulting services, and R&D grants. Intensive interaction with customers and suppliers is thought to be particularly beneficial (Lundvall, 1988).

Malerba (1992) further suggested that the effectiveness of 'learning-by-interacting' would be boosted by regional clustering between the network actors. He also argued that emerging network structures could foster technological improvement and competitiveness through positive externalities, market linkages and possibilities for collaboration generated by geographical proximity. Close interaction between network partners engenders the building up of personal relations and trust, which

reduces these problems. Saxenian (1994a) also refer to facilitation of interaction and collaboration through trust, argueS that proximity lowers communication costs, while face-to-face contact may also enhance the quality of the interaction. Caniëls and Romijn (2003) emphasises the importance of local knowledge spillovers, including quick diffusion of new information and knowledge through close inter-firm interactions and inter-firm movement of skilled labour. However, Romijn and Albaladejo (2002) stated that others have found evidence contradicting the importance of proximity benefits. Possibly, rapidly falling transport and communication costs and rising speed and quality of long-distance interaction are reducing the significance of proximity for technological dynamism and economic.

Regional networks could foster innovativeness of small high-technology firms features prominently in current UK policy. A dense network of regional business link (BL) centres has been set up, which are designed to provide single points of easy access to a range of business support services. Innovation and technology counselors coordinate the use of local sources of innovation support and act as innovation management consultants. Several BLs have begun to facilitate local information exchange and networking through formation of local business groups, provision of referral services that put like-minded enterprises in touch with each other, and help with establishment of research collaborations. Networking is supposed to be primarily beneficial for small companies involved in related lines of business (Romijn and Albaladejo (2002). Communities of small firms are also supposed to benefit from close relations with scientific institutions. Several science parks and incubators have been created to promote such linkages.

In Figure 2.8, the oval at the top represents the innovation capability of a firm, which accumulates as a result of the various internal and external inputs. For the

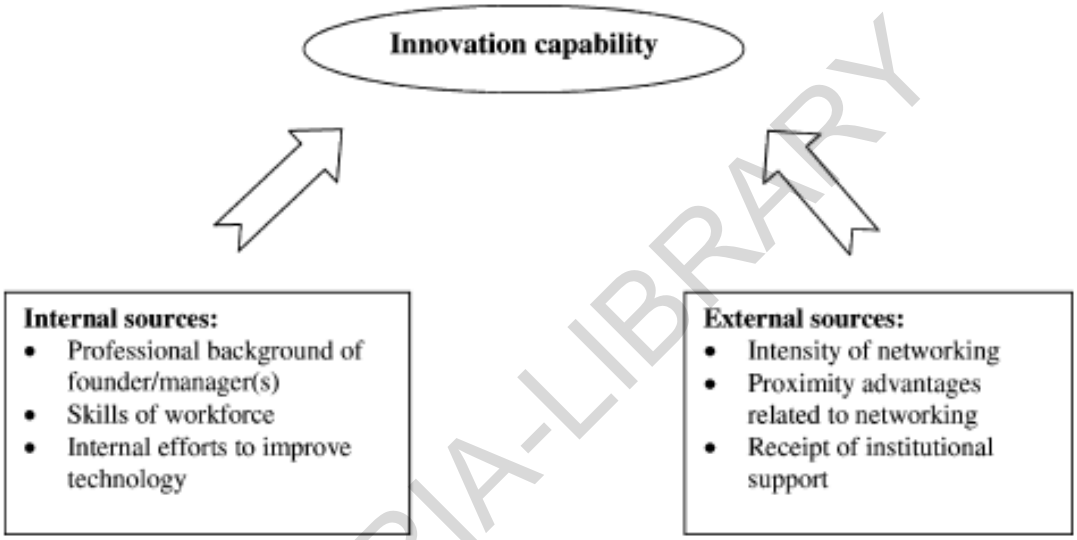

Figure. 2.8: Innovation Capability Framework

Source: Adapted from Rominjn and Alabaladejo (2002)

purpose of data analysis, these inputs have been reorganized under a few main headings. Potentially, important internal sources include: (a) the initial educational background and prior working experience of the founder/manager(s); (b) the professional qualifications of the workforce; and (c) ongoing technological efforts which induce further learning over time, such as formal and informal R&D, formal

and informal (on-the-job) training, investments in technological licenses, among others. Potentially important external sources are represented by: (a) the intensity of networking with a variety of agents and institutions; (b) geographical proximity advantages associated with networking; and (c) receipt of institutional support. Institutional support is represented as a separate factor, because actual transfers of finance and/or knowledge may well have an effect independent from networking intensity or proximity to the assistance source. Romijn and Albaladejo (2002) limited the focus of measuring innovation capability to product innovation alone as this was a dominant form of innovation for their sample. The Romijn and Albaladejo (2002) model was designed using UK data of small electronics and software firms in south east England. The characteristics are different due to some certain reasons such as: inadequate and unreliable basic infrastructure, which constitutes an issue in developing countries which is not the case in developed countries like UK (Oyebisi, 2001).

In Nigeria for example, incessant power failure is a big issue and it has crippled a lot of businesses (Oyebisi, 2001); this is because the cost of maintaining backup electricity is quite enormous. Also, the constructs in the work of Romijn and Albaladejo (2002) only measure product innovation. But in this work, in addition to product innovation other types of innovation like: process, organisational, and marketing innovation will also be explored so as to examine the behaviour and possible impacts in the context of developing countries.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The Oslo manual has been extensively used in literature as a manual for collecting and interpreting data on technological innovation (OECD, 2005). Roper *et al.* (2010) reported that the manual is robust because it provides a guide for measuring hidden innovations which are non-technical. The hidden innovations include, among others, marketing and organisational innovations. The manual was adopted for data collection in this research work. This is in addition to the technical innovation measures which cover product and process innovation at firm-level.

3.2 Conceptual Framework

In Figure 3.1 both the internal and external capabilities generate firm-level cluster production and innovation capabilities. The elements of internal capabilities include: (a) socio-economic characteristics of the firm which comprise factors such as: age, size and location of the business; (b) enterprise human resources, which consist of the educational background of the business owner/founder, his/her area of specialisation and previous work experience as well as skills of the workforce in the firms; (c) production capabilities which include product and process changes; and (d) investment efforts which consists of investments on R&D, trainings, number of R&D staff (as a function of total employees), acquisition of equipment, software and knowledge (license). The external factors (externalities) are: (a) linkages with knowledge institutions, this consists enterprise cooperation and location of cooperation partners; (b) intensity of networking which was measured by the frequency of interaction with customers, suppliers, competitors, financial, training

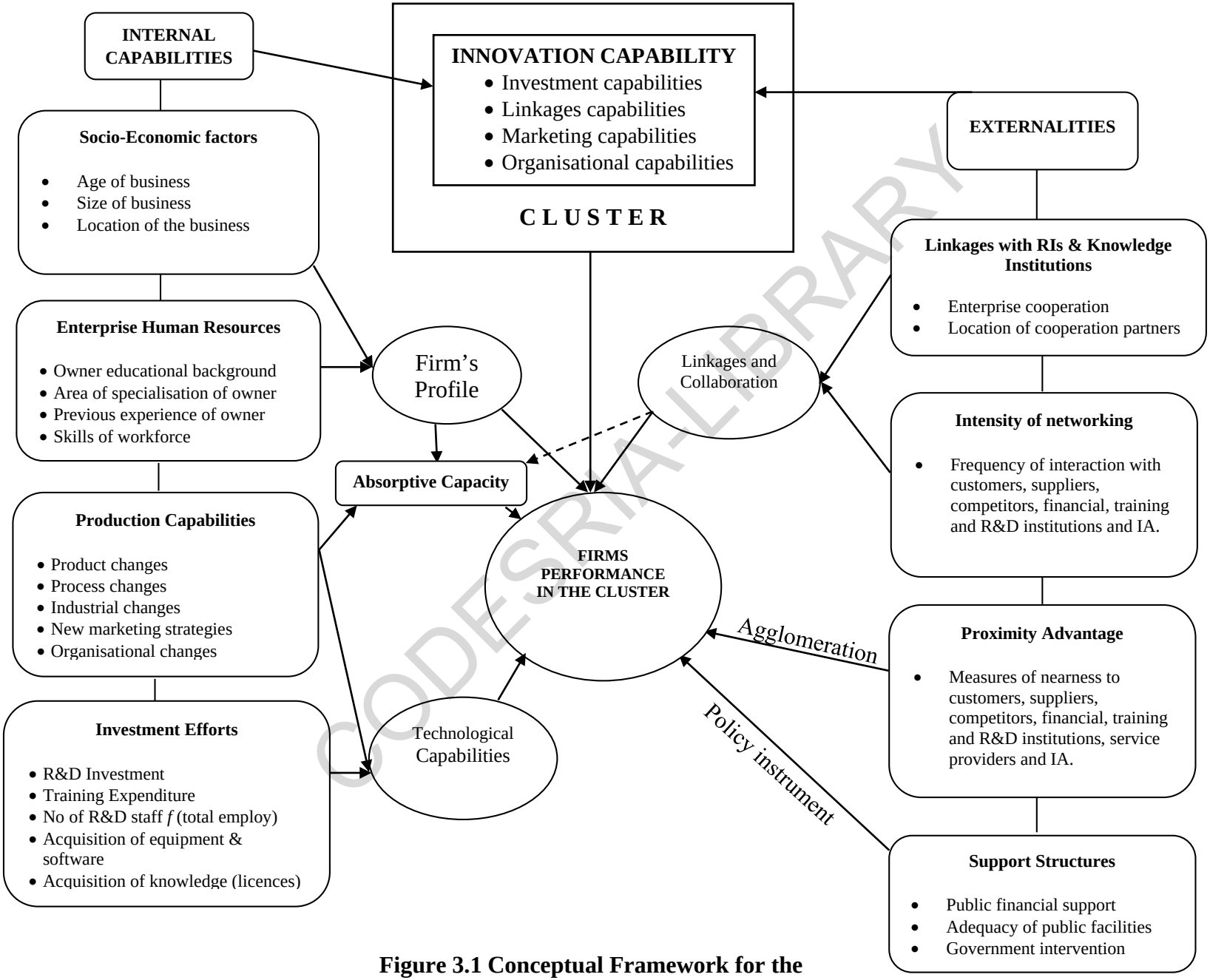

Figure 3.1 Conceptual Framework for the Assessment of Innovation Capability

and R&D institutions and industrial associations; (c) proximity advantage, which measures nearness to customers, suppliers, competitors, financial, training and research institutions and industrial association; and (d) support structures, which measures the receipt of support structures such as public financial support, adequacy of public facilities and other government intervention.

In the framework, some related capabilities have been renamed for the purpose of modularity and brevity. For example, the socio-economic characteristics as well as enterprise human resources have been christened firm's profile, while the combination of production capabilities and investment efforts are categorised as internal technological capabilities (ITCs). Linkages with research institutions and other knowledge institutions (universities, polytechnics, etc) as well as intensity of networking are depicted by the oval representing linkages and collaboration (Figure 3.1). The link between proximity advantage and performance is its agglomeration impact. Absorptive capacity which is the ability to insource and adapt external knowledge for innovation to take place is therefore captured by the combination of the firm's profile, production capabilities as well as linkages and collaborations. In summary, production and innovation capability which consist of both internal and external capabilities impact performance in the clusters. Finally, in this research work, the performance of firms in ICT cluster is influenced by the following elements: firm's profile, absorptive capacity, linkages and collaborations, technological capabilities, firms agglomeration and policy instrument.

3.3 Area of Study

The sample was drawn from three major ICT clusters in Nigeria which are located in Abuja, Port-Harcourt and Lagos. The Abuja clusters are located in two places the first location is at Wuse Zone 3, where there is a high concentration of

firms dealing in computers and related items. The second cluster in Abuja is called "GSM village" which is located in Wuse Zone 1. The activities of the clusters include assembling, sales and repairs of mobile telephones. The cluster in Port Harcourt is located at Ogbunabali road. The Ikeja Computer Village in Lagos is located at Ikeja and bordered by Unity Road, Awolowo road and Oba Akran Avenue. Lagos is the commercial centre of the nation and home to many industries, government agencies, head offices of most financial institutions, embassies of other countries and many commercial institutions. It has the major sea port entry into the country and the busiest international airport in Nigeria.

3.4 Research Instrument

The research instrument employed by this study was both primary and secondary data sources. The primary data were collected through structured questionnaire, interviews and observations directed at owners/founder or managers of the firms. The secondary sources were collected from journals, textbooks, Internet and magazines, manuals and reports on the operations of firms in ICT clusters.

3.5 Sample Population and Sampling Technique

The total number of firms in ICT clusters in Nigeria is not known, but an estimate of the businesses was calculated (Kothari, 2004; Mugenda and Mugenda, 2004) as shown in equation 3.1.

$$n = \frac{z^2 \sigma^2}{e^2} \qquad \text{……. equation 3.1}$$

The confidence level or reliability is the expected percentage of times that the actual value will fall within the stated precision limits. A confidence level of 95% was adopted in this research and this mean that there are 95 chances in 100 (or .95 in 1)

that the sample results represent the true condition of the that it does not. The variable 'n' represents the unknown sample size which is thuspopulation within a specified precision range against 5 chances in 100 (or .05 in 1) calculated. Margin of error is denoted by 'e' which was put at 0.05. Precision is the range within which the answer may vary and still be acceptable; confidence level indicates the likelihood that the answer will fall within that range, and the significance level indicates the likelihood that the answer will fall outside that range. When the confidence level is 95%, then the corresponding significance level will be (100–95) that is, 5%. It is also worth noting that the area of normal curve within precision limits for the specified confidence level constitutes the acceptance region and the area of the curve outside these limits in either direction constitutes the rejection regions. Summarily, given a significance level of 5.0% with corresponding confidence level and critical value (z-score) of 95% and 1.96 respectively coupled with the standard deviation (δ=0.5) equation 3.1 thus translates to the following. The standard deviation (δ) represents the amount of variance expected in responses.

$$\text{Sample size (n)} = \frac{(1.96^2)(0.5^2)}{0.05^2}$$

$$= \frac{3.8416\ X\ 0.25}{0.0025}$$

$$=0.9604\ /0.0025$$

$$=384.16$$

thus, 385 respondents will just be representative but an approximate 400 firms were chosen.

The 400 respondents thus chosen are firms involved in sales, repairs (maintenance) and manufacturing of ICT equipment within the clusters and these were purposively sampled. This survey covered firm activities for the year 2011-2013

period, which represents 3 years preceding the survey. This is in line with innovation assessment as recommended by OECD (2005). A multi-stage sampling technique was used to select four hundred (400) firms in the ICT clusters identified. The businesses that were sampled include micro, small and medium enterprises using the SMEDAN (2010) size classification, micro-scale (0-10 employees), small-scale (11 and 49), medium-scale (50 and 199). Fifty percent of the respondents were drawn randomly from the cluster in computer village, Lagos and 25% each from the 2 remaining clusters. Ikeja Computer Village in Lagos is the largest and has been described as the ICT hub of West Africa, and the Silicon Valley of West Africa (Oyelaran-Oyeyinka, 2006; Bamiro, 2006) following the huge volume of businesses in the cluster.

3.6 Variables and their Measurement

The variables for this study were guided by the statement of the problem in the research questions and objectives; this is as presented as follows. This is categorised into socio-economic variables, assessment of production capability, nature and extent of innovation capabilities, sources of information and co-operation for innovation activities and factors influencing the building of production and innovation capabilities.

3.6.1 Socio-economic Variables

The socio-economic variables are: size, age, education, enterprise structure and type of business activities.

(i) Size of firm was measured in categories and number of permanent staff. The numbers of permanent staff were represented by actual head count of number of employees.

(ii) The age of firm was measured in years and derived by subtracting the year of establishment of the firm from year 2013.

3.6.2 Assessment of Production Capability

The production capability of the firms was measured by educational background, skills of workforce, area of specialisation, previous experience and training courses attended, among others. It further investigated whether firms have manufactured or have achieved any improvement on computer assembly, repairs, maintenance and manufacturing and related peripherals, production capacity, level of capacity utilisation, types of customers, quality control measure, constraints of firm's production capacity and level of involvement in ICT product types etc. These are further expatiated as follows:

(i) Highest Education of the owner was measured by the highest educational attainment of the respondents. This is an ordinal variable from 0 to 6 representing primary, secondary, technical, polytechnic, university, masters, and Ph.D. degrees.

(ii) Skills of workforce were measured by the number of technicians and engineers in the firms as a percentage of total firm employees.

(iii) Area of specialisation of the owner and the management team was indicated by summing their area of specialisation as depicted by the following categories, Science/Engineering, Management/Finance related, and others.

(iv) Previous experience of the management team was measured by the type of organisations the owner had previously worked. This included SMEs, large corporations; knowledge institutions, government ministries or parastatals and others.

(v) The trainings and workshops which the owner attended during the three year period preceding the survey was also measured by the frequency of participation in the following training categories: strategic planning, product

development, marketing, human resources management and quality control and others.

(vi) Dichotomous variable Yes or No was used to indicate whether firms have manufactured or have improved on any computer components.

(vii) Production capacity was measured by the number of computers the ICT firms has the capacity to produce yearly between 2011 and 2013.

(viii) Level of capacity utilisation was measured on a 5-point item code where 1 represents 51-60, 2 -represents 61-70, 3 -represents 71-80, 4 -represents 81-90, 5 -represents 91-100.

(ix) Type of customers for the firm's products was measured by frequency counts of the different categories of organisations that patronise the firms such as; government, universities, banks, research institutes, and others.

(x) The type of quality control that was adopted by the firms was indicated on a 2 item code: (i) traditional quality control and (ii) total quality control.

(xi) Sources of constraints as it affects firm's production capacity were measured on a 5-point likert type scale, 4=strongly severe, 3=severe, 2= moderately severe, 1= less severe, 0=no effect.

(xii) The level of involvement which includes sales and repairs of a number of ICT product types were also measured on a 5 point likert-type scale, with extremely high being 4 and not at all being 0.

3.6.3 Nature and Extent of Innovation Capability

Assessment of product innovation was measured by dichotomous variables and count of innovations on the following proxy variables: see Table 3.1 and 3.2

(i) Introduction of new or significantly improved goods, Yes=1, No=2

(ii) Introduction of new or significantly improved Service(s) Yes=1, No=2

Table 3.1: List of Variables used to Measure Technological Innovations of ICT Clusters in Nigeria.

Factors	Variables	Measurement
Products (good or service) Innovation	• During 2011-2013 introduction of:	
	– New or significantly improved goods;	Yes/No
	– New or significantly improved services;	Yes/No
	• Authority that developed the product Innovation.	Either: (a) enterprise/enterprise group (b) enterprise with other institutions (c) mainly other enterprise/institutions.
	• During 2011-2013 innovations new to:	
	– the Market	Yes/No
	– the firm	Yes/No
	• Distribution in percentages of total turnover in 2013 for:	
	– Goods and services innovation introduced in 2011-2013 *new to the market*	Turnover (%)
	– Goods and services innovation introduced in 2011-2013 *new to the firm*	Turnover (%)
	– Goods and services innovation that were unchanged or only marginally modified during 2011-2013	Turnover (%)
		Total Turnover in 2013 (100%)
Process Innovation	• Innovation introduction during the three year 2011-2013:	
	– for new or significantly improved methods of manufacturing or producing goods and services;	Yes/No
	– for new or significantly improved logistics, delivery or distribution method for your inputs, goods or services;	Yes/No
	– for newly or supporting activities for your processes	Yes/No
	• Authority that developed the process innovation	Either: (a) enterprise/enterprise group (b) enterprise with other institutions (c) mainly other enterprise/institutions

Table 3.2: Variable List for Non-technological Innovations of ICT Clusters in Nigeria.

Organisational Innovation	• During 2011-2013 introduction of:	
	– New business practices for organising procedures;	**Yes/No**
	– New methods of organising work responsibilities and decision-making;	**Yes/No**
	– New method of organising external relations with other firms or public institutions	**Yes/No**
	• Importance of each of the following objective for enterprises' organisational innovations introduced during 2011-2013	
	– Reduced time to respond to customers or supplier needs;	**High=3, Medium=2, Low=1, Not relevant=0**
	– Improved ability to develop new products or processes	
	– Improved quality of your goods or services	
	– Reduced costs per unit output	
	– Improved communication or information sharing within your enterprise or with other enterprise/institution	
Marketing Innovation	• **During 2011-2013 enterprise introduction of:**	
	– Significant changes to aesthetic design or packaging of a good or service	Yes/No
	– New media or techniques for product promotion;	Yes/No
	– New methods for product replacement or sales channels	Yes/No
	– New methods for pricing good or services	Yes/No
	• **Importance of each of the following objective for enterprises' marketing innovations introduced during 2011-2013**	
	– Increase or maintain market share	High=3, Medium=2, Low=1, Not relevant=0
	– Introduce products to new customer groups	
	– Introduce products to new geographic markets	

(iii) Innovations new to their market, Yes=1, No=2

(iv) Innovations new to their firm, Yes=1, No=2

Assessment of process innovation was measured by dichotomous variables and count of innovations on the following proxy variables:

(i) Introduction of new or significantly improved manufacturing method, Yes=1, No=2

(ii) Introduction of new or significantly improved logistics delivery/ distribution, Yes=1, No=2

Assessment of Organizational innovation was measured by dichotomous variables and count of innovations on the following proxy variables:

(iii) Introduction of new or significantly improved support activities, Yes=1, No=2

(iv) Introduction of new or significantly improved knowledge mgt. systems, Yes=1, No=2

Introduction of major change to the organisational of work, Yes=1, No=2

(i) Introduction of new or significantly changes in relation to other firms, Yes=1, No=2

Assessment of marketing innovation was measured by dichotomous variables and count of innovations on the following proxy variables:

(i) Introduction of significant changes to design of a good or service, Yes=1, No=2

(ii) Introduction of significant changes to packaging of a good or service, Yes=1, No=2

(iii) Introduction of new marketing strategies for new customers/market segments, Yes=1, No=2

(iv) Introduction of new sales channels e.g direct selling, internet sale etc, Yes=1, No=2

(v) Introduction of new concepts for products presentation, Yes=1, No=2

(vi) Introduction of new pricing methods to market goods or services, Yes=1, No=2

3.6.4 Sources of Information and Co-operation for Innovation Activities.

Table 3.3 presents information on innovation sources (internal, market, institutional and others). The innovation sources were measured on a 5-point likert-type scale with 4=highly important, 3=very important, 2=important, 1= slightly important, 0=not important. These innovation services were: suppliers of materials, components and software, client and customers, competitors, consultants and private R&D, universities and other higher educational Institutions others were; government and pubic research institutes, conferences, trade fairs and exhibitions, scientific journals and trade publications and professional and industry associations.

3.6.5 Factors Influencing the Building of Production and Innovation Capabilities

The following measures were used to assess innovation performance in the ICT clustered firms in Nigeria.

Y- Sales turnover (Average sales of total sales in 2011 and 2013)

(i) X_1 – Highest Qualification of Founder/MD
(1=Secondary school, 2=Technical, 3=Polytechnic, 4=University, 5=Masters, 6=PhD.)

(ii) X_2 - Highest Qualification of Production Manager MD
(1=Secondary school, 2=Technical, 3=Polytechnic, 4=University, 5=Masters, 6=PhD.)

(iii) X_3 - Highest Qualification of Marketing Manager MD
(1=Secondary school, 2=Technical, 3=Polytechnic, 4=University, 5=Masters, 6=PhD.)

Table 3.3: Sources of Information, Cooperation and Linkages for Innovation Activities in Nigeria ICT Clusters.

Factors	Variables	Measurement
Linkages and cooperation	• Enterprise cooperation during the three years 2011-2013 on any innovation activities with other institutions.	Yes/No
	• Location of cooperation partner: – Other enterprises within your enterprise group – Suppliers of equipment, materials, components or software – Clients or customers – Competitors or other enterprises in your sector – Consultants, commercial labs or private R&D institutes – Universities or other higher education institutions – Government or public research institutes	– Nigeria – Africa – Europe – United States – India/China – All other countries
Internal sources	• Rating of importance of the following information source to enterprises innovation activities:	
	• Within enterprise or enterprise group	High=3, Medium=2, Low=1, Not relevant=0
Market sources	• Suppliers of equipment, materials, components, or software. • Clients or customers • Competitors or other enterprises in your sector • Consultants commercial or private R&D institutes	High=3, Medium=2, Low=1, Not relevant=0
Institutional sources	• Universities or other higher educational institutions • Government or public research institutes	High=3, Medium=2, Low=1, Not relevant=0
Other sources	• Conferences, trade fairs, exhibitions • Scientific journals and trade/technical publications • Professional and industry associations	High=3, Medium=2, Low=1, Not relevant=0

(iv) X_4 -Highest Qualification of Admin. Manager *MD*
(1=Secondary school, 2=Technical, 3=Polytechnic, 4=University, 5=Masters, 6=PhD.)

(v) X_5 – Prior Work Experience of Founder/MD
(0=No experience, 1=SME, 2=Large Corporations, 3=Academic Institutions, 4=Government Miniseries)

(vi) X_6 - Prior Work Experience of Production Manager
(0=No experience, 1=SME, 2=Large Corporations, 3=Academic Institutions, 4=Government Miniseries)

(vii) X_7 - Prior Work Experience of Marketing Manager

(0=No experience, 1=SME, 2=Large Corporations, 3=Academic Institutions, 4=Government Miniseries)

(viii) X_8 – Area of specialisation of founder/MD (3=Science and Engineering, 2=Finance and management, 1=Marketing, Law etc)

(ix) X_9 – Managers Trainings (1=Strategic, 2=Product development, 3=Marketing, 4=Human resources, 5=Quality maintenance).

(x) X_{10} – Total Innovation Expenditure (sum of expenditure on intramural R&D, acquisition of R&D, acquisition of machinery, equipment and software, acquisition of other external knowledge).

(xi) X_{11} – Percentage of Technicians (Number of technicians as percentage of total workforce.

(xii) X_{12} – Percentage of Engineers (Number of university-trained engineers as percentage of total workforce.

(xiii) X_{13} – Internet Services - (Average summation of frequency of use rating of the following : Website, Internet payments, POS, use of email on 4-point likert-type scale ranging from 0=Not used, 1=Rarely, 2=Often, 3=Very often

(xiv) X_{14} – Social Communication (Average summation of frequency of use rating of the following : Facebook, Youtube, Twitter, Linkedln on 4-point likert-type scale ranging from 0=Not used, 1=Rarely, 2=Often, 3=Very often

(xv) X_{15} – Suppliers (degree of importance to innovation activities rating on a 5-point likert-type scale from 4- Highly important, 3 Very important, 2- Important, 1- Slightly important, 0- Not important)

(xvi) X_{16} – Linkages to Knowledge Institutions (degree of importance rating on a 5-point likert-type scale 4- Highly important, 3 Very important, 2- Important, 1- Slightly important, 0- Not important)

(xvii) X_{17} – Competitors (degree of importance rating on a 5-point likert-type scale 4- Highly important, 3 Very important, 2- Important, 1- Slightly important, 0- Not important)

(xviii) X18 – Customers(degree of importance rating on a 5-point likert-type scale from 4- Highly important, 3 very important, 2- important, 1- slightly important, 0- not important)

(xix) X19 – Industrial Association (degree of importance rating on a 5-point likert-type scale from 4- Highly important, 3 very important, 2- important, 1- slightly important, 0- not important)

(xx) X20 – Public Support (1-Yes or 0=No)

(xxi) X21 – Cooperation (degree of importance rating on a 5-point likert-type scale from 4- Highly important, 3 very important, 2- important, 1- slightly important, 0- not important)

(xxii) X22 – Age of Business (2013-Year of establishment)

(xxiii) X23 – Size of Employee (Number)

3.6.6 Description of Cluster-related Factors Influencing Business Performance

The 20-item cluster related variables (factors influencing business performance) were captured on a 5-point likert-type scale as follows: 4=Strongly

agree (SA), 3= Agree (A), 2=Disagree (D), 1= strongly disagree (SD), 0=not applicable (NA). The respondents were required to rate their level of agreement on the items (section D, Appendix I) to their business and innovation activities of the firms. This permits the owner's/manager's perception to be translated into measurement.

3.7 Production and Innovation Capability Performance Model

Firm's performance (Y) was expressed as a function of a number of independent variables mathematically written as follows.

$Y = f(X_1, X_2, X_3, X_4 \ldots\ldots, X_{n-1}, X_n + \varepsilon)$

The effect of the explanatory variables on the performance of the firms was estimated by the following linear function.

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_{n-1} X_{n-1} + \beta_n X_n + \varepsilon \ldots \text{equation (3.2)}$$

Y= Firm performance (dependent variable)

X_i = independent variables

β_i= the parameter of the coefficient of X_i

α = constant term

ε = stochastic error term

n=23

(a) Firm's profile

Firm's profile is a function of highest qualification of founder, production, marketing and administrative manager. This also includes their work experiences, area of specialisation and trainings they have attended previously. This is expressed mathematically as follows:

Firm's profile $= f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9) + \varepsilon$

Thus the relationship of firm's profile with sales performance is thus given as

$$Y = \alpha_1 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \varepsilon$$

…… equation (3.3)

(b) Technological capabilities

This represents the technological capabilities possessed by the firms, this among others are total innovation expenditure, percentage of technicians, percentage of engineers, use of Internet services and social communication. This is represented as follows.

Technological capabilities = $f(X_{10}, X_{11}, X_{12}, X_{13}, X_{14}) + \varepsilon$

The relationship of technological capabilities with sales performance is thus given as

$Y = \alpha + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \varepsilon$ …… equation (3.4)

(c) External factors (absorptive capacities)

The external factors are the absorptive capacities which enable the firms to collaborate with external sources. These represent suppliers of materials and components, linkages to knowledge institutions, competitors, customers, industrial association, public support and level of cooperation between the firms. The Algebraic representation is as follows.

External factors = $f(X_{15}, X_{16}, X_{17}, X_{18}, X_{19}, X_{20}, X_{21}) + \varepsilon$

$Y = \alpha + \beta_{15} X_{15} + \beta_{16} X_{16} + \beta_{17} X_{17} + \beta_{18} X_{18} + \beta_{19} X_{19} + \beta_{20} X_{20} + \beta_{21} X_{21} + \varepsilon$

…… equation (3.5)

(d) Control variables

Age and size of the firms were chosen as the control variables in the study

Control variable = $f(X_{22}, X_{23}) + \varepsilon$

$Y = X_{22} + X_{23} + \varepsilon$ …… equation (3.6)

Description of models tested

The following models were tested in this study, stepwise addition of variables based on the categories previously discussed was adopted, these are: firm's profile,

technological capabilities, external factors and inclusion of control variables. For example Model 1 comprised only the elements of firm's profile as depicted by equation (3.3). Model 2 combined firm's profile and technological efforts/capabilities, which is the addition of equations (3.3) and (3.4). Model 3 thus combined all the elements of model 2 (firm's profile and technological efforts/capabilities with external factors as represented by equation (3.5). Model 4 thus added the control variables to all the variables in model 3. This thus accommodated all the available variables that were put together to investigate the factors influencing the building of production and innovation capabilities of the ICT firms in the clusters.

MODEL 1

Model 1 was derived from equation (3.3) and this is given as follows

$$Y = \alpha_1 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \varepsilon$$

…… equation (3.7)

MODEL 2

Model 2 is the summation of equations (3.3) and (3.4), and this is given as follows.

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \varepsilon$$

…… equation (3.8)

MODEL 3

Model 3 is the summation of equations (3.8) and (3.5), thus

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + \beta_{17} X_{17} + \beta_{18} X_{18} + \beta_{19} X_{19} + \beta_{20} X_{20} + \beta_{21} X_{21} + \varepsilon$$

……equation (3.9)

MODEL 4

Y is the summation of equations (3.9) and 3.6) this is given as

$$Y=\alpha+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\beta_4 X_4+\beta_5 X_5+\beta_6 X_6+\beta_7 X_7+\beta_8 X_8+\beta_9 X_9+\beta_{10} X_{10}+\beta_{11} X_{11}+\beta_{12} X_{12}+\beta_{13} X_{13}+\beta_{14} X_{14}+\beta_{15} X_{15}+\beta_{16} X_{16}+\beta_{17} X_{17}+\beta_{18} X_{18}+\beta_{19} X_{19}+\beta_{20} X_{20}+\beta_{21} X_{21}+\beta_{22} X_{22}+\beta_{23} X_{23}+\varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ equation (3.10)}$$

3.7.1 Model assumptions

The following are the assumptions of the model:

(i) Measurement error: That both the dependent and independent variables were observed without measurement error;

(ii) Normality: That the population distribution were normal;

(iii) Randomness: that the dependent variable (Y) was an unvaried random variable for each specific combination of the independent variables;

(iv) Linearity: That the regression of Y and Xs (independent variables) were linear

(v) Auto-correlation: that the observations of the dependent variables were statistically independent;

(vi) Multicolinearity: That two or more independent variables were not highly correlated, that is having correlation coefficient of less than 0.6.

3.8 Validation of Questionnaire

Measures were taken to validate the questionnaire used for this study. Efforts were made to ensure that the questions were relevant to the research questions, objectives of the study, the theoretical framework as well as conceptual framework. A pilot study was carried out in Dugbe cluster, Ibadan, Oyo state using 10 ICT firms that were also involved in sales, servicing and repairs. This was with a view to gaining some knowledge that was used to redesign the instrument before the main

survey was carried out. The comments, suggestions and corrections made by the respondents from these 10 ICT firms were collated and used to improve the quality of the questionnaire.

3.9 Data Analysis

The data were coded and analysed using the IBM Statistical Package for Social Sciences (SPSS) version 20. Both inferential and descriptive statistics were carried out on the data. Among the descriptive statistical techniques used were percentages, frequency counts to describe the observations. The research also employed correlation, multiple regression, one way analysis of variance (ANOVA), Duncan multiple range and factor analysis. The statistical tools are described below:

a) The frequencies and percentages were used to analyse some of the socio-economic characteristics. For example age, no of employees, no of technicians, no of engineers, enterprise structure, main business activities, educational qualifications, area of specialisation and previous work experience.

b) Analysis of Variance (ANOVA) was used to analyse the variables on constraint affecting production capacity as well as cluster effect on business performance among ICT clustered firms. The Duncan multiple range test was used as a post-hoc analysis to determine which means differ and to test the differences between each pair of means. It separated the means based on location of the clusters.

c) Correlation test was used to examine the relationship between the dependent variable (sales turnover) and independent variables as well as relationship among the independent variables. It explained the direction, strength and significance of the bivariate relationships between the independent and

dependent variables. Some of the independent variables are: highest qualification, work experience, area of specialisation, manager trainings, total innovation expenditure, percentage of technicians, percentage of engineers, age and size of business among others. It was also employed to show that there is no indication of multicollinearity among the indicators, (Amoako-Gyampah and Acquaah, 2008.

d) Regression was employed to examine the effects and magnitude of independent variables on the dependent variable (sales turnover) using ordinary least square (OLS) method. The independent variables represents the production and innovation capability variables, some of which are: highest qualification, work experience, area of specialisation, manager trainings, total innovation expenditure, percentage of technicians, percentage of engineers, age and size of business, linkages to knowledge institutions, industrial association among others.

e) Factor analysis as a factor reduction tool was employed. Reliability estimates of the study variables were first tested; this reveals appropriate internal consistency of the measures. The research initially examined the convergent validity of 20-cluster items using exploratory factor analysis (EFA). It adopted the Kaiser-Meyer-Olkin measure of sampling adequacy calculating a value of 0.74 (Appendix III) which is just about the recommended threshold of 0.7 (Kline, 1998; Gunday *et al.,* 2011; Sok *et al.,* 2013). All the constructs eigen values were greater than 1.0 and all factor loadings exceeded 0.5 as recommended by Sok *et al.,*(2013), this thus confirms the convergent validity of the research constructs (Yam *et al.,* 2011). The convergence thus reduced the 20-item cluster variables to 7 latent variables (Appendix IV). Thus, the

convergence was achieved at 12 iterations with Varimax Kaiser Normalization (Cooper and Kleinschmidt, 1995; Griffin and Page, 1996; Gunday *et al.*, 2011) Secondly, the Bartlett's test of sphericity was also significant (χ^2 (120) = 2679.547, $p < 0.01$) as shown in Appendix III. Also, the communalities measured were all above 0.4 (Appendix II). This further confirms that each item shared some common variance with other items. Lastly, cronbach alpha was adopted to assess the scale reliability of each item; an average of 0.74 was calculated for all the items this was found to be above the threshold of 0.7 as recommended by Kline (1998).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Characteristics of Respondents

This section presents the demographic and socio-economic characteristics of the ICT clustered firms.

4.1.1 Responses to Questionnaire Administration

Table 4.1 shows the distribution of the questionnaire, two hundred copies of the questionnaire were administered in the Lagos cluster, 100 each in Abuja and Port-Harcourt. Out of the 400 copies distributed, 228 copies of the questionnaire were retrieved and analysed for the study. Majority 118 (59%) of the respondents were from the Lagos cluster while 61% and 49% were retrieved from the Abuja and Port-Harcourt clusters respectively. The high response rate from Lagos was probably due to the fact that the Lagos cluster is the first and the largest IT market in Africa (Zeng *et. al*, 2008). Oyelaran-Oyeyinka and Lal (2006) reported a response rate of 90% in the computer village cluster. This high response rate received in this cluster may be as a result of requesting assistance of the Industry Association, Computer and Allied Products Dealers Association of Nigeria (CAPDAN) which office was not accessible for the whole period of this exercise.

4.1.2 Size of the Sampled Firms

Table 4.2 shows the categories of firms sampled in the clusters. All the firms were Micro, Small and Medium enterprises based on SMEDAN (2010) classification. One hundred and fifty six (68.7%) of the firms were micro enterprises, each of them employed less than ten employees. Sixty four (28%) were small scale enterprises because they employed between 10-49 employees while 7 (3%) are in the medium scale category

Table 4.1: Percentage Distribution of Firms in the ICT Clusters

Cities/Location	Distribution	Questionnaire Returned	Return Rate (%)
Lagos	200	118	59.0
Abuja	100	61	61.0
Port-Harcourt	100	49	49.0
Total	**400**	**228**	**57**

Source: Field Survey, 2014

Table 4. 2: Business Category and Size of Permanent Staff

Categories of Firms	Size of employee	No of ICT Clustered firms	Percentage (%)	Average Employee
Micro	<10	156	68.7	5.68
Small	10-49	64	28.2	17.46
Medium	50-199	7	3.0	94.71

Source: Field Survey, 2014

4.1.3. Characteristics of ICT Clustered Firms in Nigeria

Table 4.3 reveals that about 12% of the firms were established within the last 5years. About 46% of the firms were established within the last 10 years, that is shortly after 2001 when the telecommunications industry was liberalised (Oyeyinka-Oyelaran and Adeya, 2002; Awoleye *et al.,* 2008). Between 11-20, 16-20 years category about 34% and 7.8%, respectively were found to have been in business. Computer business started in the first ICT cluster (the computer village, Ikeja) around 1985 according to Oyelaran-Oyeyinka (2006). Since most of the firms had passed the threshold of first 5years of business operations they would have developed internal capacity and enhanced their knowledge by learning over time (Calantone *et al.,* 2002). Building internal capacities makes firms immune to failure and enables them to be able to successfully absorb relevant capacities to enhance innovativeness (Gachino, 2007; Cohen and Levinthal, 1989, 1990).

Majority (87%) of the firms in the clusters employed 1-5 technicians, while about 9% and 4.5% employed 6-10 and 11-15 technicians respectively. Similarly, 90% of them employed 1-5 engineers while about 6.9% employed 6-10 engineers, and very few (0.04%) employed between 11-50 engineers. This result indicates a high stock of technical human resources present in the ICT clusters. These categories of workforce are important for technological growth of innovative firms (Bell, 2009; Lall, 1992). They have been identified as important drivers of innovation and implementers of technological change (Silvestre and Dalcol, 2009). In addition technological strength and investment in human resources are important determinants of absorptive capacity for any firm aspiring to grow and be resilient (Gachino, 2007).

Table 4.3 shows that about 12% of the firms belong to the enterprise group. This group consists of two or more legally defined enterprises under common

Table 4. 3: Profile of the ICT Clustered Firms in Nigeria

Parameters		No of ICT Clustered firms	Percentage (%)
Age of Business (N=218)	1 - 5	26	11.9
	6 - 10	100	45.9
	11 - 15	74	33.9
	16 - 20	17	7.8
	21 over	1	-
No of employees (N=194)			
	1-10	135	69.58
	11-20	28	14.43
	21-30	18	9.28
	31-40	5	2.58
	50-199	8	4.12
No of Technicians (N=187)			
	1 - 5	162	86.6
	6 - 10	17	9.1
	11 - 15	8	4.3
	16 - 20	-	-
No of Engineers (N=144)			
	1 - 5	129	89.6
	6 - 10	10	6.9
	11 - 15	1	0.01
	16 - 20	3	0.02
Enterprise Structure (N=215)			
Enterprise Group		25	11.6
Non-Enterprise Group		190	88.4
Main Business Activities			
Sales		185	81.14
Services, Repairs and Maintenance		161	70.61
Production		127	55.70

Source: Field Survey, 2014

ownership. Each enterprise in the group served different markets or segments within the ICT clustered markets. However, majority (88%) of the firms did not belong to any enterprise group. It has also been reported that over 80% of micro and small scale enterprises were based on sole proprietorship which seems to be the characteristic of firms in developing countries. This may be partly due to the advantages of sole proprietorship such as low investment cost and ease of entry into the business (Adegbite, 2010). Further benefits of such businesses include, among others, control and decision making processes which are directed by one person who is the entrepreneur. However, such firms lack the competence, knowledge and skills necessary for innovations. Which is paramount for successful competition in the market where innovation is important (Youli and Huiwei, 2011; Crespi**,** 2014).

The main business activities in the ICT clusters firms as indicated by 81% of the respondents was merchandising in computers, telephones, etc (Table 4.3). The Table also shows that about 71% of the firms are also involved in services, repairs and maintenance of computer systems, telephones and related peripherals. About 56% of the enterprises were involved in computer production activities such as computer assembly, components manufacturing and improvement. This also includes repairs and maintenance of telephones. Oyelaran-Oyeyinka and McCormick (2007) in a previous study on Ikeja Computer Village reported that the activities in the cluster are characterised by computer assembly, components sales, repairs and limited production efforts. Apart from computer accessories, computer peripherals such as printers, scanners and networking equipment as well as office equipment were also among the items that were sold in the market. Oyelaran-Oyeyinka (2006) added that the firms are involved in the sale of branded computer systems which could be foreign or locally branded. The foreign branded computer systems were reported to be

dominated by IBM, Compaq, Dell, HP, Toshiba, Sun Microsystem and Gateway brands. On the other hand, the locally branded systems were majorly Zinox Systems and OMATEK.

4.1.4. Qualification of Respondents

A number of researchers have enumerated the importance of education to innovation and business performance (Sanni *et al.*, 2001). Table 4.4 indicates that 9.8% of the business owner/managing directors had primary education, while 2.9% completed secondary education. About 7.2% attended technical colleges and 18.4% had attended polytechnic and had obtained HNDs. Majority (61.7%) of the owners of the firms had university education. Specifically, 49.1, 11.6 and 1.0% had B.Sc. /BA, M.Sc and Ph.D, respectively. This result indicates that most (80.1%) of the business owners/entrepreneurs in ICT clusters in Nigeria had post-secondary school education. Oyelaran-Oyeyinka (2006) reported a similar observation in Ikeja ICT cluster where 90% of the entrepreneurs had formal education. The implication of these findings is that managers in the clusters possess the required prerequisite educational background necessary to give adequate strategic directions to their firms in a competitive environment.

Production capabilities are the skills and knowledge needed for the operation and improvement of a plant. These capabilities range from routine functions to intensive and innovative efforts; adaptation and improvement in technology. It includes both process technological capabilities as well as product capabilities, such as product redesign, product quality improvement and introduction of new products. In Table 4.4 a good proportion (95.5%) of the production managers were educated at least to technical education. Specifically, 32.6% had polytechnic diploma and 53.9% obtained university degrees.

Table 4. 4: Highest Academic Qualification of Owner and Management Staff

Qualifications	Owner/ Managing Director (N=207)		Production Manager (N=89)		Marketing Manager (N=109)		Admin Manager (N=142)	
	No of firms	%	No of firms	%	No of firms	%	No of firms	%
Primary	12	9.8	-	-	-	-	-	-
Secondary	6	2.9	1	1.1	15	13.8	14	9.9
Technical College/NCE	15	7.2	8	9.0	9	8.3	9	6.3
Polytechnic/HND	38	18.4	29	32.6	37	33.9	48	33.8
University	110	49.1	48	53.9	38	34.9	63	44.4
Masters	24	11.6	3	3.4	10	9.2	8	5.6
Ph.D.	2	1.0	-	-	-	-	-	-

Source: Field Survey, 2014

A paltry (3.4%) possess master's degrees as well. Production is a task that requires highly skilled workforce which includes technicians and engineers who are also likely to be innovative.

Similarly, 86.2 and 100% of the marketing managers and administrative staff respectively had tertiary education. The implication of this finding is that the ICT firms would have internal strength and capacity to innovate and absorb external knowledge (Cohen and Levinthal, 1989) especially in product design, packaging, product placement, promotion and pricing. Ernst *et al.*(1998) also reported that high level of education among the workforce facilitates collaboration and linkages for exchange of knowledge, skills and experience from their peers in knowledge institutions in the process of production and innovation.

4.1.5. Area of Specialisation

Table 4.5a shows that about 66% of the owners/managers of ICT-clustered firms specialised in engineering and technology, while 28.2% specialised in management and finance and 5.8% in marketing related disciplines. For the Administrative staff, 71% specialised in management, human resource and finance. This suggests that a good number of the owners of the firms have engineering and technology background. This indicates that the firms in the clusters are guided by high technological strength emanating from the owners by given direction that could facilitate innovativeness in the enterprises. Other administrative staff in the firms were reported to have relevant background to assist them in carrying out the day to day running of their businesses. This is in agreement with Aberijo (2010) who reported a similar scenario with owner managers of small and medium food companies.

Table 4. 5a: Area of Specialisation of Owners and Management Staff of the ICT Clustered Firms in Nigeria

Characteristic	Engineering and Technology	Management and Finance	Marketing and Others
Owner (N=156)	103 (66)	44 (28.2)	9 (5.8)
Production manager (N=70)	56 (80.0)	14 (20.0)	-
Marketing manager (N=105)	25 (23.8)	60(57.1)	20 (19.0)
Administrative manager (N=88)	15 (17.0)	63 (71.6)	10 (11.4

Percentages are in parenthesis

Source: Field Survey, 2014

4.1.6 Previous Work Experience

Table 4.5b reveals that about 51.4% of the marketing managers had previously worked in SMEs. Similarly, 25.3 and 26.4% of the production managers and administrative managers respectively had worked with large corporations before taking appointment with the firms in the ICT clusters. Furthermore, 29.3% of the owners had prior working experience with large corporations. Specifically, about 5.7% of production, 4.3% marketing and 3.3% administrative managers had prior working experience from knowledge institutions; while 15% had worked previously as civil servants. Some marketing (28.6%), administrative managers (20.9%), firm owners (6.8%) and production managers (6.9%) did not have prior working experience before joining firms in the clusters.

This indicates that there is a vast labour turnover from other SMEs other than firms in the ICT clusters where the managers had worked previously. This contributes to the cluster literature on inter-industry labour mobility which has shown the intensity and pattern of labour markets, productivity growth, and overall industrial promotion (Maliranta & Nikulainen, 2008). This is also similar to what obtains with Nokia industry and the rest of the Finnish economy in the 1990s. The result shows a relatively strong upstream labour flow link from the Nokia industry through the research industry up to the education industry. This suggests the fact that one of the main strength of firm agglomeration is its capability to attract highly skilled individuals from other sectors of an economy (Straubhaar, 2000; Maliranta & Nikulainen, 2008).

Table 4.5b: Work Experience of Owners and Management Staff of the ICT Clustered Firms in Nigeria

Characteristics	SME	Large Corporations	Research Institutes/Universities	Government Ministries	No Experience
Owner	60 (45.1)	39 (29.3)	24 (18.0)	1 (0.8)	9 (6.8)
Production manager	41 (47.1)	22 (25.3)	5 (5.7)	13 (14.9)	6 (6.9)
Marketing manager	36 (51.4)	8 (11.4)	3 (4.3)	3 (4.3)	20 (28.6)
Administrative manager	43 (47.3)	24 (26.4)	3 (3.3)	2 (2.2)	19 (20.9)

Percentages are in parenthesis

Source: Field Survey, 2014

4.1.7 Attendance of Training Courses/Workshops and Conferences by Owners/Staff of ICT Clustered Firms

Table 4.5c shows the training courses, workshops, seminars and conferences attended by the owners and staff of the ICT clustered firms. About 29.5% of them had attended training workshops on human resource management while 12%, 25.1%, 7.7% and 25.7% attended training workshops/seminars on quality maintenance, marketing, product development and strategic management respectively. Providing opportunities for CEOs and managers of enterprise has been noted to enhance their performance and productivity. For example, in a study of industrial districts in Europe, Schmitz and Musyck (1994) reported the function is of organising seminars and courses for retraining or updating of know-how for entrepreneurs.

4.2 Production capabilities of ICT clustered firms in Nigeria

Ilori (1994) recommended the exploitation of local potentials and capabilities to generate knowledge to adapt, modify and imitate foreign technologies, thereby impacting indigenous production. Tables 4.6 reveals that only a few (14.9%) of the ICT firms were involved in product improvement that lead to innovation. A good number (85.1%) of them reiterated that they had not succeeded in manufacturing or improving on any computer components. Whether they attempted and failed along the line or not, we cannot determine that here, since the response is only dichotomous.

From Table 4.6, majority of the firms (59.5%) in the clusters assembled 1-20 computers in a month while 18.6% and 9.5% assembled between 21-40 and 41-60 computers on a monthly basis respectively. During the interview process the respondents reiterated that most times the firms assembled computers based on request for a given specification.

Table 4.5c: Training Courses/Conferences attended by Owners and Management Staff in the ICT Clustered Firms in Nigeria

Characteristics	Strategic	Product development	Marketing	Human resources	Quality maintenance
Owner and Management staff	47 (25.7%)	14 (7.7%)	46 (25.1%)	54 (29.5%)	22 (12.0%)

Percentages are in parenthesis
Source: Field Survey, 2014

Table 4. 6: Production capacity of ICT clustered firms

	No of ICT clustered firms	(%)
Product manufacturing and improvement (N=195)		
No	166	85.1
Yes	29	14.9
Computer assemblage capacity/month (N=116)		
Number of computers		
1 - 20	69	57.0
21 - 40	27	22.3
41 – 60	11	9.1
61 – 80	5	4.1
81 – 100	-	-
101 – 120	-	-
121 – 140	-	-
141 – 160	2	1.7
161 – 180	-	-
181 – 200	2	1.7
201 – 220	-	-
221 – 240	2	1.7
241 – 260	2	1.7
261 – Over	1	0.8

Source: Field Survey, 2014

This made customisation possible for different customers, since the need for computer systems differs. For example the specifications for customers that used the computer for memory intensive operations like video editing, computer server or graphics rendering were different from customers who only needed the computer system for word processing, spreadsheet and some light applications.

In summary, a total of about 500 computers could be produced by any one firm in the ICT clusters in Nigeria in a year. Translating this to monetary terms, given that the average prevalent market price across the three clusters was N60,000 ($324), the sum per year thus will total N30million (N60,000 x 500 computers) naira. This is about $160,000 approximately, given $1=N185. This means that any of the ICT firms in the clusters that are into the production of computers can make a turnover of about N30million yearly. The cost per unit of the computers produced was put at (N60,000) $324. This includes preloaded choice software operating systems and application packages, whereas the cost of branded computer systems is more than double. Ordinarily the price of an original windows operating system and a complete office package is about the same cost of cloned computer in the clusters. This is possible because most of the software used by the firms for installation are pirated and they are easily available for about 100-200 naira ($1) depending on the number of CDs used for the package. Although government through the Standard Organizations of Nigeria (SON), Nigerian Copyright Commission (NCC) has been attempting to clamp down on the firms involved in piracy, but they have since not been able to indict anybody for this nefarious activity. Most of these ICT firms in the clusters claim not to use pirated software for any of the computers they clone, but they do it stealthily through the back-door for regular customers.

Despite the fact that the cost of buying a computer is relatively cheaper now than what it used to be about a decade ago (Oyelaran-Oyeyinka, 2006) the demand for cloned computers has also reduced; however, this contradicts the law of supply and demand. The shrinking demand of cloned computers can be largely traced to cheaper fairly used imported (Tokunbo) branded computers which are more affordable. Interview reveals that a complete system unit including flat screen monitor of a fairly used computer systems was between N10,000-N18,000 ($54-$100) depending on the specification. Another reason why the demand of the cloned desktop computers may be dwindling could also be traced to the demand for laptops including new and used ones. Other reasons could be advancement of technology which may have employed economics of scale for cheaper/lower production of computers couple with competition from other manufacturers that have joined the business. In addition, availability of substitute products such as smart phones, tablets, etc may also have been responsible for the reduction in demand for cloned computers.

4.2.1 Production Capacity Utilization

Capacity utilisation plays an important role in evaluating economic activity. It has been used along with other factors to explain the behaviour of investment, inflation, productivity, profits and outputs (Ragan, 1976). As indicated in Table 4.7 11.2% of the ICT firms in the clusters had achieved capacity utilisation of between 50-70% for computer production. Most (60.8%) of the firms were able to achieve 70-90% capacity utilisation while 18.4% achieved 90-100%. The findings indicate that some of the firms in the clusters did not fully utilise their capacities in terms of computer production. However, they have the potentials for greater production, given the capital stock, without having to incur major expenditures for new capital or equipment (Klein and Summers, 1968).

Table 4. 7: Production Capacity Utilization (N=125) of the ICT-clustered Firms

Capacity category (%)	Number of ICT clustered firms	Percentage (%)
40-50	12	9.6
51-60	10	8.0
61-70	4	3.2
71-80	48	38.4
81-90	28	22.4
91-99	19	15.2
100	4	3.2

Source: Field Survey, 2014

4.2.2 Software Production Characteristics

There are two types of software developed in the clusters. These are standalone and embedded software. Standalone software in this context are referred to as application programs/packages that are run on a computer as is when booted up or launched without the assistance of any external modules or library functions. Examples are payroll package, student record management system (SRMS), attendance and clocking packages, among others. Embedded systems on the other hand are referred to as computer software, written to control machines or devices that are not typically thought of as computers. In Table 4.8, majority (89.5%) of the ICT firms in the clusters was involved in standalone software development and 10.5% of them developed embedded software.

Table 4.8 shows that about 34.6% of the firms sold their software to the government, while 41.7, 3.1, 6.1 and 14.7% developed software for tertiary institutions, banks, non-governmental organisations and secondary schools respectively. Some of the ICT firms were also involved in web development and maintenance for the institutions. About 15% of the ICT firms were involved in software development for secondary schools. These software were used mainly for teaching, learning and administrative purposes. About 34.6% of the firms indicated that government at all levels and their agencies patronised them for services. Apart from buying computers, they requested for services such as software development for special applications such as web development. Furthermore, 3.1 and 6.1% of the firms had banks and non-governmental organisation (NGO) as their customers. Interviews reveals that they assisted banks in developing software which were used to perform some peripheral operations such as data gathering and banking operations.

Table 4. 8: Software Production Characteristics

Criteria	No of firms	Percentage (%)
Types of software developed		
Stand alone	51	89.5
Embedded	6	10.5
		100.0
Customers for developed software		
Universities/polytechnics	68	41.7
Government	56	34.6
Secondary Schools	24	14.7
NGOs	10	6.1
Banks	5	3.1
		100.0

Source: Field Survey, 2014

Some of the respondents claimed that the software used by banks in performing their major operations were sourced from India and other parts of the world. An online report (Azeez, 2013) stated that Finacle software is the most prevalent banking software used among the banks in Nigeria. Awoleye *et al.* (2013) also reported that most of the Nigerian bank websites developments were handled by foreign firms. This is an indication that local content in software and website development is still minimal in the country. However, the respondents claimed that the microfinance banks solely depend on local ICT firms for web and other software development for their main operations.

The software produced by the ICT firms were mostly user-specific applications tailored to the specific need of the institutions. Some of these specific applications include result processing, registration purposes, transcript processing, online payment, payroll, library books processing, computer based tests, etc. Some of these packages are delivered as a suite or as individual standalone software.

4.2.3 Quality Control

In Table 4.9, most (94%) of the respondents reiterated their adoption of general quality control. About 23% also are reported to be practicing. TQM in their production. TQM consists of organisation-wide efforts to install and make permanent a climate in which an organisation continuously improves its ability to deliver high-quality products and services to customers. Since the major target of TQM was to integrate management philosophy aimed at continuously improving the performance of products, processes, and services to achieve and surpass customer expectations, this indicates that the preparedness of the firms in the ICT clusters for quality delivery is still low. For example, as reported by Bayazit and Karpark (2006) Turkish manufacturing industry has a readiness level of 59.2% for implementing TQM in their

Table 4. 9: Type of Quality Control Measure Adopted by the ICT Firms

Quality Control Type	ICT Firms	
	Frequency	**Percentage (%)**
General Quality Control		
Yes	151	93.8
No	10	6.2
		100.0
Total Quality Control		
Yes	36	22.8
No	122	77.2
		100.0

Source: Field Survey, 2014

production. The success of the Turkish industry is related to some of the TQM success factors as identified by Black and Porter (1996). These among others are: people and customer management, supplier partnerships, communication of improvement information, customer satisfaction orientation, external interface management, strategic quality management, teamwork structures for improvement, operational quality planning, quality improvement measurement systems, and corporate quality culture. The low preparedness and adoption of TQM in the ICT clusters in Nigeria may be as a result of inadequate management of some of these success factors responsible to boost its operation.

In summary, adoption of TQM is expedient in any firm aspiring to be competitive and willing to improve the propensity of organisational effectiveness (Ugboro and Obeng, 2000; Fok et al., 2001).

4.2.4 Customer's Service

Table 4.10 shows that only 1.7% of ICT firms were able to meet 100% of their customer's demand; while 84.9 and 13.6% meet 71-99 and 50-70% of their demand respectively. This result shows that there are gaps in meeting customers demand wholly in the ICT clusters in Nigeria. This may be as a result of some inadequacies of the firms in its operations including marketing, production processes and supply chain. Shortages of raw materials may also be a major constraint in meeting customer's demand; this is identified by Hlioui et al. (2015). Also Lambart and Cooper (2000) reported that to achieve a good customer-focused system requires processing information both accurately and in a timely manner for quick response systems that require frequent changes in response to fluctuations in customer demand. This reiterates the importance of information processing and giving cognizance to its characteristics, especially timeliness.

Table 4.10: Proportions of Customer's Demand Serviced (N=118)

Percentage of customer's demand met	No of ICT clustered firms	Percent (%)
50 - 60%	8	6.8
61 - 70%	8	6.8
71 - 80%	35	29.7
81 - 90%	29	24.6
91 - 100%	36	30.5
100%	2	1.7

Source: Field Survey, 2014

4.2.5 Constraints Militating Against the Activities of the Firms in the ICT Clusters

Table 4.11 shows the significant difference in the constraint militating against the activities of the firms in the ICT clusters. There was significant difference ($F = 4.36$; $p < 0.05$) in the mean ratings of shortage of raw materials as a constraint to production capability among the firms surveyed in the clusters. Firms in the Lagos cluster rated shortage of raw materials as a severe constraint (3.08) while firms in the Abuja (2.46) and Port-Harcourt (2.57) clusters rated it moderately severe. There was statistically significant difference ($p < 0.05$) between Lagos cluster and both Abuja and Port-Harcourt clusters. This indicates that shortage of raw materials is a severe factor that has been limiting the production capability of the firms in the clusters in Nigeria. This is probably because the Ikeja cluster is close to the port of Lagos where most imported items pass through. Lagos has been described as the ICT hub of West Africa, christened the Silicon Valley of West Africa according (Oyelaran-Oyeyinka, 2006). A good number of the ICT equipment (computers, mobile telephone, etc) sold in Nigeria are imported through the Lagos port. Some of the firms in the Abuja and Port-Harcourt clusters reported that they source material from the Ikeja, Lagos clusters.

Table 4.11 shows that shortage of employees was not statistically significant ($F = 1.42$; $p > 0.05$) as a constraint to production activities in the clusters although it was found to be less severe across all the clusters sampled specifically for Abuja (0.94), Lagos (1.03) and Port-Harcourt (1.33) clusters. This implies that, availability of employees is not a severe constraint to production. This is not unexpected since there are many qualified graduates who are unemployed in the Nigerian labour market.

Table 4.11: Constraint Affecting Production Capacity in ICT clusters

Constraint	Abuja	Lagos	Port-Harcourt	Average	F	*p*
Shortage of raw materials	2.46 [b]	3.08 [a]	2.57 [b]	2.70	4.36	0.015
Employee shortages	0.94 [b]	1.03 [b]	1.33 [b]	1.10	1.42	0.245
Low demand	1.78 [a]	2.35 [b]	2.45 [b]	2.19	6.08	0.003
Irregular power supply	2.33[a]	3.24 [a]	3.76 [a]	3.11	21.58	0.000
Lack of fund	1.13 [a]	2.03 [b]	2.22 [b]	1.79	12.29	0.000

Key:

Strongly Severe (SS) =4

Severe (S) =3

Moderately Severe (MS) =2

Less Severe (LS) =1

No Effect (NE) =0

Mean with different alphabets are significantly different ($p < 0.05$)

Source: Author's Survey, 2014.

This indicates that there are many qualified persons who are available for any vacant job that may be available. This is supported by the report of NBS (2010) that noted an unemployment rate of 21.3% (post-secondary) in the country. However, interviews reveals that firms experienced shortages of employees as a result of staff leaving for further studies and some for fresh admission purposes.

There was a significant difference ($F = 6.08$, $p < 0.05$) between the factors affecting production capacity utilisation with respect to low demand for cloned computers in the ICT clusters. For this factor it was noted that low demand is moderately severe (1.78, 2.35, 2.45) across the clusters in Abuja, Lagos and Port-Harcourt, respectively. However, the mean difference in the clusters as shown by the table suggests that low demand is statistically significant in Abuja but not for Lagos and Port-Harcourt. This indicates that the demand for locally cloned computers exist but at a reduced rate due to customer's preference for imported brand new and fairly used laptops and some low cost used branded desktop computers. This is contrary to Angel and Engstrom (1995) where high contribution of Taiwan and Singapore (which accounts for 59.3% of cloned units of computer systems) relative to US importation was reported to have lowered the demand for branded computers. Also in China the demand for cloned computers was reported to have reduced the demand for branded computers due to cost saving which sometimes can be up to 50% less than the price of foreign brands (Kraemer and Dedrik, 2001).

Table 4.11 further shows that irregular supply of electricity was statistically significant ($F = 21.58$; $p < 0.01$) among other factors that affect production capacity in ICT clusters. The supply of electricity to the ICT clusters was not regular. However, firms in the ICT cluster in Port-Harcourt have made an arrangement with a private company for steady supply of electricity. It further showed that low supply of

electricity has strong severe effect on Port-Harcourt cluster (3.76), and severe (3.24) effect on Lagos cluster as well as moderately severe (2.33) effect on Abuja cluster. Although the mean difference among the cluster locations are not statistically significant. This indicates that electricity supply from the national grid was quite low, especially in Port-Harcourt where the effect on limiting production capacity has been highly rated by the ICT firms. This is in agreement with the report of Adenikinju (2003) whose findings confirmed that the cost of electricity failure on the Nigerian manufacturing sector is enormous. Also Akinlo (2009) assessed the relationship between electricity consumption and economic growth in Nigeria. He concluded that electricity consumption, infrastructural shortages and problems of blackout and constant interruptions are so rampant in the country and could adversely affect the country's social and economic progress.

To alleviate the problem of electricity supply, the Port-Harcourt cluster introduced an innovative means of cutting costs on electricity supply. This was achieved by cooperating with others within the cluster to run industrial generators which collectively power the cluster rather than running generators individually. This arrangement is handled by another private firm as a service to the cluster. Each interested firm subscribed monthly to the private company for electricity supply at a fee relative to their capacity. The charges ranges from N200 to N500 daily and there is also the option of a monthly prepaid fee of N10,000. The firm was supplying the electricity through two 250KWA capacity generators which run alternately. All the beneficiary firms claimed that the arrangement is cost effective compared to running individual generators. However, this system is non-existent in Abuja and Lagos where each firm acquires its own generator to run its businesses.

Table 4.11 further shows lack of funds as another statistically significant (F = 12.29; p > 0.01) constraint to production activities in the ICT clusters. It was found that lack of funds was moderately severe (2.22, 2.03) in firms in the Port-Harcourt and Lagos clusters respectively but less severe (1.13) in the Abuja cluster. The mean difference is statistically significant in Abuja cluster but not in both Lagos and Port-Harcourt clusters. This indicates that production activities are affected by inadequate funding which could facilitate innovation inputs lead to further innovations in the clusters. It is likely that the firms in the Abuja cluster may have more access to funding support from the government because of its proximity to the seat of the Federal Government. The other clusters in Port-Harcourt and Lagos may have been sourcing for funding through bank loans and other sources available within and around the clusters. During the interview sessions, it was gathered that some of them have been leveraging on bank loans, but they found that it was not sustainable due to high lending rates charged by the commercial banks in Nigeria, which is usually up to 24% per annum. Odusola and Akinlo (2001) opined that dynamic responses are generated by lending rates which could impact the state of the economy. Ilori *et al.* (2002) also opined that high lending rate could increase the cost of production which in turn could impact the growth of small business.

4.2.6 Firm's activities in the ICT clusters

The business activities in the clusters are shown in Table 4.12. It shows that sales of computer accessories were ranked the highest as about 80% of firms are in this business activity. This was closely followed by software installation activities which were carried out in 72.6% of the firms. Similarly, it was also observed that dealing with new desktop computers was ranked third (71%) in the firm's business activities. In conclusion, sales of computer accessories, software installation and sales

Table 4.12: Firm activities in the ICT clusters

	Type of activities	Number of Firms	Regular dealer Firms	Occasional dealer Firms	Rank
Hardware	**New items**				
	Laptops	127	84 (66.1)	43 (33.9)	5
	Desktops	168	119 (70.8)	49 (29.2)	3
	Telephones	77	44 (57.1)	33 (42.9)	8
	Tablets	113	56 (49.6)	57 (50.4)	10
	Computer Accessories	186	148 (79.6)	38 (20.4)	1
	Telephone Accessories	89	55 (61.8)	34 (38.2)	6
	Fairly used (Tokunbo) items				
	Tokunbo Desktops	29	13 (44.8)	16 (55.2)	12
	Tokunbo Laptops	30	14 (46.7)	16 (53.3)	11
	Tokunbo Mobile Phones	29	16 (55.2)	13 (44.8)	9
Software	*Software Installation*	190	138 (72.6)	52 (27.4)	2
	Hardware maintenance	167	111 (66.5)	56 (33.5)	4
Others	*Other ICTs, eg Office equip. networking*	128	75 (58.6)	53 (41.4)	7

Percentages are in parenthesis
Source: Author's Survey, 2014

of desktop computers were ranked highest in the business activities of the firms in the clusters. Computer hardware maintenance was rated fourth (67%) major business activities in the clusters. Bamiro (2006) defined computer hardware production as the bringing together of discrete computer components to get a complete computer system. Most developing countries including Africa and especially in Nigeria prefer cloned computers, and this is premised on three key factors. These are (i) lower prices relative to imported branded computers, which are mostly affordable (ii) ease of servicing and maintenance since the components are available in the market and (iii) customisation; which allows the users to specify the configuration (Bamiro, 2006). The procedure involved in assembling/cloning a computer system does not require too much time. Despite the benefits and flexibility of computer cloning, the corollary is that the products are not guaranteed and are not supported after sales; hence there is no after sales service. Some of the firms however claimed that they give up to a maximum of 30 days warranty which does not cover accidental damage. About 66% of firms were also involved in sales of new laptop computers while 57.1% and 61.8% of firms deal regularly with new mobile phones and accessories respectively. Firms in the clusters were also involved in sales of imported fairly used desktops, laptop components and mobile phones.

The respondents from the firms claimed that some people prefer fairly used computers and phones because of economic reasons. An average fairly used laptop was reportedly sold for N15,000-N60,000 while used desktop ranges between N7,500 and N15,000 depending on the grade, brand as well as specifications. For the used desktop computers, the monitors are sold at a sum of N4,500 to N7,500 depending on the size, technology and brand. Sizes such as 14”, 15” or 17” monitors and liquid crystal display (LCD) technology with the following brand: HP, Dell, IBM, Compaq

among others are now more prominent in the market .

About 59% of the firms were also involved in the sale of other ICT equipment such as: (i) Office equipment which include: printers, scanners, binding machine, photocopiers, washing machines, stationeries, and (ii) networking equipment which include: switches, routers, cables, connectors, LAN tester, among others.

4.2.7 Learning Capability of the Computer Assembly/Cloning Process

Two major approaches to assembling computers in the clusters were identified. These were (i) customer-centred approach and, (ii) supply approach. The assemblage starts with knowing beforehand the requirements of customers. However, some customers according to the firms come to the clusters without any requirement in mind. They were usually assisted by asking questions about the intended use of the computer and amount of funds budgeted for the purchase.

On the supply approach, the dealers assemble the computers without direct input from the customers. The production manager applies the power of intuition (Casanueva *et al.,* 2013) to take the decision on the specifications of the computers to be assembled. This decision is usually guided by their previous market experience from multiple inputs received from previous buyers coupled with market survey in the cluster through interaction with other firms. Leveraging on geographic proximity (Bell and Zaheer, 2007) to tap knowledge through other firm's knowledge spill overs (Casanueva *et al.,* 2013; Choi and Williams, 2014).

4.2.8 Learning Path of Mobile Phone Repairs and Management

In the ICT clusters sampled in Nigeria, it was revealed that there were a number of channels by which mobile phones reach the market. Some of the phones come as new through different sources such as from Asia (China and Taiwan), Dubai

and others. Some also arrive the clusters by importation of fairly used phones tagged ‘UK’ or ‘London used’. These are phones that have not reached the end of their useful lives. Some utilities are still derivable from such phones especially when they are serviced to improve the condition, as reported by the dealer firms. The other channel is faulty phones which are brought to the market by the users themselves or through a third party. Some of these are probably due for updating or needs component repairs or replacement. Maintenance services provided by the firms in the cluster usually involve hardware repairs and software related services.

The hardware repair of mobile phone could involve replacement of: screen, ear piece and speaker, flex ribbon cable, keypad membrane, charging connector, battery connector, SIM connector, printed circuit board (PCB) board among others. The respondents reported that troubleshooting of the phones is carried out first, by taking input from the users. The respondents reported that the knowledge to carry out repairs and maintenance of mobile phones are acquired through formal on the job training and informally from colleagues in the clusters and more experienced people from firms within the cluster. This is in agreement with Taiwo *et al.* (2001) who reported the existence of formal and informal modes of learning of personnel involved in repairs and maintenance of household equipment.

Software related maintenance which was carried out in the clusters include: telephone unlocking, software version updating, application downloads, contacts and personal information management, popularly called PIM-PIM among others. They reiterated that when they have any challenge or difficulty fixing any phone, external help is sought from colleagues from within and outside the clusters as well as using online resources. The search for such help usually start with colleagues in the clusters. This may be referred to as spillover effect which in turn is a contributor to

innovativeness (Beaudry and Schiffauerova, 2009; Ilori and Irefin, 1997). When they have exhausted all possible approaches then they collectively explore online resources such as blogs, support forums, social media and designated platforms for specific manufacturers. The ability of the staff of these firms to use online resources successfully to solving a problem is a demonstration of their technological capability.

4.3 The Nature and Extent of Innovations in ICT Clustered Firms in Nigeria

It has been acknowledged that firms innovate through variety of sources and that innovation patterns are industry-specific (Pavitt, 1984; von Hippel, 1998; Evangelista *et al.,* 1997).

4.3.1 Product Innovation

Product innovations involve introduction of new or significantly improved goods or services. Table 4.13 shows that 37.6% of the firms in the clusters had introduced new or significantly improved goods. These firms all together had generated 132 new and significantly improved goods within the 3 year of the survey.

Adegbite (2010) reported a high prevalence of product innovation (89%) in the Nigerian textile weaving industry. The high prevalence of the product innovation in the textile industry may be as a result of inexpensive cost of innovation in the sector compared to the cost of acquisition of machinery and other equipment that could facilitate product innovation in hi-tech ICT zone (Germain, 1996; Chesbrough and Rosenbloom, 2015). Some of these innovations include the improvement on power packs to forestall the surge usually caused by incessant power failure to desktop computer systems. Some other examples are: the design of keyboard that can accommodate the three major Nigerian languages, auto switch-on for server computers, etc.

Table 4.13: Nature and Extent of Innovation in ICT Clustered Firms in Nigeria

Innovations	Nature of Innovations		Extent of Innovation
	Number of firms	%	No of innovations
Product			
Introduction of new or significantly improved good(s)	85	37.6	132
Introduction of new or significantly improved Service(s)	151	66.8	286
Innovations new to their market	79	35.0	92
Innovations new to their firm	60	26.5	81
Product Innovation average		**41.5**	**148**
Process			
Introduction of new or significantly improved manufacturing method	70	31.0	215
Intro. of new or significantly improved logistics delivery/ distribution	137	60.6	548
Process Innovation average		**45.8**	**382**
Organizational innovations			
Introduction of new or significantly improved support activities	122	54.0	349
Introduction of new or significantly improved knowledge mgt. systems	154	68.1	462
Introduction of major change to the organisational of work	148	65.5	658
Introduction of new or significantly changes in relation to other firms	144	63.7	522
Organisational Innovation average		**62.9**	**498**
Marketing Innovations			
Introduction of significant changes to design of a good or service	91	40.3	179
Introduction of significant changes to packaging of a good or service	119	52.7	357
Intro. of new marketing strategies for new customers/market segments	167	73.9	321
Introduction of new sales channels e.g direct selling, internet sale etc	173	76.5	684
Introduction of new concepts for products presentation	153	67.7	307
Introduction of new pricing methods to market goods or services	180	79.6	523
Marketing Innovation average		**65.1**	**396**

Source: Field Survey 2014

Examples of software products innovation produced include the design of schools management information system such as: clocking, online registration, results processing, web based transcript generator, library information system among others. Also 66.8% of them have also introduced new or significantly improved service which have generated 286 innovations within the clusters. Kajogbola (1997) reported that 87% of respondents in the informal footwear sector were able to carry out incremental adaptation. Obembe (2013) also reported that about 97% of the master furniture makers are engaged in various improvements, adaptation or modification of furniture products. Also 35% and 26.5% of the firms have produced innovations that are new to the market and new to their firms respectively. This indicates that the firms in the ICT clusters have produced some product innovations which could further be developed to meet international standards (Kramer *et al.,* 2011; Samara *et al.,* 2012).

4.3.2 Process Innovation

Process innovation refers to any new equipment, process or improved process introduced in the industry in the past 3 years 2011-2013. Process innovations reduce the cost of producing existing products or results in the production of new products (Adegbite, 2010) could also reduce the processing time in production line. Table 4.13 shows that 70 (31%) of the firms in the ICT clusters have a total of 215 process innovations through introduction of significantly improved manufacturing methods. In an earlier study on Industrial Innovation in Sub-Saharan Africa Oyelaran-Oyeyinka *et al.,*(1996) found 39% of the manufacturing sector in Nigeria to have introduced process innovation. In the same vein, Dada (2014) reported that process innovation as the only innovation type with the highest mean rank (3.57) on a scale of 5 among others. Some examples of these innovations as found by this report are introduction of automated software installation process using Norton Ghost. This is a process of hard

drive cloning and imaging which fast-track software installation time considerably. Also, about 137 (61%) of the firms in the ICT clusters have introduced 548 improved logistics delivery and distribution channels. The firms identified some of these methods of delivery which include confirmation of payments for goods by customers before they are delivered to the given address. The payments are usually made by either bank transfer or other online payment facilities provided. Other innovations in the delivery of goods and products to customers is that, the goods are packaged so as to secure it from water spills or rain drops; sometimes they are wrapped to ensure the safety of the content. These goods are thus sent through public transport vehicles to any specified destination in the country. This method of delivery is adopted because it is cost effective, the average charges ranges between N500 (about $3) to N5,000 ($30) depending on the distance and the size of the luggage. Another creativity in the delivery of such goods to the owner or designated person to collect is that, his phone number will be used as confirmation before the goods are delivered. Also within this environment, some indirect employments have been created as some freelance drivers are also employed to carry out the delivery and distribution of goods. Some freelance car owners who have vehicles also hover around the clusters and are sometimes requested to deliver good to nearby customers. For example, in the Lagos cluster, during the data collection for this research work a driver within the cluster was requested to deliver some items to a customer in a location in Ikorodu from the computer village, Ikeja cluster. Further investigation shows that some of these drivers are educated and do use technologies to navigate their routes and track their locations. Mobile phones with Internet presence with google map application was employed to achieve this.

4.3.3 Organisational Innovation

This is a type of innovation where management methods are intended to improve firms' use of knowledge, the quality of firms' goods and services or the efficiency of work flows. In Table 4.13 it was observed that 54% of the firms had introduced 349 new or improved support activities, and 68.1% had introduced 462 knowledge management systems, while 65.5% had introduced 658 major changes to their organisation of work and 63.7% had made 522 changes in relation to other firms in the ICT clusters within the period 2011-2013. In the same vein, Egbetokun *et al.* (2012) in their research on assessment of innovation capability in the cable and wire manufacturing industry in Nigeria reported a high prevalence of organisational innovation among other innovation types measured. This indicates that organisational innovation is on increase in among firms in developing countries especially in the Nigeria ICT clusters.

4.3.4 Marketing Innovation

Table 4.13 shows that 91 (40.3%) of the firms had introduced about 179 significant changes to design of a good or service. 119 (52.7%) have introduced significant packaging of a good or service. This includes cleaning of fairly used computer systems to make it more attractive and wrapping of the same in cellophane to safeguard it for easy forwarding to end users. Table 4.13 further shows that 167 (73.9%) of the firms have introduced 321 new marketing strategies to carve a niche in the market through market segmentation. Also 173 (76.5%) have introduced 684 new sales channels e.g. direct selling, Internet sale, etc. The impact of information technology on product marketing has been enumerated by Adetayo *et al., (*1999) in the context of Nigeria. Furthermore, about 153 (67.7) firms had introduced a total of 307 new concepts of product presentations. In the same vein, 180 (79.6%) have

introduced new pricing method to market goods or services. It was reported in literature that a low cost strategy leads to improvements in efficiencies that a firm can use to reduce its price and achieve increase in sales growth and market share. A firm that develops a strategy that allows it to achieve volume and mix flexibility while keeping costs low and quality high will be able to respond faster to market changes and thus achieve higher performance (Amoako-Gyampah and Acquaah, 2008).

In conclusion, the study shows that the total number of both organisational and marketing innovations generated by the firms is higher compared to what obtains for product and process innovations as previously reported. This indicates that organisational and marketing innovations (which are non-technical) are more prominent than technical innovations counterpart in the ICT clusters in Nigeria.

4.3.5 Contributions of Innovations Types to Business Growth

Table 4.14 shows the correlation analysis of sales turnover and the four innovation types. A parametric test of this nature was necessary in order to investigate if there is any relationship among the innovation types in relation to sales turnover. Table 4.14 shows that there is no indication of multicollinearity among the indicators, (Amoako-Gyampah and Acquaah, 2008) with the exception of the relationship between marketing innovation (iNNOVMARK) and average turnover changes, which is almost at the borderline. From Table 4.14 all the innovation types except product innovation (iNNOVPROD) are positively correlated with sales turnover. For example, there was a weak negative correlation between sales turnover and product innovation ($r = -0.074$, $p < 0.05$). However, sales turnover was strongly positively and significantly related to organisational innovation ($r = 0.434$, $p < 0.05$) this implies that organisational and marketing innovation ($r = 0.661$, $p < 0.05$) improve sales turnover.

Table 4. 14: Relationship among Sales Turnover and Innovation Types

	Average turnover	**1**	**2**	**3**	**4**
Average turnover	1				
iNNOVPROD	-0.074	1			
iNNOVPROC	0.032	0.096	1		
iNNOVORG	0.434**	0.061	-0.066	1	
iNNOVMARK	0.661**	0.036	-0.103	0.571**	1

*** correlation is significant at 0.01 level (2-tailed)*

Key:

iNNOVPROD = Product Innovation
iNNOVPROC = Process Innovation
iNNOVORG = Organisational Innovation
iNNOVMARK = Marketing Innovation

Process innovation also had positive but not significant correlation with sales turn over ($r = 0.032$, $p > 0.05$). There was also negative and weak correlation between process innovation and organisational innovation ($r = -0.066$, $p > 0.05$). However, marketing and organisational innovation are strongly positively and significantly correlated ($r = 0.571$, $p < 0.05$). This implies that marketing innovation may necessitate the need for organisational innovation. Table 4.14 further shows that there was a negative correlation between iNNOVPROD and the two main innovations iNNOVORG ($r = -0.066$, $p > 0.05$) and iNNOVMARK ($r = -0.103$, $p > 0.05$) that were prevalent among the firms in the ICT clustered firms in Nigeria. Although the negative correlation is not significant, this indicates that both organisational and marketing innovation efforts may not contribute to generating process innovation. This further suggests that different kinds of knowledge, skills and capabilities are drivers of these innovations. This is consistent with the findings of Casanueva *et al.* (2013) who reported that negative correlation between measurements of centrality and structural holes, was due to differences in the nature of the skills and capabilities, firms need in order to benefit thereof. However, there was positive and significant correlation ($r = 0.571$, $p < 0.05$) between organisational and marketing innovation. This indicates that, there is a link between the inputs that are responsible for generating these innovations as it applies to the ICT clustered firms in Nigeria.

4.3.6 Sources of Information for Innovation

Technological changes necessitate the need for organisations to innovate. The literature have identified some main sources for innovation activities especially at firm level (Romijn and Albaladejo, 2002; OECD, 2005). Table 4.15 shows the findings on the importance of identified sources of information and cooperation of innovation activities across the selected ICT clusters in Nigeria. The result shows that

Table 4.15: Sources of Information and Cooperation for Innovation Activities in ICT Clusters in Nigeria

Sources of Information for Innovation	Abuja	Lagos	Port-Harcourt	Average	F	p
• Suppliers of materials, components and software	3.33 [b]	3.24 [b]	3.65 [a]	3.41	8.62	0.000
• Client and Customers	3.20 [a]	3.52 [a]	4.00 [a]	3.57	1.05	0.285
• Competitors	2.3 [a]	2.98 [a]	3.63 [a]	2.97	26.73	0.000
• Consultants and Private R&D	1.61 [a]	0.95 [b]	1.04 [b]	1.20	5.58	0.005
• Universities and other higher educational Institutions	1.09 [b]	1.48 [a]	1.22 [b]	1.75	4.99	0.008
• Government and Pubic Research Institutes	1.35 [b]	1.13 [b]	2.08 [a]	1.52	9.81	0.000
• Conferences, Trade Fairs and Exhibitions	2.04 [a]	1.63 [a]	2.47 [a]	2.05	10.91	0.000
• Scientific Journals and Trade Publications	1.57 [b]	1.51 [b]	1.53 [b]	1.54	0.05	0.951
• Professional and Industry Associations	1.87 [b]	1.95 [b]	1.43 [b]	1.26	1.73	0.183

Key: 4- Highly important, 3 very important, 2- important, 1- slightly important, 0- not important
Mean with different alphabets are significantly different ($p < 0.05$)

the mean rating for the following sources of information for innovation were significantly different ($p < 0.01$). These sources are: suppliers of materials ($F = 8.62$, $p < 0.01$), impact of competitors ($F = 26.73$, $p < 0.01$), collaboration with consultants and private R&D ($F = 5.58$, $p < 0.01$), linkages with Government and public research institutions ($F = 9.81$, $p < 0.01$), attendance at conferences, trade fairs and exhibitions ($F = 10.91$, $p < 0.01$) as well as professional and industry associations ($F = 4.99$, $p < 0.01$). The mean rating of the innovation sources relative to suppliers were rated highly important (3.65) in the Port-Harcourt cluster and very important (3.33, 3.24) at both the Abuja and Lagos clusters, respectively.

The table further shows the mean difference across the clusters, as the Port-Harcourt cluster was statistically and significantly different from the other two clusters in both Abuja and Lagos. This indicates that if there are no constant supplies of materials, components and software to the clusters, the chances of carrying out innovation related activities will be small. This factor (suppliers of materials) was found to limit the propensity for innovation activities in the Port-Harcourt cluster. This may be partly due to the sources of their supplies, which is largely dependent on the Ikeja, Lagos cluster. If there is a dearth of materials in the Ikeja, Lagos cluster, it will have a translational effect on the supplies to all the other dependent clusters in Abuja and Port-Harcourt. All other sources of information that were found to be significant are discussed as follows. Competition among the firms ($F = 26.73$, $p < 0.01$), was found to be highly important (3.63) and important (2.98) at both Port-Harcourt and Lagos clusters respectively. It was also observed to be significant across the three clusters assessed in the survey. Information through consultants and private R&D ($F = 5.58$, $p < 0.01$) was also found to be significant, as this factor was important (1.61), and slightly important (0.95, 1.04) in Abuja, Lagos and Port-Harcourt respectively. Other sources of information that were significant as revealed

by this study are through: universities and other higher educational institutions (F = 4.99, p < 0.01), Government and public research institutes (F = 9.81, p < 0.01) and through attendance of conferences, trade fairs and exhibitions (F = 10.91, p < 0.01).

4.4 Relationship between Sales Turnover, Production and Innovation Capabilities in Selected ICT Clustered Firms in Nigeria.

The correlation matrix Table 4.16 shows the relationship between the dependent variable, (Sales turnover), Y and each of the independent variables as well as the correlation among independent variables. There were significant and positive correlations between the performance of the business (Y) and qualification of owner/founder, X_1 (r = 0.321, p < 0.01); prior work experience of owner, X_5 (r = 0.492, p < 0.01), prior work experience of production manager, X_6 (r = 0.432, p < 0.01), prior work experience of marketing manager, X_7 (r = 0.321, p < 0.01), percentage of technicians, X_{11} (r = 0.326, p < 0.01), percentage of engineers, X_{12} (r = 0.523, p < 0.01), suppliers, X_{15} (r = 0.40, p < 0.01), linkages to knowledge institutions, X_{16} (r = 0.167, p < 0.05), age of the business, X_{19} (r = 0.419, p < 0.01) and number of employees, X_{20} (r = 0.418, p < 0.01). The positive correlation thus suggests that each of the variables enhanced the performance of the industry. These suggests that human capacity which includes owner's qualification as well as experience of the management team especially that of the founder, the production and marketing managers was key to the performance of the firms in the clusters. Other internal technological capability contributing to increased sales turnover includes the adequate mix of technicians and engineers in the firms relative to their total employees.

However, some of the explanatory variables were negatively correlated and significant with business performance these are: qualification of production manager (X_2) (r = -0.09, p<0.05), managers' trainings (X_9) (r= -0.052, p<0.05), total innovation expenditure (X_{10}) (r = -0.141, p < 0.05), social communication (X_{14}) (r=-.021, p<0.05),

Table 4.16: Correlation Matrix of Factors Influencing Production and Innovation Capabilities in Selected ICT Clusters in Nigeria

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}
Y	1																							
X_1	0.321**	1																						
X_2	-0.090	-.132	1																					
X_3	0.066	-.139*	-.197**	1																				
X_4	0.060	-.130	-.026	.287**	1																			
X_5	0.492**	.326**	-.207**	.230**	.184**	1																		
X_6	0.432**	.015	-.172*	.241**	.128	.520**	1																	
X_7	0.522**	.068	.053	.113	.109	.474**	.584**	1																
X_8	0.010	-.269**	.303**	.156	.083	.004	-.065	.079	1															
X_9	-0.052	.098	-.147	.046	-.159*	-.120	.117	-.151*	-.294**	1														
X_{10}	-0.141	.049	.067	.043	.017	-.173*	-.257**	-.402**	-.219*	.211*	1													
X_{11}	0.326**	.204**	-.065	-.003	.094	.199**	-.038	.211**	.047	.108	-.139	1												
X_{12}	0.523**	.329**	-.094	-.150*	.116	.358**	.325**	.263**	.171	.170*	.034	.228**	1											
X_{13}	0.055	-.027	.030	.100	.296**	.143*	-.028	-.005	.224*	-.023	.071	.200**	.036	1										
X_{14}	-0.021	.010	.137	-.019	.064	-.173*	-.052	-.117	.370**	.133	.081	.131	.048	.309**	1									
X_{15}	0.400**	-.154*	.123	-.124	.071	.146*	.176*	.274**	.238*	-.136	-.098	-.044	.209**	-.023	.091	1								
X_{16}	0.167*	.106	-.162*	.255**	.210**	.403**	.117	.198**	.076	-.168*	-.055	.056	-.016	.431**	.059	.076	1							
X_{17}	-0.060	.061	-.164*	-.059	.088	.008	-.070	-.152*	-.161	.185*	.223**	.023	.030	.020	.087	.163*	.118	1						
X_{18}	-0.299**	.117	-.104	-.080	.151*	-.065	-.126	-.094	.027	-.048	.228**	-.060	-.018	-.051	-.093	.044	.008	.551**	1					
X_{19}	0.419**	-.086	.193**	-.101	-.069	.024	.078	.374**	.256**	-.291**	-.319**	.125	.058	.228**	-.092	.115	.076	-.397**	-.168*	1				
X_{20}	0.418**	.134*	-.035	-.032	-.077	.173*	.142	.307**	-.269**	-.103	-.221**	.117	-.139	.064	-.107	.061	.101	-.265**	-.250**	.349**	1			
X_{21}	-0.241**	.021	-.117	.195**	.120	-.009	-.075	.025	-.002	-.043	.076	.060	-.127	.216**	.025	-.380**	.419**	-.146*	.054	-.001	.017	1		
X_{22}	-0.062	.130	-.135	.053	.084	.013	-.165*	-.006	.040	.025	.023	.061	.027	.119	.260**	-.059	.168*	-.084	-.201**	.004	-.032	.135	1	
X_{23}	0.015	-.273**	.273**	.115	.273**	-.105	-.207	-.107	.872**	-.099	.312**	-.151	-.055	.273**	.354**	.328**	-.050	.090	.077	-.020	-.029	-.012	.145	1

***correlation is significance at the 0.01 level (2-tailed), *correlation is significance at the 0.05 level (2-tailed)*

Y - Average Sales Turnover in 2011 and 2013
X_1 – Highest Qualification of Founder/MD
X_2 - Highest Qualification of Production Manager
X_3 - Highest Qualification of Marketing Manager
X_4 -Highest Qualification of Admin. Manager
X_5 – Prior Work Experience of Founder/MD
X_6 - Prior Work Experience of Production Manager
X_7 - Prior Work Experience of Marketing Manager
X_8 – Area of Specialization of Founder/MD
X_9 – Managers Trainings
X_{10} – Total Innovation Expenditure
X_{11} – Percentage of Technicians
X_{12} – Percentage of Engineers
X_{13} – Internet Services
X_{14} – Social Communication
X_{15} – Suppliers
X_{16} – Linkages to Knowledge Institutions
X_{17} – Competitors
X_{18} – Customers
X_{19} – Age of Business
X_{20} – Size of employee
X_{21} – Industrial Association
X_{22} – Public support
X_{23} – Cooperation

competitors (X_{17}) (r = -0.06, p < 0.05), low customer patronage (X_{18}) (r = -0.299, p < 0.01), industrial association (X_{21}) (r = -0.241, p < 0.01) and public support (X_{22}) (r =-0.062, p < 0.05). Although, only low customer patronage (X_{18}) (r = -0.299, p < 0.01) and industrial association (X_{21}) (r = -0.241, p < 0.01) are statistically significant.

This suggests that these variables have a negative impact on the performance of the firms in the ICT clusters in Nigeria. The low customer patronage experienced by the firms in the clusters may be partly due to the shift to online purchases made available through e-commerce as championed by their competitors. E-commerce was propelled by technological advancements enabled by information technology (Ugwu *et al.,* 2000). A number of local e-commerce web shops such as Jumia.com, lumia.com, konga.com, kaymu.com have taken over the online market in the sales of ICT products. The ease of online shopping and payment became prevalent at the advent of the cashless policy which was introduced by the Central Bank of Nigeria (CBN) in 2011 and enforced in June 2012 (Awoleye *et al.,* 2013).

Table 4.16 also shows a negative impact on industrial association on business performance; this result is contrary to what is mostly reported in literature. A good number of the interviewees sadly reported that there has been gross mismanagement in the leadership of the association, especially in the Lagos cluster.

Most of the firms believe that the leadership of the association has been lured to support the government more on issues that need mutual agreement between the government and the firms in the clusters. They accuse their leadership of corruption and prejudice rather than play brokerage between them (the firms in the industry and the government).

The respondents reported that they received financial support collectively from the major suppliers to the market every year for the development of the

environment in the clusters. This was reported to be coordinated by Computer and Allied Products Dealers Association of Nigeria (CAPDAN) which is the umbrella body for the association of the firms. Though, the respondents expressed their displeasure about the management of the funds by the leadership of the association (CAPDAN). This was peculiar to the computer village cluster in Ikeja where the association seems to have started.

4.4.1 Factors influencing Production and Innovation Capabilities in ICT Clusters in Nigeria.

In order to examine the factors influencing the building of production and innovation capabilities in the ICT clusters, a simple ordinary least squares (OLS) model was used. The model was estimated using multiple regression; which produced 4 models as presented in Table 4.17. Model 1 tests all the factors that constitute internal capabilities in the firms; Model 2 adds the main technological efforts including information technology adoption. Model 3 adds to Model 2 external capabilities which include absorptive capacity. Finally, model 4 represents the full model which includes all the variables and the controls (Age and Size).

The regression result as shown from Table 4.17 shows that model 1 became $Y = 16.44 + 8.80X_1 + 7.26X_2 + 23.47X_3 - 4.6X_4 - 18.07X_5 + 5.78X_6 + 14.41X_7 - 4.27X_8 + 2.73X_9$ ……..……. equation (4.1)

This shows that educational qualification of owners ($\beta = 8.80$, $\rho < 0.01$), production managers ($\beta = 7.26$, $\rho < 0.1$), marketing managers ($\beta = 23.47$, $\rho < 0.05$), experience of owners ($\beta = 14.41$, $\rho < 0.05$) are positively and statistically significant with sales turnover (dependent variable).

Table 4.17: Effect of factors that influence Innovation Capability in ICT firms in Nigeria

Dependent variable: Sales Turnover Indicators	Model 1 (Firm's Profile)	Model 2 (Firm's profile + Technological efforts)	Model 3 (Model 2 + Externalities)	Model 4 (Model 3 + control variables)	VIF
Constant (α)	16.44	1.570	-27.55	-208.083***	3.81
Qualification of Owner	8.80***	10.001***	12.616***	16.170***	3.11
	(2.380)	(2.133)	(2.277)	(0.133)	
Qualification of Production M'ger	7.26*	6.175*	4.015	3.829	4.30
	(3.735)	(3.594)	(3.508)	(0.321)	
Qualification of Marketing Manager	23.47***	22.999***	18.846***	30.655***	3.74
	(4.931)	(4.655)	(5.133)	(0.233)	
Qualification of Admin. Manager	-4.60	-9.429**	-4.998	-.351	4.43
	(3.987)	(3.721)	(3.957)	(0.268)	
Experience of Production M'ger	-18.07**	-15.443**	-11.247	-15.452**	3.79
	(7.463)	(6.847)	(7.479)	(0.156)	
Experience of Marketing M'ger	5.78	9.747**	10.994**	5.434*	5.94
	(3.545)	(3.748)	(3.864)	(0.264)	
Experience of Owner	14.41**	7.319	1.575	-3.880	3.79
	(5.608)	(4.978)	(5.774)	(0.072)	
Area of Specialization of Owner	-4.27	-2.743	-.665	-8.597***+	2.22
	(3.164)	(3.225)	(3.384)	(0.264)	
Managers Trainings	2.73	1.411	2.891	4.099**	6.03
	(1.901)	(1.690)	(1.760)	(0.450)	
Total Innovation Expenditure		3.596**	2.503**	8.800***	2.80
		(1.157)	(1.242)	(0.166)	
Percentage of Engineers		0.754	0.823	1.106**	2.26
		(0.579)	(0.621)	(0.357)	
Percentage of Technicians		-1.478**	-1.409**	-0.277	4.84
		(0.481)	(0.495)	(0.442)	
Internet Services		9.652**	10.553***+	8.939**+	3.62
		(3.098)	(2.979)	(0.207)	
Social Communication		-1.586	-2.666	11.389***	2.18
		(2.992)	(3.436)	(0.276)	
Suppliers			11.499	22.155***	2.30
			(7.947)	(0.459)	
Linkages to Knowledge Institutions			-0.744	-0.223	5.69
			(4.670)	(0.339)	
Competitor			3.032	13.762***	4.48
			(2.769)	(0.130)	
Customers			-9.359**	-10.520***	5.56
			(3.738)	(0.223)	
Industrial Association			-7.034**	-2.891**	2.89
			(3.007)	(1.301)	
Public support			-54.700**	-9.954**	4.56
			(17.362)	(8.094)	
Cooperation			5.250	4.122	5.72
			(1.127)	(1.002)	
Age of Business				6.969***	4.63
				(0.054)	
Size of employees				.511	
				(0.094)	
Observations	205				
R^2	0.574	0.716	0.758	0.893	
Adjusted R^2	0.523	0.658	0.692	0.859	
R^2 Change	0.574	0.142	0.042	0.135	
F statistic	11.097	12.425	11.337	26.204	
Durbin Watson	1.475				
Significance	0.000	0.000	0.000	0.000	

, **, *, + denote statistical significance at the 10, 5 and 1% levels and borderline significance respectively.*

This indicates that for each unit increase in educational levels of the owners, production manager and marketing manager, sales turnover increased business performance by **N**8.88m, **N**7.26m and N23.47m respectively per annum. In the same vein, for one additional year of experience added by the owners of firms in the clusters, there would be an increase in sales turnover and overall performance of N14.41m. This suggests that the educational background of the management staff is business related and technical in nature to enable the staff undertake production and innovation activities to enhance business performance. Also, firms with high skilled personnel (especially owners, production manager and marketing manager) coupled with good relevant experience of owners/founders tend to innovate more. This is in agreement with the study of Caloghirou *et al.* (2004) in on the assessment of internal capabilities and external knowledge sources for innovative performance. The authors reported that high skilled personnel in the firms studied appear to innovate more. This is also in line with Fabayo (1996) who reiterated the importance of educational background for technological dependence in Nigeria and its institutions. On the other hand, this is contrary to the findings of Adegbite (2010) and Abereijo (2010) who reported no significant relationship between educational qualification and sales turnover. This is understandable as Adegbite (2010) work was centred on indigenous textile weaving industry which requires little or no education to thrive. Also Abereijo (2010) however reiterated the importance of experience and on-the-job training for better performance in gaining technological spillover to SMEs
especially in Nigeria food industry.

Further to the above, Table 4.17 reveals that the use of experience of the production manager (β = -18.07, $\rho < 0.05$) negatively affects the level of innovativeness of the firms. This thus indicates that for each unit increase in the

experience of production manager in the ICT clustered firms, the sales turnover could decrease business performance by about N18m. This indicates that the firms that innovate tend not to necessarily depend on the experience of production manager. This may be largely due to the fact that majority of the firms are micro firms which do not necessarily have standard production unit or department that can impact innovation activities in the enterprises. All other variables in Model 1 are not significant, although the overall fit (R^2 = 57.4%) of the model is satisfactory. This indicates that approximately 57% of the variance in the sales turnover was explained by the independent variable in the regression.

The results in Table 4.17 shows that model 2 became

$$Y = 1.57 + 10.00X_1 + 6.18X_2 + 23.00X_3 - 9.43X_4 - 15.44X_5 + 9.75X_6 + 7.32X_7 - 2.74X_8 + 1.41X_9 + 3.60X_{10} + 0.75X_{11} - 1.48X_{12} + 9.65X_{13} - 1.59X_{14}$$

…… equation (4.2)

the result shows that qualification of owner (β = 10.00, $\rho < 0.01$), qualification of production manager (β = 6.18, $\rho < 0.1$), qualification of marketing manager (β=23.00, $\rho < 0.01$), experience of marketing manager (β = 9.75, $\rho < 0.05$), total innovation expenditure (β = 3.60, $\rho < 0.05$) and the use of Internet services (β = 9.65, $\rho < 0.05$) have a positive and statistically significant relationship with sales turnover. This indicates that a unit increase in the qualification of owner, production and marketing manager, experience of marketing manager, total innovation expenditure and Internet use, the sales turnover could increase the business performance by N10, N6.18, N23, N9.75, N3.6 and N9.65m, respectively.

This confirms the strong effect of educational background of the management team which includes that of the owner, production and marketing manager. The experience of marketing manager coupled with the commitment of the firms to

innovation expenditure and the intensity of use of various Internet services tend to give firms the propensity to innovate more. Also the availability and the use of Internet infrastructure could facilitate access to the experience of other people or firms outside the organisation. If one couples the internal capabilities and the technology-enabled experience, it could enhance performance among the firms in the ICT clusters. This result is consistent with the study of Adetayo *et al.* (1999) who reported the contribution of the impact of the use of information and communication technologies on marketing and performance of multinational companies.

Furthermore, Model 2 reveals that the proportion of engineering personnel shows positive relationship with sales turnover. This indicates that engineering skill is important for innovation and technological development to gaining an edge in a competitive environment (Wenberg and Lindqvist, 2010). The overall fit for Model 2 stood at 71.6%, this indicates that approximately 71.6% of the variance in the sales turnover was explained by the independent variables.

The results in Table 4.17 shows that model 3 became

$$Y= -27.55 + 12.62X_1 + 4.02X_2 + 18.85X_3 - 5.00X_4 - 11.25X_5 + 11.00X_6 + 1.58X_7 - 0.67X_8 + 2.89X_9 + 2.50X_{10} + 0.82X_{11} - 1.41X_{12} + 10.55X_{13} - 2.67X_{14} + 11.50X_{15} - 0.74X_{16} + 3.03X_{17} - 9.36X_{18} - 7.03X_{19} - 54.70X_{20} + 5.25X_{21} \quad \ldots\ldots\ldots\text{equation (4.3).}$$

Table 4.17 model 3 is the addition of external sources to model 2. The results remain robust with a little improvement over the previous. This is evident by the overall fit of the model which stood at $R^2 = 75.8\%$ as against 71.6% in Model 2 This represents R^2 change of 4.2% compared to Model 2. Furthermore, the addition of the external sources also shows that all the significant variables retain their signs at almost identical levels of significance. These are qualification of owner ($\beta = 12.62$, $\rho < 0.01$), marketing manager ($\beta = 18.85$, $\rho < 0.01$), experience of marketing manager (β

= 9.75, ρ < 0.05), total innovation expenditure (β = 2.50, ρ < 0.05), and use of internet services (β =10.55, ρ < 0.05). The model further shows the importance and the relevance of suppliers of equipment (β = 11.499), materials, components and software, as well as competition (β = 3.032), and cooperation (β = 5.250) among the firms as they positively contributed to business performance, although not significant. This suggests that innovation is influenced by suppliers of materials, components and software, coupled with competition among the firms. However, the latter is moderated because the firms in the clusters also do cooperate (Dhewanto *et al.*, 2012; Wu, 2014) and share information (Porter, 1998).

On the other hand, Model 3 further reveals some external factors that show a negative and significant relationship with sales turnover. These are low customer demand (β = -9.359, ρ < 0.05), industrial associations (β =-7.034, ρ < 0.05) and inadequate public support (β = -54.700, ρ < 0.05). This shows that the success of any business depends on continuity of getting patronage and also gaining more market share which is dependent on customer acquisition and retention. Also, technology market and industrial associations have been appraised as important sources of technology information for SMEs to innovate (Zeng *et al.,* 2010). The respondents registered their concern about the leadership of the industrial associations in the clusters and expressed that the leaders are no more committed to the firm's course and may have been biased in favour of the government. This may be largely responsible for the low impact of the association which could have boosted the overall performance of the business environment in the clusters. The respondents also believed that government was not doing enough, especially in giving support for the provision of adequate infrastructure and its maintenance. This is necessitated because inadequate electricity supply for example as a huge constraint that inhibit the

growth of business in the clusters.

The results in Table 4.17 shows that model 3 became

$Y= -208.08 + 16.17X_1 + 3.89X_2 + 30.66X_3 – 0.35X_4 – 15.45X_5 + 5.43X_6 – 3.88X_7 – 8.60X_8 + 4.10X_9 + 8.80X_{10} + 1.11X_{11} – 0.28X_{12} + 8.94X_{13} + 11.39X_{14} + 22.16X_{15} – 0.22X_{16} + 13.72X_{17} – 10.52X_{18} - 2.89X_{19} - 9.54X_{20} + 4.12X_{21} + 6.97X_{22} + 0.52X_{23}$ …… …… equation (4.4)

Model 4 in Table 4.17 considered all the factors, viz: internal capabilities, the technological efforts, externalities (external factors) as well as the control variables (age and size). Firstly, R^2 for the model stood at 0.893 which indicates that about 89% of the variance in the performance was explained by the independent variables in the regression.

Furthermore, the effect of the control variables (Age and Size) is shown in Table 4.17. The result is not too different from what obtained previously for Model 3 except that some of the factors though retain their positive signs are now statistically significant. For example, suppliers ($\beta = 22.155$, $\rho < 0.05$), competitors ($\beta = 13.76$, $\rho < 0.05$), proportion of Engineer ($\beta = 1.106$, $\rho < 0.05$), internet services ($\beta = 8.939$, $\rho < 0.05$), social communication ($\beta = 11.389$, $\rho < 0.05$). This indicates the influence of the control variable (Age and Size) on these factors.

Lastly, age is the only control variable that seemed to be positively significant with sales turnover ($\beta = 6.969$, $\rho < 0.01$), although size ($\beta = 0.511$) was also positively related but not significant. This indicates that if the age of any one firm in the clusters was increased by one year the sales turnover would increase the performance by about N7m. This further indicates that when any one firm in the clusters rolls over to another year, there is a possibility that it will add about N7m to its total sales turnover, other things being equal. The significance of age in this instance may be as a result of

the accumulation of experience over time and a better understanding of the business environment in the clusters. This supports the literature (Wennberg and Lindqvist, 2010) in the context of ICT clustered firms in developing economies that innovation performance increases with firm age. Also, the positive relationship of size with sales turnover indicates that larger companies outperform smaller ones. This may be premised on the fact that much bigger access to resources is related to innovation such as: economies of scale, financial resources, risk spreading and greater capacity for specialisation in people and equipment (Laforet, 2013).

4.5 Impact of Clustering on Business Performance in ICT-clustered Firms

Table 4.18 shows the rating of clustering of firms effect on business performance. There was significant difference on the following factors: increased profits ($F = 4.49$, $p < 0.01$), keen competition ($F = 10.97$, $p < 0.01$), increased customer base ($F = 71.04$, $p < 0.01$), quick diffusion of information ($F = 44.55$, $p < 0.01$), sharing of by the owners of firms in the clusters, there would be an increase in sales turnover and overall performance of N14.41m. This suggests that the educational background of information and cross skills development ($F = 20.86$, $p < 0.01$), task outsourcing ($F = 23.73$, $p < 0.01$), increased sales turnover ($F = 91.49$, $p < 0.01$), receipt of assistance from other firms ($F = 15.92$, $p < 0.01$), increased trust among the firms ($F = 34.66$, $p < 0.01$), reduction in transportation and communication cost, ($F = 6.02$, $p < 0.01$), easy access to skilled and qualified labour ($F = 2.96$, $p < 0.05$) among others.

Further on the impact of the cluster related factors on business performance, Duncan multiple range separated the means based on the mean rating in the three different cluster locations. On increased profit factor, the respondents in the Abuja

Table 4.18: Rating of clustering effect on business performance among ICT clustered-firms

Cluster factors	Abuja	Lagos	Port-Harcourt	Average	F	*p*
• Increased profits	3.65 [b]	3.47 [a]	3.67 [b]	3.60	4.49	0.010
• Keen competition	3.31 [b]	3.32 [b]	3.73 [b]	3.45	10.97	0.000
• Increased customer base	3.36 [a]	2.96 [a]	3.91 [a]	3.41	71.04	0.000
• Diffusion of information	2.93[a]	3.53 [b]	3.63 [b]	3.36	44.55	0.000
• Sharing of Info. and cross skills development	3.33 [a]	2.97 [a]	3.71 [a]	3.33	20.86	0.000
• Task outsourcing	3.63 [a]	2.94 [a]	3.34 [a]	3.30	23.73	0.000
• Increased sales turnover	3.00 [b]	3.01 [b]	3.82 [a]	3.28	91.49	0.000
• Assistance from others	3.52 [a]	3.00 [a]	3.23 [a]	3.25	15.92	0.000
• Trust among the firms	3.24 [a]	2.60 [a]	3.64 [a]	3.16	34.66	0.000
• Transportation and comm. cost reduction	2.77 [b]	3.20 [b]	2.96 [b]	2.98	6.02	0.003
• Access to skilled and qualified labour	2.66[b]	2.65[b]	3.00[a]	2.77	2.96	0.022
• Adequate commonly shared facilities	2.38 [b]	2.31 [b]	2.65 [b]	2.45	3.31	0.044
• Adequate maintenance of public facilities	2.13 [a]	2.43 [b]	2.51[b]	2.36	3.09	0.058
• High Employee turnover	2.37 [a]	2.01[b]	2.04 [b]	2.14	3.29	0.033
• Receipt of financial assistance	1.51 [a]	1.87 [a]	2.81 [a]	2.06	27.73	0.000
• Economies of scale	1.76 [b]	1.85 [b]	2.07 [b]	1.89	3.06	0.039
• Adequacy of Micro finance facilities	1.14 [a]	1.88 [a]	2.34 [a]	1.79	21.03	0.000
• Availability of cooperative society	1.59 [b]	1.69 [b]	2.03 [a]	1.77	3.20	0.054
• Joint staff training	2.00 [b]	1.87[b]	1.34 [b]	1.74	8.63	0.000
• Linkages with knowledge institutions	1.57 [b]	1.29 [b]	1.11 [b]	1.32	3.51	0.026

Key: Strongly Agree (SA) =4, Disagree (D) =2, Not Applicable = 0, Agree (A) =3, Strongly Disagree (SD) =1, Mean with different alphabets are significantly different ($p < 0.05$)

Source: Author's Survey, 2014.

(3.65) and Port-Harcourt (3.67) clusters strongly agreed that clustering had a higher impact on profits than those in Lagos who agreed (3.47) that it had an impact on increased profit.

Also on the effect of clustering of firms on competition the respondents in the Port-Harcourt (3.73) strongly agreed that clustering of firms had a higher impact on competition than those in Abuja (3.31) and Lagos (3.32) who agreed that it had an impact on competition. The competition among the ICT clustered firms may be traced to some foreign competitors who have also taken part of the market share within the Nigerian ICT cluster market. It has been reported that competition increases as 'Asian tigers' (Trajtenberg, 2001; Nabi and Luthria, 2002) move into local economies. When competition is moderated, it has the propensity to propel the firms to innovate more (Mintzberg, 1988), and in the end impact firm's performance in the clusters (Amoako-Gyampah and Acquaah, 2008). Cooperation could be in the exchange of technical know-how, this enables firms to build competitiveness in clusters (Hoffmann *et al.*, 2014). This is in agreement with the findings of Oyelaran-Oyeyinka (2006) in a similar study in Ikeja computer village who empirically supported this position. Price war was also noticed to be a contributory factor to competition in the market since they operate open market in the clusters. On one hand, this could be of great benefit to the buyers as they take advantage of low prices. This is similar to low cost strategy propounded by Porter (1990), the firms that adopt this strategy were noted to have increased sales growth and have captured more market share (Amoako-Gyampah and Acquaah, 2008). On the other hand, competition may be detrimental to the firms as this may lower their profit margins and may threaten their survival. Although the enterprises in the ICT clusters firms in Nigeria have agreed to

discontinue open publication of product prices either through the newspapers, media houses and distribution of fliers. This agreement may be a strategy to leave a level playing field for fair competition in the clusters.

Table 4.18 further shows the mean difference in the clusters relative to diffusion of information and sharing of skills across the firms in the clusters. While the firms in Abuja (2.93) agreed that there is quick diffusion of new information and knowledge within the cluster through close inter-firm interactions, the firms in Port-Harcourt (3.63) and Lagos (3.53) strongly agreed. The mean difference was statistically significant in Abuja cluster but not in both Lagos and Port-Harcourt. This indicates that information is a resource and resource sharing provides access to knowledge spillovers especially in central positions (Ahuja, 2000). Information sharing vis-à-vis knowledge sharing may culminate into accumulation of tacit knowledge which has been identified in literature to have impacted innovations in clusters (Bell, 2005; MacKinnon *et al.*, 2002).

The cluster in Port-Harcourt strongly agreed (3.7), Abuja (3.33) and Lagos (2.97) also agreed that sharing and cross skills development has been enhanced by the proximity. There is statistical significant difference across the three clusters. Geographic proximity facilitates the exchange of knowledge, especially tacit knowledge between firms and their employees (Bell and Zaheer, 2007). This stock of knowledge may be tacit or codified knowledge (Ernst and Lundvall, 1997). The impact of knowledge has been reported in literature to have impacted the decision making process and innovative development of firms (Abereijo *et al.*, 2007).

About task outsourcing, the mean rating of the firms suggest that the cluster in

Abuja (3.63) strongly agreed and both Lagos (2.94) and Port-Harcourt (3.34) clusters also agreed that task outsourcing is a factor that had great impact on their performance. This indicates that the firms in the clusters outsourced some of their tasks in order to meet deadlines. During the interview, the kind of tasks outsourced by these firms was investigated. It was found that production of computer systems (cloning) as well as software development especially for educational institutions, top the list of the tasks outsourced. In the same vein, some high-tech intensive tasks such as replacement of tiny components on printed circuit boards (PCBs) of mobile telephones were also foremost among others. The main challenge for outsourcing these tasks was premised on lack of relevant equipment to effect the maintenance on the devices. This study further found that such skills are not readily possessed by micro and new entrant firms, this gives a competitive edge to bigger and older firms over others.

However, the disagreement by the firms on some of the items as revealed by their average mean rating (Table 4.18) which suggests that some elements of these factors exist in the clusters but the prominence may not be of high degree. For example in Table 4.18 the firms disagreed that employee turnover (2.14), receipt of financial assistance (2.06), economies of scale (1.89), adequacy of microfinance facilities (1.79), joint staff training (1.74) and linkages with knowledge institutions (1.32) impact on business performance in the clusters. For instance, the mean rating of employee turnover in Abuja (2.37), Lagos (2.01) and Port-Harcourt (2.04) suggests that the firms disagreed that employee turnover impact on business performance. This is statistically significant for Abuja but not for either Lagos or Port-Harcourt clusters. This indicates that job mobility is not rampart in Abuja like

the other two clusters in Lagos and Port-Harcourt. This may likely be pointing to the fact that both Lagos and Port-Harcourt clusters were a bit more dynamic and that any one firm may likely lose his best staff to another in the clusters. This is also unconnected with the competition that exists in and around the clusters.

4.6 Principal Component Analysis of Cluster Effects on Business Performance of ICT Clustered Firms in Nigeria.

The 20-cluster items analysed in the previous section was subjected to further analysis using the factor analysis as a factor reduction tool. Table 4.19 shows the outcome of the analysis. The result separated 7 major components and this was classified under the following latent variables as shown in Table 4.19. These are: resource spillover, cooperation and linkages, financial resources, resource sharing, increased performance, collaborations and information sharing. The overall 7 components extracted represents 71.45% total variance explained by the model which achieved convergence in 12 iterations. This is the best fit derived after experimenting with all other available models such as generalized least squares, maximum likelihood, unweighted least squares etc coupled with rotated methods such as: direct oblimin, quartimax, equalmax and promax.

The resource spillover latent variable consist 5-items which all together represent 14.4% variance explained by the variable. These are level of agreement of the ICT clustered firms on the following: easy access to skilled and qualified labour,high employee turnover, economies of scale as influenced by other firms, free diffusion of information and cross skills development and trust among firms.

The prominence of high employee turnover indicates that any job loss by any

Table 4.19: Cluster Analysis and Extraction of Principal Components

Cluster items (constructs)	Factor loading for items						
	#1	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**
Resource spillover							
• Easy Access to skilled and qualified labour	0.870						
• High Employee turnover	0.613						
• Economies of scale	0.554						
• Information and cross skills development	0.627						
• Trust among the firms	0.667						
Cooperation and linkages							
• competition to generate new idea		-0.685					
• Joint staff training		0.779					
• Linkages with knowledge institutions		0.748					
Financial resources							
• Reduction in transportation and comm. cost			-0.534				
• Receipt of financial assistance			0.851				
• Availability of cooperative society			0.777				
• Adequacy of micro finance facilities			0.755				
Resource sharing							
• Adequacy of commonly shared facilities				0.536			
• Adequacy of public facilities				0.792			
Increased performance							
• Increased customer base					0.728		
• Increased profits					0.741		
• Increased sales turnover					0.555		
Collaboration							
• Task outsourcing						0.761	
• Assistance from others						0.784	
Information sharing							
• Quick diffusion of new info							0.797
Percentage of variance	**14.4**	**11.5**	**11.4**	**10.6**	**8.3**	**8.2**	**7.7**

Extraction method: Principal component, 7 components extracted which explained 71.45% total variance.

one firm in the cluster may have been influenced by another in the same location with some attractive packages. This culminates to job mobility; this may probably be responsible for the high employee turnover reported. Any knowledge, skills developed and information acquired by such employees will remain with them and could easily be transferred. For example, Straubhaar (2000) reported that employees can change their jobs and, even when there are restrictions on the transferring of knowledge, they will transfer a part of their knowledge and, therefore, produce a positive externality for the new employer. Other authors have provided evidences that within- cluster workforce mobility as a factor for knowledge transfer (Basant, 2002; Asheim and Isaksen, 2002), which also means geographic proximity facilitates a rapid exchange of information among firms, socio-cultural structures and institutions, facilitating collective learning and permanent innovation, advantages not available to firms located outside the knowledge-intensity of the cluster (Hoffmann *et a*l, 2014). Generally, knowledge spillovers have been recognized an important mechanism underlying endogenous growth (Audretsch and Feldman, 2003). Its importance in providing working relationship between research laboratories of universities and private enterprises for exploitation has also been emphasised (Mansfield, 1995, 1998). This is also supported by other empirical findings which found that knowledge created in university laboratories spills over to contribute to the generation of commercial innovations by private enterprises (Audretsch and Feldman, 1994; Feldman and Audretsch, 1999).

On cooperation and linkages, it was noticed that joint staff training and linkages with knowledge institutions prominently characterise the 11.5% variance explained by the latent variable. This indicates that there exists cooperation on staff

training among the ICT firms. It also suggests that there are some linkages with research and knowledge institutions like Universities, technical colleges, secondary schools etc. This linkage may be in the form of staff training through further education, software design and development, sales of products and services among others. Hershberg *et al*. (2007) reported how linkages could facilitate knowledge generation from the institutions to the industrial sectors and how this synergy could impart much of the economic impetus and generate the bulk of new job opportunities.

From Table 4.19, the variable that represents financial resources constitutes related items such as receipt of financial assistance such as loans, or grants from financial houses, the use of standard cooperative society available in the cluster as well using facilities from micro finance banks in the clusters. All of these items represent 11.4% of the variance explained by the latent variable as shown in Table 4.19. Empirical studies have shown evidences about the role of finance and its contribution to successful innovations and better performances. Specifically Hsu (2004) provided empirical evidence on startup companies that received multiple offers from venture capitals and how it has impacted their performances. In the same vein, Girma and Gong (2008) found that Chinese enterprises with foreign capital participation and those with good access to domestic bank loans innovate more than others. Ahuja (2000) and Casanueva, *et al.* (2013) reports how central positions facilitates resource-sharing and provides access to knowledge spillovers. This work found that adequacies of commonly shared facilities as well as its maintenance by government were given considerable attention by the ICT firms in the clusters. Examples of these commonly shared resources are electricity transformers, good

roads among others.

Also increased performance was revealed by some items which were grouped in the same component christened ‘increased performance’, these are: increased customer base, increased profits and increased sales turnover. This component represents 8.3% of the total 71.45% variance explained of the overall model. This suggests that agglomeration of ICT clustered firms could impart business performance of firms by increasing their market share through increased customer base, turnover and overall profits. This is evident as shown by Mano and Suzuki (2011) in their study on agglomeration economies on Ethiopian cut flower Industry.

4.6 Design of a Policy Framework for ICT Clusters in Nigeria

The following highlight the policy framework for facilitating ICT clusters that would be innovatively oriented in the production and distribution of computer, computer accessories and other ICT products in Nigeria.

These are:

(i) popularisation of the ICT cluster policy when it is formulated;

(ii) human Resource Development;

(iii) provision of financial and technology support services;

(iv) building effective linkage and collaborations of the cluster with knowledge institutions and ICT clusters within and outside the country;

(v) promote demand pull R&D activities among the firms and knowledge institutions;

(vi) development and improving working environment;

(vii) standardisation and promotion of quality assurance;

(viii) provision of Cluster Knowledge Management System (CKMS).

4.6.1 Popularisation of the ICT Cluster Policy when it is Formulated

Strategies

(i) Involve of various relevant stakeholders in policy formulation process;

(ii) Create awareness for the populace on the importance of the development of ICT clusters for local capacities and sustainable economic development;

(iii) Make ICT related career development attractive by creating incentives;

(iv) Use the available mass media avenues, technology fairs, workshops, ICT seminars to popularize the ICT clustered activities;

(v) Make ICT related disciplines more attractive and lucrative by improving the conditions of service of the IT professionals;

(vi) Utilising the available local ICT capacities for consultancy purposes.

4.6.2 Human Resource Development

Strategies

(i) Facilitate the acquisition of knowledge to adapt, utilise, replicate and diffuse technologies for the growth of ICT clustered firms;

(ii) producing world class engineers and technologists who are well grounded in both theory and practical;

(iii) review of curricula to comprise relevant scientific knowledge and vocational skills related to ICT for technical colleges and institutions;

(iv) promoting tacit knowledge acquisition through regular informal training schemes;

(v) providing supports for ICT clustered firms to provide on-the-job training for their personnel;

(vi) promoting exchange programmes such as industrial trainings, sabbatical leave, etc to enhance knowledge sharing among the academia and industry.

(vii) Protection of intellectual property rights placing application through National Office for Technology Acquisition and Promotion (NOTAP).

4.6.3 Provision of Financial and Technology Support Services

Strategies

(i) To create and establish Cluster Innovation Fund (CIF) with a minimum of 0.1% of private firms yearly profit and other sources like public, NGOs and international bodies;

(ii) promotion of venture capital scheme for ICT-cluster emanated knowledge, technology and business model;

(iii) provide grants and endowments to individuals and firms to actively engage in related R&D in Nigeria;

(iv) provide a platform or mechanism to attract international funding for innovation in ICT in the Nigeria clusters;

(v) provision of regional hi-tech zone which will culminate into digital cluster environment over the cyber space of the geography.

4.6.4 Building Effective Linkage and Collaborations of the Firms in the Clusters with Knowledge Institutions and other ICT Clusters within and outside the Country.

Strategies

(i) Creation of joint venture and joint training activities among the ICT-clustered firms;

(ii) promoting exchange programmes between the clusters and academic institutions to foster knowledge creation, resource spillover and innovativeness;

(iii) effective participation of cluster stakeholders (including supplier, customers, knowledge institutions, etc) in a community of practice through the development of a web-based Cluster Knowledge Repository-CKR (Brown and Duguid, 2000);

(iv) initiating memorandum of understanding between the firms in the clusters and some Universities within the Silicon valley, California and other developed countries;

(v) Support professional bodies to facilitate creative competition among the firms to measure technological efforts periodically;

4.6.5 Promoting Demand Pull R&D Activities among the Firms and Knowledge Institutions.

(i) Foster quick development of R&D capacity and collaboration among ICT cluster stakeholders for software and hardware development;

(ii) developing local capabilities towards indigenization of production of ICT products and services in Nigeria through imitation, technology substitution and transfer;

(iii) supporting e-learning initiatives and provide a platform for educational institutions to collaborate with local ICT firms for continued development of teaching modules;

4.6.6 Development and Improving Working Environment

Strategies

(i) Creation of Regional Cluster Central Research Laboratory (RCCRL) which provides state-of-the-art equipment and environment relevant for production of ICT digital components used in the manufacture of ICT equipment, peripherals, mobile phones, etc;

(ii) ensuring constant provision and supply of infrastructure and other social amenities such as: good roads, public toilets, water, electricity;

(iii) cooperation for provision of reliable security of lives and properties within the clusters;

(iv) collaboration and cooperation for provision of alternative/backup electricity among the firms in the clusters.

4.6.7 Standardisation and Promotion of Quality Assurance

Strategies

(i) Using the existing capability in SON to enforce standards and quality assurance towards global competitiveness of goods and services;

(ii) providing appropriate tools to aid standard and quality assurance checks of technological activities which involve design, development and production processes;

(iii) to regularly carry out product checks and recertification because of technological change and dynamic nature of ICT products;

(iv) to ensure that all imported ICT products (goods and services) conform to requisite best practices and standards;

(v) to limit importation of used ICT products by hiking the tariff on such importation.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study assessed the production and innovation capability of selected ICT clusters in Nigeria with a view to determining the nature and extent of innovations possessed by the firms. It also investigated factors influencing the building of production and innovation capabilities and established the impact of clustering on business performance of the firms. The study thus designed a policy framework to facilitating innovativeness in the ICT clusters in the context of Nigeria.

The study was carried out using both primary and secondary data sources. A multistage sampling technique was used to select a total of 400 firms for the study. The study covered Abuja, Lagos and Port-Harcourt because of their proximity to air ports, sea-ports (in the case of Lagos and Port-Harcourt) and concentration of headquarters of government bodies, embassies and multinational companies. Primary data were collected through structured questionnaire administered on founders/CEO of the selected firms. The questionnaire elicited information on issues such as socio-economic and demographic characteristics; firm's production and innovation capability; types of innovations (product, process, organisational and marketing); sources of information for innovation activities; internal and external factors affecting production and innovation activities and impact of clustering on business performance of the firms. Personal observations and interviews were also conducted to obtain more information on the activities in the clusters. Secondary data were sourced from official documents such as reports, records, bulletins, journals and textbooks. The data were analysed using descriptive and inferential statistics.

The result showed that most (80.1%) of the business owners/entrepreneurs in ICT clusters in Nigeria had post-secondary school education, from this proportion 61.7% of them had university education. About 71% of the firms were into services, repairs and maintenance of ICT equipment, while 56% were involved in other production activities which involve computer assemblage. Majority (89.5%) of the ICT firms involved in software production in the clusters produced standalone related software. Educational institutions: tertiary institutions (41.7%), secondary schools (14.7%) and government bodies (34.6%) were noted as consumers of the software that were produced. The following constraints to production capability were significant at $p<0.05$, irregular power supply (3.11) and shortage of raw materials (2.70) were rated severe, while low demand (2.19) and lack of fund (1.79) were of moderate severity. About 65% of marketing innovation had generated average of 396 different innovations followed by 63% organisational innovation which generated an average of 498 different innovations. In the same vein, about 42%, 46% had generated product, process innovations which produced 148, 382 new or significantly improved goods and services, new to the market or their firms respectively. Information for innovation were significantly different ($p < 0.01$) for the following rated source suppliers of materials (3.41), competitors (2.97), for conferences, trade fairs, workshops and exhibitions (2.05), for Universities and other higher educational Institutions (1.75), for government and public research institute (1.52) and lastly, for consultants and private R&D (1.04) .

On the relationships between sales turnover and individual capabilities as well as relationships between independent variables, it was found that there were significant and positive correlations between performance of the business and

qualification of owners, prior work experience of owners, production and marketing manager, as well as percentage of technicians and engineers, linkages to knowledge institutions, age of business and size of employees. This positive and significant correlation thus suggests that each of the variables enhanced the performance of the firms in the clusters. It also suggest that human capital is key to business performance in the context of developing countries. There are some externalities that contribute to the performance of the enterprises in the ICT clustered firms in Nigeria. Some of these are: importance of suppliers and linkages to knowledge institutions. The linkages to knowledge institutions are majorly based on regular supply of skilled graduates to the clusters. There is no evidence on relationship between the firms and knowledge institutions on the ground of using their research outcomes for knowledge creation. Also, as the age of the firms increases, sales turnover also increases, which indicates that the longer the existence of any firm in the cluster, the better the chances are that it would have develop the required experience and know-how to capture more market. The impact of clustering on business performance found the following components as important contribution to business performance in the ICT clusters in Nigeria. These are: resource spillover, cooperation and linkages, availability of financial resources, inter-firm resource sharing, collaborations and quick information diffusion.

5.2 Conclusion

This study conceptualised production and innovation capability in ICT clusters in Nigeria. It concluded that while firms in the ICT clusters have adequate organisational and marketing capabilities to impact innovations, there also exist moderate capabilities to create minor changes to local production of ICT products.

The important sources of inputs to innovation as found by this research are availability of qualified technical personnel including technicians and engineers as well as management staff with good educational backgrounds. The effects of production, innovation capability and clustering impacted positively on the performance of ICT cluster firms.

5.3 Recommendations

At presently, little attention is given to ICT cluster related policy in various policy documents in Nigeria such as Science, Technology and Innovation (STI) and ICT policies. It is therefore recommended that government and other ICT stakeholders adopt this framework as basis for formulating either implicit or explicit policy in this area. This will enhance indigenous hi-tech development in Nigeria. Thus the following recommendations highlighted were put forward to facilitate production, innovation capability and performance in ICT clustered firms in developing countries, especially Nigeria.

(i) Government should provide conducive environment in and around the ICT clusters that could promote businesses. This will assist in graduating the huge micro firms in these clusters to expand with time, thereby providing better chance of gaining further productive and manufacturing skills.

(ii) Through public private partnership (PPP) a well-equipped central laboratory could be established in each of the clusters or better still in each of the 6 geo-political zones of the country. These will service the firms that may want to achieve some innovative tasks but constrained with equipment.

(iii) There should be creation of cluster knowledge centre for the whole country,

which will be a web portal that will be available to all stakeholders, customers, suppliers, government, financial institutions, among others.

(iv) There should be a provision for Cluster Innovation Fund (CIF) which will be a research fund to maintain the cluster central laboratory.

(v) A platform could also be created where firms or individual's innovative ideas could be nurtured or possibly monetised which may depend on the choice of the prospective innovator.

(vi) Firms tend to be threatened when their scientists, researchers and other key personnel migrate after a discovery to a higher paying rival or exploit the discovery on their own (Delerue and Lejeune, 2010). Job mobility should be restricted to the minimum by keeping key staff with impressive conditions of service relative to the market situation. There should be stiffer penalty for defaulters who may contravene the quality and standards of production and maintenance of ICT equipment in the clusters.

(vii) The telecommunication regulatory body should enforce quality of service delivery by the providers of mobile and Internet services to enhance smooth running of the technologies as adopted by the firms.

(viii) School's curriculum should be reviewed and tailored towards the need of the current and future market demand; this tends to improve the synergy between the academia and private firms.

(ix) Firms in the clusters also need to further develop effort to cooperate more by creating alliances leveraging on strengths of individual firms.

(x) The government should discourage (through high tariffs), the influx of used products so as to force the firms to redirect their technical know-how towards

local production of computers and mobile phones.

(xi) There should be improved infrastructure in and around the ICT clusters to facilitate better communication with suppliers, customers and partners as their contributions have been identified as key in the performance of the firms, especially in the context of developing countries.

5.4 Suggestion for Further Studies

This study focused on production and innovation capability of ICT clusters in Nigeria from the perspective of the firms, it does not consider the perception of other external sources like customers, suppliers, knowledge institutions among others. The scope can also be broadened by extending coverage to all the six geo-political zones of the country other than the three regions covered in the study.

A comprehensive study of production and innovation capability in ICT clusters of major clusters in other African nations could be carried out. This will allow for comparative analysis of the regions and will facilitate Hi-tech synergy for production activities in the continent.

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APPENDIX I

Survey of Production and Innovation Capability in ICT Clusters in Nigeria

The African Institute for Science Policy and Innovation (AISPI)
Faculty of Technology, Obafemi Awolowo University, Ile-Ife

Purpose of this survey:

The purpose of this survey is to collect information about innovation in ICT clusters in Nigeria between 2011 and 2013. This is to enable us compare businesses with and without innovation activities, we request all businesses to respond to **all** questions, unless otherwise instructed. For further clarification please call Mike on 07069197823.

Person we should contact if there are any queries regarding the form:

Job title: _____Phone: _____

A. BACKGROUND OF THE FIRM

1. Year of establishment_____
2. Website (if any) http://www. _____
3. Type of business:☐Computers ☐Telephones ☐Networking ☐Office equipment

   Others Electronics (*specify*) ☐
4. Main activity: ☐Sales ☐Services, repairs & maintenance ☐Production
5. Is your enterprise part of an enterprise group? *(A group consists of two more legally defined enterprises under common ownership* (a) Yes ☐ (b)No ☐
6. In which country is the head office of your group located _____
   (*If your enterprises are part of an enterprise group, please answer all further questions only for your enterprise in Nigeria.*
7. Which type of product do you deal in? *(tick all that apply)*

   (a) New ☐ (b) Used (Tokunbo) ☐ (c) Both ☐
8. In which geographic markets did your enterprise sell goods or services during the three years 2011 to 2013?

	Yes	No
a) Local/regional within Nigeria	☐	☐
b) Other African countries	☐	☐
c) European Union (EU)	☐	☐
d) United States of America	☐	☐
e) Asia (China, India etc)	☐	☐
f) All other countries	☐	☐

9. Position in the Enterprise ☐Owner ☐Manager ☐Paid worker ☐Family

B. FIRM PRODUCTION AND INNOVATION CAPABILITY

B1. HUMAN RESOURCES

1. Size of permanent staff (*tick as appropriate*):

a	Between 1-15	
b	Between 16 and 50	
c	Between 51-200	
d	Over 200	

2. Indicate the number of staff in the following skills

	Number
a) Technicians	
b) Scientists and Engineers	

3. Highest qualification of Owner and management staff *(tick appropriate option)*

	Secondary	Technical	Tertiary		Post-Graduate	
			Poly	Uni	Master	PhD.
a) Owner/Entrepreneur						
b) Production manager						
c) Marketing Manager						
d) Administrative manager						

4. Area of specialisation of the owner and management staff *(tick appropriate option*

	Science and Engineering	**Management or Finance related**	**Others *(specify)***
a) Owner/Entrepreneur			
b) Production manager			
c) Marketing manager			
d) Administrative manager			

5. Work experience (*the area where owner and each of the management staff had worked before*).

	SMEs	**Large corporations**	**Research Institutes/ Universities**	**Government Ministries**	**No experience**
a) Owner/Entrepreneur					
b) Production manager					
c) Marketing manager					
d) Administrative manager					

6. Which of these training courses/workshops did owner and each of the management staff had worked before in the past 3 years *(tick as appropriate)*

strategic	**Product development**	**Marketing**	**Human resources**	**Quality Maintenance**	**Others**

B2. PRODUCTION CAPABILITY

1. Has your organisation manufactured or improved on any computer components (*e.g casing, power pack etc*)? (a) Yes ☐ (b) No ☐ (s*pecify)* ☐
2. What is the average number of computers your firm assemble/clone in a month? ☐
3. What is the current level of utilisation of the production capacity in your organisation?

a) 100% (b) 90 - <100 (c) 80 - <90 (d) 70 - <80 (e) 60 - <70 (f) 50 - <60

4. Could your firm increase this level of utilisation of production capacity? (a) Yes b) No
5. If your firm develops software, is it stand-alone application or embedded software?

(a) Stand-alone application ☐ (b) Embedded ☐

6. Who are your customers for the developed software? (a) government (b)Universities (c) Banks (d) research institutes (e) other private firms (*specify*)
7. What percentage of customers demand do you usually meet?

a) 100% b) 90 - <100 c) 80 - <90 d) 70 - <80 e) 60 - <70 f) 50 <60

8. Do you firm carry out any quality control measure? (a)Yes (b)No
9. What type of quality control is in place?

(a) General quality control (b) Total quality control

10. Rate the following constraints as it affects your firm's production capacity.
(4=strongly severe, 3=severe, 2= moderately severe, 1= less severe, 0=no effect)

	4	3	2	1	0
a) Shortage of raw materials	☐	☐	☐	☐	☐
b) Shortage of employees	☐	☐	☐	☐	☐
c) Low demand for products	☐	☐	☐	☐	☐
d) Irregular power supply	☐	☐	☐	☐	☐
e) Lack of fund	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

11. Please indicate your level of involvement on the following
(4=extremely high, 3=high, 2= medium, 1= low, 0=not at all)

	4	3	2	1	0
a) New laptops	☐	☐	☐	☐	☐
b) New desktops	☐	☐	☐	☐	☐
c) New Telephones	☐	☐	☐	☐	☐
d) New Tablets	☐	☐	☐	☐	☐
e) Software Installation	☐	☐	☐	☐	☐
f) Hardware installation (cloning)	☐	☐	☐	☐	☐
g) Used (tokunbo) laptops	☐	☐	☐	☐	☐
h) Used (tokunbo) desktops	☐	☐	☐	☐	☐
i) Used (tokunbo) mobile phones	☐	☐	☐	☐	☐
j) Computer accessories	☐	☐	☐	☐	☐
k) Telephone accessories	☐	☐	☐	☐	☐
l) Other ICTs solutions	☐	☐	☐	☐	☐

B3. INNOVATION ACTIVITIES AND INVESTEMENTS

1.0 During the three years 2011 to 2013, did your enterprise engage in the following innovation activities?

	Yes	No	Number
1.1) Creative work undertaken within your enterprise to Increase the stock of knowledge and its use to devise new and improved products and processes (including software development).	☐	☐	
If yes, did your firm perform R&D during 2011 to 2013	*a)* Continuously? ☐ b) Occasionally? ☐		
1.2). Same activities as above, but performed by other companies by public or private research organisations and purchased by your enterprises	☐	☐	
1.3 Acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved processes.	☐	☐	
1.4 purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other enterprises or organisations	☐	☐	
1.5 Introduction of your new or significantly improved goods and services, including market research and launch advertising	☐	☐	

1.6 Please estimate the amount of expenditure for each of the following four innovation activities in 2013 only. *(Include personnel and related costs)*[1] *Tick 'nil' if your enterprise had no expenditure*

		Nil
a. Intramural (in-house) R andD *(include capital expenditures on buildings and equipment specifically for R&D).*		☐
b. Acquisition of R&D (extramural R&D)		☐
c. Acquisition of machinery, equipment and software *(Excluded expenditure on equipment for specifically for R&D)*		☐
d. Acquisition of other external knowledge *(licensing, patent etc)*		☐
e. Total of these four innovation expenditure categories		☐

2. What was your enterprise's total turnover for 2011 and 2013[2]? Turnover is defined as the market sales of goods and services (*Include all taxes except VAT*).

2011 ☐ **2013** ☐

3. What was your enterprise's total number of employees in 2011 and 2013?[3]

2011 ☐ **2013** ☐

4. During the three years 2011 to 2013 did your firm receive any form of government support for innovation activities? a) Yes b) No

[1] Give expenditure data in 000's of Naira units to eight digits
[2] Give turnover in 000 of Naira units to nine digits
[3] Annual average. If not available give the number of employees at the end of each year. Give figures to six digits

5. Please rate the importance of the following government support *(4=highly important, 3=very important, 2=important, 1= slightly important, 0=not important).*

	4	3	2	1	0
a) R&D funding	☐	☐	☐	☐	☐
b) Training	☐	☐	☐	☐	☐
c) Subsidies	☐	☐	☐	☐	☐
d) Tax Rebates	☐	☐	☐	☐	☐
e) Technical support/advice	☐	☐	☐	☐	☐
f) Infrastructure support	☐	☐	☐	☐	☐
g) Loans and Grants	☐	☐	☐	☐	☐
h) Others (please specify)	☐	☐	☐	☐	☐

B4. SOURCES OF INFORMATION AND CO-OPERATION FOR INNOVATION ACTIVITIES

1.During the three years 2011 to 2013, how important to your enterprise's innovation activities were each of the following information sources?

(4=highly important, 3=very important, 2=important, 1= slightly important, 0=not important).

		Degree of importance 4	3	2	1	0
a. Internal	(i) Within your enterprise or enterprise group	☐	☐	☐	☐	☐
b.Market Sources	(i) Suppliers of equipment, materials, components, or software.	☐	☐	☐	☐	☐
	(ii) Clients or customers.	☐	☐	☐	☐	☐
	(iii) Competitors or other enterprises in your sector.	☐	☐	☐	☐	☐
	(iv) Consultants commercial or private R&D institutes.	☐	☐	☐	☐	☐
c.Institutional sources	(i) Universities or other higher education institutions.	☐	☐	☐	☐	☐
	(ii) Government or public research institutes.	☐	☐	☐	☐	☐
d. Other sources	(i) Conferences, trade fairs, exhibitions.	☐	☐	☐	☐	☐
	(ii) Scientific journals and trade/technical publications.	☐	☐	☐	☐	☐
	(iii) Professional and industry associations.	☐	☐	☐	☐	☐

2). During the three years 2011 to 2013, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions? a) Yes **b)** No

3). Please indicate the type of co-operation partner and location *(Tick all that apply)*

Type of cooperation partner	**Nigeria**	**Asia**	**Europe**	**USA**	**UAE**
a) Other enterprises within your enterprise group	☐	☐	☐	☐	☐
b) Suppliers of components or software	☐	☐	☐	☐	☐
c) Client or customers	☐	☐	☐	☐	☐
d) Competitors or other enterprises in your sector	☐	☐	☐	☐	☐
e) Consultants commercial or private R&D institutes	☐	☐	☐	☐	☐
f) Universities or other higher education institutions	☐	☐	☐	☐	☐
g) Government or public research institute	☐	☐	☐	☐	☐

C. NATURE AND EXTENT OF INNOVATION CAPABILITY

C1. PRODUCT (GOOD OR SERVICE) INNOVATION

*A product innovation is the market introduction of a new good (hardware components, software) or service or a **significantly** improved good or service with respect to its capabilities, such as improved software, user friendliness, components or sub-systems.*

1. During the three years 2011 to 2013, did your enterprise introduce:

	Yes	*No*	*Number*
a. New or significantly improved goods.	☐	☐	
b. New or significantly improved services *(e.g. new ways of delivery)*	☐	☐	

2. Who developed these product innovations?

Select appropriate option(s)

a. Mainly your enterprise or enterprise group ☐

b. Your enterprise together with other enterprise or institutions ☐

c. Mainly other enterprises or institutions ☐

3. Were any of your goods and service innovations during the three years 2011 to 2013

		Yes	*No*	*Number*
a) New to your Market?	*Your enterprise introduced a new or significantly improved good or service onto your market before your competitors*	☐	☐	
b) Only new to your firm	*Your enterprise introduced a new or significantly improved already available good or service that was from your competitors in your market* **.**	☐	☐	

4. Using the definitions above, please give the percentage of your total turnover[4] in 2013

a. Goods and services innovations introduced during 2011 that were **new to your market** ☐☐☐ %

b. Goods and service innovations introduced during 2011 to 2013 that were **only new to your firm** ☐☐☐ %

c. Goods and services that were **unchanged or only marginally modified** during 2011 to 2013 *(includethe resale of new goods or services purchased from other enterprises)* ☐☐☐ %

Total turnover in 2013 1 0 0

[4] Turnover here means Interest receivable

C2. PROCESS INNOVATION

A process innovation is the implementation of a new or significantly improved production process, distribution method, or support activity for your goods or services. The innovation (new or improved) must be new to your enterprise, but it does not need to be new to your sector or market. It does not matter if the innovation was originally developed by your enterprise or by other enterprises. Exclude purely organisational innovations.

1. During the three years 2011 to 2013, did your enterprise introduce:

	Yes	No	Number
a. New or significantly improved methods of manufacturing or producing goods or services	☐	☐	☐
b. New or significantly unproved logistics delivery or distribution Methods for our inputs, goods or services.	☐	☐	☐
c. New or significantly improved supporting activities for your Processes such as Maintenance systems or operations for purchasing accounting or computing.	☐	☐	☐

2. Who developed these process innovations? *Select appropriate option(s)*

a. Mainly your enterprise or enterprise group ☐

b. Your enterprise together with other enterprise or institutions ☐

c. Mainly other enterprises or institutions ☐

C3. ORGANISATIONAL INNOVATIONS

An organisational innovation is the implementation of new or significant changes in firm structure or management methods that are intended to improve your firm's use of knowledge.

1. During the three years 2011 to 2013, did your enterprise introduce:

	Yes	No	Number
(a) New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within your enterprise	☐	☐	☐
(b) A major change to the organisation of work within your enterprise, such as changes in the management structure or integrating different departments or activities	☐	☐	☐
(c) New or significant changes in your relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting	☐	☐	☐

2. If your enterprise introduced an organisational innovation during the three years 2011 to 2013, how important were each of the following effects?
(4=highly important, 3=very important, 2=important,

1= slightly important, 0=not important).

	Degree of importance				
	4	**3**	**2**	**1**	**0**
a. Reduced time to respond to customer or supplier needs	☐	☐	☐	☐	☐
b. Improved quality of your goods or services	☐	☐	☐	☐	☐
c. Reduced costs per unit output	☐	☐	☐	☐	☐
d. Improved employee satisfaction and/or reduced rates of employee turnover	☐	☐	☐	☐	☐

3. Compared to other enterprises of a similar size and sector, how close was your enterprise's organisational structure in 2013 to best practice in other developed countries like Europe? (*Best practice is defined as an organisational structure in 2013 that maximized productivity, quality, and customer service.)*

a. Close to or at best practice ☐
b. Above average ☐
c. Average ☐
d. Below average ☐
e. Well below average ☐

4. What was the source of the ideas for your enterprise's organisational innovation?
Select the appropriate option(s)

a. Mainly your enterprise or enterprise group ☐
b. Both your enterprise and other enterprises, institutions, publications, etc ☐
c. Mainly other enterprises, institutions, publications, etc ☐

5. How important were each of the following effects of your enterprise's organisational innovations between 2011 and 2013?*)*

		strongly agree **4**	***agree*** **3**	***disagree*** **2**	***strongly disagree*** **1**	***Not relevant*** **0**
a.	Reduced time to respond to customer or supplier needs	☐	☐	☐	☐	☐
b.	Improved quality of your goods or services	☐	☐	☐	☐	☐
c.	Reduced costs per unit output	☐	☐	☐	☐	☐
d.	Improved employee satisfaction and/or lower employee turnover	☐	☐	☐	☐	☐
e.	Improved communication or information sharing	☐	☐	☐	☐	☐
f.	Increase ability to develop new products or processes.					

6. Were any of these organisational innovations essential to the implementation of other types of innovations introduced by your enterprise between 2011 to 2013?

		Yes	**No**	**Not Relevant**
a.	Process innovation	☐	☐	☐
b.	Product innovation for a new or improved service	☐	☐	☐
c.	Product innovation for a new or improved good	☐	☐	☐

7. Why did your enterprise not introduce an organisational innovation between 2011 and 2013?

	Yes	**No**
a. Organization innovations were introduced before 2011 and no need for further change	☐	☐
b. Lack of funds or staff to implement an organisational innovation	☐	☐
c. Resistance of staff or management to organisational change	☐	☐

C4. MARKETING INNOVATION

A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promoting or pricing.

1 During the three year 2011 to 2013, did your enterprise introduce the following marketing innovations?

		Yes	
a. Design	**(i)** Introduce significant changes to the design of a good or service (Exclude routine/ seasonal changes such as clothing fashions).	☐	☐
	(ii) Introduce insignificant changes to the packaging of a good	☐	☐
b. Promotion	**(i)** Implement a new marketing strategy to target new customer group of market segments	☐	☐
	(ii) Use new media or techniques to promote products such as new advertising concepts, a new brand image of new techniques to customize promotion to individual customers or groups	☐	☐
c. Placement	**(i)** Use new sales channels, such as direct selling, internet sale, or product licensing	☐	☐
	(ii) Introduce new concepts for product presentation is sales outlets (e.g sales rooms, websites, other types of outlets)	☐	☐
d. Pricing	**(i)** Use new pricing methods to market goods or services	☐	☐

No

2. Who developed these marketing innovations? *Select appropriate option(s)*

a. Mainly your enterprise or enterprise group ☐
b. Your enterprise together with other enterprises or institutions ☐
c. Mainly other enterprises or institutions ☐

3. How often does your firm use the following, if used at all?

		Very often	often	rarely	not used
a.	The use of website to provide information and for advertisement	☐	☐	☐	☐
b.	Provision of online platform for Internet payment	☐	☐	☐	☐
c.	Provision of Point of Sale (POS) for payment	☐	☐	☐	☐
d.	The use of email for communication	☐	☐	☐	☐
e.	The use of mobile phone for communication	☐	☐	☐	☐
f.	The use of social media (facebook) to provide information	☐	☐	☐	☐
g.	The use of social media (youtube) to provide information	☐	☐	☐	☐
h.	The use of social media (twitter) to provide information	☐	☐	☐	☐
i.	The use of social media (linkedln) to provide information	☐	☐	☐	☐

4. How important were each of the following affect your enterprise's marketing innovations between 2011 and 2013.

		Very important	important	less important	not important
a.	Sales growth for your goods and services	☐	☐	☐	☐
b.	Introduced products to new markets or customer groups	☐	☐	☐	☐
c.	Increased visibility of products or business	☐	☐	☐	☐
d.	Strengthened relationships with customers	☐	☐	☐	☐
e.	Improved customer satisfaction	☐	☐	☐	☐

5. How important were the following market-related activities for your enterprise's innovation projects between 2011 and 2013?

a. Maintaining close links between your marketing departments or groups involved in developing or implementing your innovations	☐	☐	☐	☐
b. Systematic analysis of your customer's needs by your marketing division	☐	☐	☐	☐
c. Systematic analysis of the effectiveness of your marketing techniques	☐	☐	☐	☐

7. If your firm introduced a marketing innovation <u>and</u> introduced a product innovation between 2011 and 2013:

	Yes	No
a. Were any of these marketing innovations an integral part of any of your enterprise's product innovations? *(for example, a design change was an essential part of a technical innovation, or a new marketing method was part of a process innovation)?*	☐	☐
b. Were any of these marketing innovations necessary for the successful induction of your enterprise's product innovation.	☐	☐

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8. During the three years 2011 to 2013, were any of your innovation activities or project

	Yes	No
a. Abandoned in the concept stage	☐	☐
b. Abandoned after the activity or project was begun	☐	☐
c. Seriously delayed	☐	☐

C5. FACTORS INFLUENCING INNOVATION ACTIVITIES

1. During the three years 2011 to 2013, how important were the following factors on your innovation activities or projects in influencing the decision to innovate or not to innovate?

		Degree of importance			
		High	**Medium**	**Low**	**Factor not Experienced**
a.Cost factors	(i) Adequacy of funds within your enterprise or group	☐	☐	☐	☐
	(ii) Funds availability from sources outside your enterprise	☐	☐	☐	☐
	(iii) Affordable cost of Innovation	☐	☐	☐	☐
b.Knowledge factors	(i) Easy access to qualified personnel	☐	☐	☐	☐
	(ii) Availability of Information on technology	☐	☐	☐	☐
	(iii) Free flow of information on markets	☐	☐	☐	☐
	(iv) Availability of partners to cooperate on innovation	☐	☐	☐	☐
c. Market factors	(i) Market dominated by competition of established enterprises	☐	☐	☐	☐
	(ii) Demand for innovations is high in the market	☐	☐	☐	☐
d.Reasons not to innovate	(i) No need due to prior innovations	☐	☐	☐	☐
	(ii) No need because of no demand for innovations	☐	☐	☐	☐

2. During the three years 2011 to 2013 did your enterprise:

	Yes	**No**	**Number**
a) Apply for a patent	☐	☐	
b) Register an industrial design	☐	☐	
c) Register a trademark	☐	☐	
d) Claim copyright	☐	☐	

3. Is your firm currently using each of the following knowledge management practices? *(If yes, please indicate if your firm first introduced or made a significant change to each practice between 2011 and 2013inclusive.)*

		No	Yes *(tick both if relevant)*
3.1	A written knowledge management policy	☐	☐ Introduced/changed 2011-2013 ☐ Introduced/changed before 2011
3.2	Incentive for employees to share knowledge within your enterprise	☐	☐ Introduced/changed 2011-2013 ☐ Introduced/changed before 2011
3.3	Dedicated resources to monitor and obtain knowledge from outside your enterprise	☐	☐ Introduced/changed 2011-2013 ☐ Introduced/changed before 2011
3.4	A policy to bring in external experts from universities, research institutes, or other firms to participate in project teams, as needed[2]	☐	☐ Introduced/changed 2011-2013 ☐ Introduced/changed before 2011
3.5	Regular updates of internal databases or manuals of good work practices, lessons learned, or expert advice	☐	☐ Introduced/changed 2011-2013 Introduced/changed before 2011

C6. EFFECTS OF INNOVATION DURING 2011-2013

1. How important were each of the following effects of your products (good or service) and process innovations introduced during the three years 2011-2013?

		Degree of observed effect: High	Medium	Low	Not relevant
a. Product oriented effects	(i) Increased range of goods or services.	☐	☐	☐	☐
	(ii)Entered new markets or increased market share.	☐	☐	☐	☐
	(iii) Improved quality of goods or services.	☐	☐	☐	☐
b. Process oriented effects	(i) Improved flexibility of production or service provision.	☐	☐	☐	☐
	(ii) Increased capacity of production or service provision.	☐	☐	☐	☐
	(iii) Reduced labour costs per unit output.	☐	☐	☐	☐
	(iv)Reduced material and energy per unit output.				
c. Other effect	(i) Reduced environmental impacts or improved health and safety.	☐	☐	☐	☐
	(ii)Net regulatory requirements.	☐	☐	☐	☐

D. IMPACT OF CLUSTERING ON BUSINESS PERFORMANCE OF THE FIRMS

*Rate your level of agreement of the following to business and innovation activities of your firm (4=Strongly agree (**SA**), 3= Agree(**A**) , 2=Disagree (**D**), 1= strongly disagree(S**D**), 0=not applicable (NA)*

		4	**3**	**2**	**1**	**0**
a)	Within the cluster, access to skilled and qualified labour is easy and cost effective.	☐	☐	☐	☐	☐
b)	We have experienced high staff turnover because of inter-firm movement of skilled labour within the cluster.	☐	☐	☐	☐	☐
c)	The business has benefited from other businesses through outsourcing some tasks in order to meet deadlines.	☐	☐	☐	☐	☐
d)	Our relationship with other firms has developed economies of scale in the production and sale of our products as influenced by the co-operative network.	☐	☐	☐	☐	☐
e)	Sharing of information and cross skills development has been enhanced by the proximity.	☐	☐	☐	☐	☐
f)	We request for assistance from other firms within the cluster to solve a problem.	☐	☐	☐	☐	☐
g)	We have close interaction with other firms and partners in the cluster and this has increased trust.	☐	☐	☐	☐	☐
h)	There is quick diffusion of new information and knowledge within the cluster through close inter-firm interactions.	☐	☐	☐	☐	☐
i)	Having our businesses close to one another in the cluster has reduced transport and communication cost considerably.	☐	☐	☐	☐	☐

j) Competition among the firms is so intense and it has helped us to generate new ideas and device better ways of doing things.	☐	☐	☐	☐	☐
k) We have cooperated with other firms to jointly organize training for our staff.	☐	☐	☐	☐	☐
l) We have linkages with universities and research institutes for acquisition knowledge that has assisted our innovativeness.	☐	☐	☐	☐	☐
m) We have received financial assistance e.g loan or grants from finance houses (e.g. commercial banks, bank of industry etc.)	☐	☐	☐	☐	☐
n) There are substantial common facilities which we are sharing with other firms in the clusters, such as good roads, electricity transformer(s) etc.	☐	☐	☐	☐	☐
o) The public facilities around the cluster are adequately maintained by the government.	☐	☐	☐	☐	☐
p) Within the cluster there is a standard cooperative society which we run by ourselves.	☐	☐	☐	☐	☐
q) Micro finance bank also exist in the cluster which provides some loans and related facilities for our businesses.	☐	☐	☐	☐	☐
r) Our customer base has increased	☐	☐	☐	☐	☐
s) With our firm in the cluster we have made more profits.	☐	☐	☐	☐	☐
t) Our sales have increased since we started the business in the cluster.	☐	☐	☐	☐	☐

APPENDIX II

Reliability test and communality loading for ICT cluster items in Nigeria

Factors/Constructs	Reliability (alpha)	Communalities
• Access to skilled labour	0.732	0.815
• Staff turnover	0.742	0.683
• Task outsourcing	0.730	0.765
• Economies of scale	0.728	0.637
• Information sharing	0.726	0.670
• Assistance from other firms	0.730	0.703
• Close interaction with other firms	0.732	0.781
• Diffusion of information and skills	0.736	0.651
• communication cost reduction	0.732	0.489
• Intense competition	0.761	0.698
• Joint staff training	0.751	0.819
• Linkages with knowledge institutions	0.756	0.785
• Receipt of financial assistance	0.764	0.826
• Availability of common public facilities	0.746	0.670
• Adequate maintenance of public facilities	0.764	0.703
• Functional cooperative society	0.761	0.689
• *Increased customer base*	0.711	0.802
• *Increased sales turnover*	0.715	0.629
• Adequacy of microfinance facilities	0.723	0.657
• competition	0.746	0.820
Overall Average (alpha)	0.740	

Assessment criteria: Eigen value >1, reliability> 0.7

APPENDIX III

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.737
Bartlett's Test of Sphericity	Approx. Chi-Square	2679.547
	df	190
	Sig.	0.000

APPENDIX IV