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LEARNING HI-TECH AND KNOWLEDGE IN LOCAL SYSTEMS: THE OTIGBA COMPUTER HARDWARE CLUSTER IN NIGERIA

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Abstract

Conventional wisdom would suggest to the fact that relatively poor countries are unlikely to host a "high-technology" sector. This paper examines an unusual phenomenon of industrial organization in an African setting; the emergence of a small and medium enterprise (SMEs) information technology hardware cluster in a very late industrializing country, Nigeria. The evolution of the Otigba Computer Hardware Village (OCV) has proceeded largely without direct support from the state and indeed within a decidedly hostile institutional and arid infrastructural environment. Yet the cluster has thrived, thus far, with institutional support from a local trade and manufacturing association. The study is as much about learning in late industrialization as it is of how an informal institution fills the hiatus in the absence of required state support.

*Keywords: learning, innovation system, computer hardware, clusters***.**

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1.0 INTRODUCTION

This paper examines an unusual phenomenon of industrial organization in an African setting. The emergence of a cluster of an information technology hardware cluster in a very late industrializing country evidently merits a close examination. Conventional wisdom suggests to the fact that poor countries are unlikely to be host to high-technology and doing so within the organization of small and medium enterprises. Significantly, the evolution of the Otigba Computer Hardware Village (OCV) in Lagos, Nigeria has proceeded largely without direct support from the state and indeed within a decidedly hostile and arid infrastructural environment. In the face of these institutional obstructions, the cluster has grown rapidly over the last decade.

The OCV exhibits two features of a cluster that could potentially transform into a local innovation system[1] producing high value products. The first is the emerging firm-level capabilities for assembling computer hardware (a "complex" product"[2]) and second, the growing inter-firm interaction for building a knowledge-based cluster. More significantly it exhibits a pattern of development associated with progress in local economies that made successful transitions to modern production. The major activity at the cluster is the assembling of and trading in computers and peripherals, a path that offers relatively lower risk approach to rapid technological advance for two reasons ((Kash et al., 2004)[3]. First, this approach thrives on incremental innovation because the basic technological design has been established and the uncertainty attending innovations in flux has been largely eliminated. Second, the technological infrastructure required is also equally established and could be built that will later support greater autonomous domestic innovation efforts that extends beyond the initial products.

[1] I apply the concept of a "local system of innovation" drawing inspiration from the approaches by (Lundvall, B.-Å. (1992) *National Innovation Systems: towards a theory of innovation and interactive learning*, Frances Printers, London.; Nelson, R. (1993) *National Innovation Systems A Comparative Analysis*, Oxford University Press, New York and Oxford. but delimited in term of a locality the same way in which a sectoral system of innovation is delimited by a sectoral boundary, Malerba, F. (2004) *Sectoral Systems of Innovation*, Cambridge University Press, Cambridge MA.. The notion of a "local system" has been applied to series of case studies in Brazil, Cassiolato, J., Lastres, H. M. M. and Maciel, M. L. (2003) *Systems of Innovation and Development Evidence from Brazil*, Edward Elgar, Cheltenham..

[2] A good is categorized as complex if either the product itself or the process of manufacturing it is complex. A complex technology unlike a simple technology such as furniture making or footwear requires organizational forms whereas the latter can be understood by an individual. Complex goods are different from "high-tech" in that the latter is measured by the ratio of R&D expenditure to output. See United Nations: *Statistical Year Book of International Trade.*

[3] Building a local system of production and innovation is a path followed by arguably the most successful PC industry in the developing world based on clustering of SMEs. Taiwanese PC industry has relied on extensive imports from Japanese progressively.

The emergence very early of a network organization of suppliers, buyers, clone builders, and parts and components traders at Otigba cluster has generated an intense competitive environment and a local milieu that provides a base on which a significant knowledge base for building a future computer hardware (CH) cluster. Network organization represented in a cluster provides a necessary learning capacity for continuous technical innovation. A local system of innovation differs from a static cluster (specified only by geography and specialization) in the sense in which it is defined as one in which it is a network of individuals, firms and organizations interact to foster continuous technical innovation. The capacity for continuous learning is a required characteristic of such a local innovation system (a dynamic cluster) to import, absorb and diffuse innovation. More importantly, transforming a cluster to a local innovation system (LIS) will require a focus from production to building a knowledge system with equal emphasis on building intra – firm technological capability.

This paper is organized as follows: The next section presents a theoretical review of the issues of institutions, types of knowledge and institutions supporting clusters. This is followed by a brief account of the evolution and market structure of the cluster. We present the methodology for carrying out this followed by an analysis of the findings and a concluding section**.**

1.1 Clustering and Industrialization

In conventional terms, a cluster is defined by geography and product specialization. To this end, “a cluster is defined as a sectoral and geographical concentration of enterprises” (Schmitz, 1995). The starting point of the debate on clusters and clustering is that firms do not innovate and grow in isolation. They rely extensively on knowledge sources external to the firm. This comes about because proximity fosters informal, face-to-face interaction as an effective means of information exchange among personnel from different enterprises and firm proprietors. The importance of face-to-face interaction in clusters and industrial districts has been cited in the literature and examples includes (Becattini, 1990) account of the Prato textile district in Italy, and (Saxenian, 1994)account of Silicon Valley. Therefore firms in dense geographic proximity tend to enjoy certain advantages of agglomeration relative to isolated enterprises.

This happens in at least two different ways. First, demand for their goods and services are enhanced as potential customers come to know about the existence of the cluster. This is especially true for micro and small enterprises, whose markets tend to be local and dependent on direct sales to traders and individual consumers (McCormick, 1999). Second, a cluster's ability to innovate and supply high quality products also benefits from agglomeration. For these reasons, the main advantage of agglomeration derives from the properties of knowledge which

is that it is largely tacit, uncodified and informal. Therefore, the fundamental system benefit of clustering is knowledge externality. Firms are embedded in a network of users, suppliers, consumers and knowledge producers (Kline and Rosenberg, 1986). These actors are repositories of market, scientific and technical knowledge that potentially provide inputs into a firm's innovation efforts and reduce technical and commercial uncertainty within a culturally bounded environment. Location in a cluster therefore increases opportunities for the relatively fast and cheaper acquisition of information and knowledge (Beaudry et al., 2000).

In sum, an industrial cluster is a dense sectoral and geographical concentration of enterprises comprising manufacturers, suppliers, users, and traders. However, an *innovative* cluster is more than a geographic phenomenon, rather strong inter-firm interaction and sectoral specialization are the defining features of a sustainable cluster (Nadvi, 1994). In this respect, three factors distinguish an innovative cluster. First, high rates of learning and knowledge accumulation lead to continual changes to the knowledge base of the cluster. Second, there are high levels of networking between key agents and institutions (suppliers, producers, and so on). Third, there is an emphasis on the existence of a dense network of formal and informal institutions, agreed to in both the cluster and innovation systems literature (Becattini, 1990); (Schmitz, 1995); (Saxenian, 1991)). In this respect, differences in national level capabilities suggest that clusters in the highly industrialized countries will be characterized by high economic performance while clusters in developing areas exhibit lesser degrees of inter-firm collaboration, lower intensity of learning and have weaker institutions. Fourth, successful SIs are characterized by a certain optimal skills structure in engineering, mathematics and sciences that support industrial development. It is not enough for a country to produce manpower per se, but also the right kinds for its level of development. While general knowledge acquired from formal educational institution forms an important component of a nation's human capital, firm-level training, R&D and production are necessary for the idiosyncratic knowledge bases of firms ((Lall, 1992, Lall, 2001); (Freeman, 2002).

However there are two sets of objections to these broad assumptions. First, while it makes intuitive sense to accept these benefits of geographic agglomeration, the precise ways in which knowledge is transmitted is not always well specified. For instance, while proximity may well foster greater information flows, the dynamics of relational capital is equally vital in the process of producing and innovating. In other words, *geographic proximity is necessary for*

agglomeration benefits it is not sufficient. Cognitive, social and cultural proximity are equally necessary for collective learning (Maskell and Mamberg, 1999); (Howells, 2002) Second, if firms make up a cluster, they are necessarily the knowledge bases of the cluster. The role of firm-level techno-managerial capability has not been well articulated in the cluster literature (Bell and Albu, 1999); (Guiliani and Bell, 2005). The differentiated nature of internal firm-level capabilities suggest to an uneven distribution of knowledge and resources even within a cluster with common cultural base. Knowledge, skills and experience are properties of individuals employed within an enterprise and cannot logically be diffused in some equitable manner within a cluster but rather directed by the power relations within the cluster. The issue of knowledge flows and the heterogeneity of firms and organizations tend to receive far more emphasis in the innovation systems literature which places emphasis on networks of actors jointly acting to create, adapt and diffuse knowledge (Freeman, 1987; Lundvall, 1992).

1.2 Learning Processes and Types of Knowledge

The growth of knowledge is related both to historically generated learning institutions as well as the depth of available stock of local knowledge.[4] This stock of knowledge could come from outside the national system or developed through domestic efforts. There are a variety of 'non-formal' local learning institutions, upon which the growth of small firms relies, but which are either overlooked in conventional analysis or, in the extreme, regarded as inferior to formal learning. In this regard, a substantial part of knowledge in modern economies is attributed to measurable codified knowledge, while non-formal learning, which is largely tacit in nature and far more difficult to measure, is unaccounted for. For instance,, small firms, rooted in crafts apprenticeship, are likely to learn through this kind of knowledge system; enterprise performance may therefore signal how well such institutions of knowledge are serving the firm. Learning based predominantly on information and knowledge is regarded as the defining concept in a world that is increasingly characterized by rapid changes in the modern sectors. Whatever the source of information and knowledge, 'low income countries and regions are as strongly affected by the learning economy and, in a sense, experience the need for competence building even more strongly than the metropolis'.

Forms of knowledge and the relevance of skills transfer processes have been altered significantly by advances in digital technologies as well as by the changes in the economic

[4] However as Johnson, B. and Lundvall, B.-Å. (2003) In *Putting Africa First*(Eds, Muchie, M., Gammeltoft, P. and Lundvall, B.-Å.) Aalborg University Press, Aalborg. observe, what is important is the process of learning rather than the stock of knowledge. They offered the notion of the 'learning economy', ''as an economy where the ability to learn is crucial for the economic success of individuals, firms, regions and national economies…the learning economy is not necessarily a hi-tech economy. Learning is an activity which takes place in all parts of the economy, including so-called low-tech and traditional sectors'' p. 143.

contexts particularly the liberal regimes of trade and production (Lundvall and Johnson, 1994); (Johnson et al., 2002, Ducatel, 1998). However, debates about the most appropriate mix of skills and the most important sources of knowledge accumulation are likely to continue in the foreseeable future. For instance, the discussion on how to assign the relative weights of formal and experiential or non-formal knowledge in firms underlines the conceptual dichotomy of tacit and codified knowledge. Despite the increasing propensity to codify technical functions, tacit knowledge remains an important component not only in the context of traditional sectors and small firms, but also as a necessary cognitive basis for interpreting codified knowledge including digital and mathematical functions.

We follow the taxonomy proposed by (Johnson et al., 2002) (hereafter JLL) that views knowledge in terms of what, who, why and how we know things. In this treatment we focus narrowly on what (Kuznets, 1965) termed 'useful knowledge', by which he meant technological knowledge as the source of modern economic growth.[5] JLL identified four forms of knowledge, namely, 'know-what', 'know-why', 'know-how', and 'know-who'. At the organizational level these categories of knowledge translate into 'shared information databases', 'shared models of interpretation', 'shared routines' and 'shared networks'. Know-what refers to knowledge about facts which is largely codified, while know-why is the knowledge of principles, rules and ideas of S&T. This form is primarily codified, but relies considerably on tacit knowledge for interpretation - particularly at the level of individual understanding. Know-how is the skill and knowledge of doing things reflected in such activities as industrial production and, due to the process of acquiring it, has a significant tacit component. Lastly, know-who is the knowledge of individuals gained through shared social interactions and networking. (Mokyr, 2002) confined his analysis to 'know-what', which he defined as *propositional* knowledge[6] and which can be used to create 'know-why' or instructional or *prescriptive* knowledge, otherwise called techniques. What this means is that know-what (*episteme*) provides the basis for know-how (technique)[7]; for instance, to translate a model or an invention into practical instructional manual. One knowledge form would feed on the other. Table 1 presents the taxonomy.

[5] See Mokyr, J. (2002) *The Gift of Athena: Historical Origins of the Knowledge Economy*, Princeton University Press, Princeton, New Jersey, USA., The Gifts of Athena: Historical Origins of the Knowledge Economy for a seminal treatment

[6] Know-what, according to Ibid., 5), takes two forms:
'one is the observation, classification, measurement, and cataloguing of natural phenomena. The other is the establishment of regularities, principles, and 'natural laws' that govern these phenomena and allows us to make sense of them. Such a definition includes mathematics insofar as mathematics is used to describe and analyse the regularities and orderliness of nature.

[7] 'Techniques are the fundamental unit of the technological knowledge set. They are essentially sets of executable instructions or recipes on how to manipulate nature, much like Nelson and Winter's 'routines'.

Table 1: Learning Processes and Types of Knowledge

	Know-What	Know-Why	Know-How	Know-Who
Knowledge type	Codified	Codified	Tacit	Tacit
Sources	Facts and information	Scientific principles and laws	Skills acquired trough experience	Developed and maintained through personal contacts in research groups and production networks
Transfer Processes	Formal joint	Formal	Non-formal	Non-Formal
Learning context	Digital libraries Formal institutions (Libraries)	Digital libraries Formal institutions	Workplace Research and Training centres	Workplace Research and Training centres

Source: Learning to compete, Oyelaran-Oyeyinka O. Forthcoming 2006

This way of analyzing knowledge has several implications for transfer mechanisms, and for the development of institutional forms (formal education, the role of firms, and training). (Ducatel, 1998) talks of the learning triangle consisting of theoretical, vocational and experimental forms, which, translated to institutional terms, suggests a closer interaction between formal schooling and workplace training. For African countries there are four broad implications. First, a large part of knowledge in these societies is tacit in nature; African societies thrived on oral history and much of techniques are passed on from master craftsman to the apprentice. Even if this is hardly acknowledged in official documentations, much of learning takes place through this institution of apprenticeship and, for much of history, knowledge of nature was regarded as secrets to be passed on to the chosen, this most often being the offspring.

Second, institutions for codification of knowledge were hardly developed and 'modern' organizations for doing this are embedded in many widely accepted social systems and practices. Thirdly, orthodox measurements of knowledge generation and flows concentrate largely on measurable data such as patents, scientific publications and R&D statistics. These practices, having been adopted by developing countries' policy makers and scholars, tend to underrate institutions of apprenticeship with a vast knowledge base that is largely tacit. Attention is focused on formal schooling, such as universities, to the exclusion of enterprise level skills and traditional crafts. Fourthly, while scholars and multilateral organizations call for increased investment in knowledge of the type that is rewarded with certificates, the precise mix of such skills, which we acknowledge is very important, is not specified and the tendency is to assume that formal training is all that developing countries require. On the contrary, skills required for building modern economies are far more complex and cannot all be acquired in

When these instructions are carried out in practice, we speak of production and they are no longer knowledge but action. It is comparable to DNA instructions 'being Ibid.

formal schooling, important as they are. (Ducatel, 1998) identified seven sets of skills, namely: (1) the capacity to manage models mentally; 2) the workings and interactions of machines; (3) the capacity to make inferences from statistics; (4) willingness to take responsibility for work process and products; (5) oral and visual communication capacity; (6) combining technical and business skills; (7) ability to make good judgement. These skills are not acquired through formal schooling but are extremely important for industry.

1.3 Varieties of Learning and Types of Knowledge

Non-formal learning, which often takes the form of learning-by-doing, is an important component of human capital, but this is particularly so in economic contexts where traditional craftsmanship, often acquired through apprenticeship, predominates. Knowledge of production, which is largely tacit, relies largely on the skills (know-how) of workers although skill itself draws on know-why to find reasons for particular procedures or routines.[8] In this chapter we will examine, in some depth, the nature, prevalence and role of apprenticeship, and the links with tacit knowledge in promoting learning in firms.

Tacit knowledge is a bundle of information that is more easily expressed than spoken. It is built from considerable practice and accumulated experience in some narrow tasks, for instance by an apprentice learning from the master. For this reason it is idiosyncratic, but not necessarily inapplicable to other situations. For instance, a great many people use the computer to perform quite complex operations, yet cannot define what an operating system means; neither is it necessary for individuals to be able do so. There are many dimensions to tacit knowledge,[9] but much of the tacit knowledge in firms is transformed into organizational routines[10] (Nelson and Winter, 1982). Routines are regularities and predictable patterns of behaviour. In small firms, the owner/manager tends to define and exemplify the nature of routines. In apprenticeship institutions, the master personifies the routines and determines the culture and rates of transferring this largely 'hard to pin down skills' to learners.

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[8] A metallurgical technician could mix iron ore, coal and other materials under the right kind of temperature and obtain molten iron without any knowledge of why this reaction had taken place. Yet skill is not the domain only of technicians; an accomplished mathematician requires elements of both know-why and know-how to be effective in solving complex problems. To master calculus, one requires consistent practice, the domain of skills and tacit knowledge.

[9] Lubit, R. (2001) *Organizational Dynamics*, **29,** 164-178. identifies four categories of tacit knowledge, namely, (a) hard to pin down skills-''know-how'', (b) mental models, which show us how the world is constructed, (c) ways of approaching problems, and (d) organizational routines. ''The word skill implies tacit knowledge which range from the ability to swing golf balls to the dexterity of handling cells in a biology lab, all which are hard to explain in words

[10] According to Ibid., 167), 'Routines solidify as standard operating procedures and roles are developed and enforced. Routines include ways of producing things, ways of hiring and firing personnel, ways of handling inventory, decision-making procedures, advertising policy, and R&D procedures'.

The nature of tacit and codified knowledge brings us to the issue of formal and non-formal institutions. As (Stiglitz, 1999), 11) argued, developing countries need to formulate effective ways to promote *local knowledge institutions* because clearly

> *the overwhelming variety and complexity of human societies requires the localization of knowledge. …Practical know-how is largely tacit knowledge that needs to be learned by horizontal methods of twinning, apprenticeship, and seconding.*

There is a clear distinction between global public goods and local knowledge and, for this reason, every society should be active in strengthening local knowledge institutions to drive the local learning process. In transforming codified global knowledge to local use, only a proportion can be transferred by formal methods, while the rest would often require a long heuristic process of imitation, reverse engineering, learning-by-doing and apprenticeship. Stiglitz termed these processes of learning 'horizontal methods of knowledge transfer', while the formal codified storable mode is called 'vertical transfer'. On the one hand, these largely practical informal methods take several forms.[11] On the other hand, formal learning is characterized by five distinct characteristics, namely: (1) it has a prescribed framework; (2) an organized learning package or events; (3) the presence of a designated teacher or trainer; (4) the award of a qualification or credit; and (5) the external specification of outcomes (Eraut, 2000).

Formal institutions and learning provided the seedbed for much of the innovation in the past but non-formal learning in factories led to equally momentous technical improvements, (Rosenberg, 1976); (Landes, 1999). Each served and continues to serve different evolutionary goals. The lesson from technological history is that institutions do serve certain ends, but they are highly conditioned by the social and economic contexts as well as by the national absorptive capacities.

For instance, apprenticeship, a process of skill formation, is a form of local knowledge institution. It often lasts from a period of about six months to three years and tends to be organized by small firms, although not limited to it (Velenchik, 1995). It is a form of learning in which the learner, in addition to learning a skill from the firm, provides labour services to the firm or the owner of a business unit. This institution is widespread in Africa, but has long historical roots in Europe and elsewhere.[12] The practice takes different forms - from highly structured training in large firms, as is the case in Germany, to the more loosely organized 'learning-observing own work mates'. Training is the object and the mode of instruction takes

[11] Among these are: study tours to other countries, cross-training which is a form of 'learning-by-observing' in other countries, an implicit knowledge acquisition process that is different from explicit training on how to do things, twinning or seconding which pair together institutions in a horizontal knowledge exchange process, Stiglitz, J. E. (1999) Department for Trade and Industry and Center for Economic Policy Research, London..

on a variety of forms - from the use of specific instructional manuals (codified) to unspecified and randomly assigned oral tasks (tacit basis) that the supervisor may give - each feeding on the other. The written and unwritten contract is the agreement to teach and to learn for a fixed period of time.

In the African context, apprentices tend to emerge from the young, low ability range with no more than secondary education, but more likely with even less (Velenchik, 1995). Training is of a generalized type that takes place on the job. Findings concerning the types of skill differ. While some findings confirm the generalized nature of the training, others found it to be idiosyncratic with little possibility of skill transfer to other firms. The alternative is for an apprentice to establish his own firm and to replicate the routines he learnt (Frazer, 2002). Frazer found that educated workers in Africa tend to be more productive apprentices, as are apprentices who remained where they trained; although he cautions that this may have no general applicability.

Smits, W. and Stromback, T. (2001) *The Economics of the Apprenticeship System*, Edward Elgar, Cheltenham, U.K., Northampton, USA. traces the practice to the reign of Tiberius Augustus in AD 36.

2. THE CONTEXT AND EVOLUTION OF THE CLUSTER

Otigba Computer Hardware Cluster (OCV) otherwise known as the Ikeja Computer Village evolved from trading in imported ICT equipments, component and products over twelve years ago. It is located within Ikeja, the industrial capital of Lagos State, the former capital of Nigeria. The geographical location of the cluster was a residential area with a handful of shops along Otigba and Pepple streets. Over time, the cluster grew to become a beehive of computer hardware, and software trade and production. Two broad phases can be identified in the evolution of the OCV.

2.1 The Phase of Stationeries & office Equipment Sales

The cluster originated from few sales and repairs outlets specialized in stationeries, printers, photocopiers, branded computers and office equipments in the early 90s within commercial nerve centre of Ikeja. The two major streets on which the cluster developed were originally designed and approved as a residential area by the Old Ikeja local government.

Soon enough, the quiet neighbourhood turned into a major business district.[13] As the demand for computers grow in Nigeria, Otigba street, which is the longest in the district, quickly assumed the agglomerative character of a cluster. By the year 1998, most of the residential buildings had been converted to new high rise shopping complexes. Moreover, the increased activities in the computer and IT business in Otigba and its environs, led to increased awareness in the knowledge based cluster which has not only encouraged the entry of new enterprises but also generated employment for several unemployed university graduates.

Once the potential of the new IT business was realized, business buildings were constructed largely through private efforts as space became scarce[14]. This singular act brought the less popular computer components and accessories business in Lagos State to national limelight but was still insufficient to elicit positive support action from the local and state governments. This market is characterized by a wide range of computer hardware and allied products on display, which ushered in a new dispensation, the era in Computer hardware assembling and allied IT business in Nigeria.

[13] Among the early comers were GAFUNK, and Balog technologies.

2.2 The Phase of Computer Assembly

By the year 2002-2003 the Otigba ICT cluster had about 2500 sale and repair outlets spreading all over the cluster. With the new era in full operations, the cluster started attracting new sets of actors and the ecology of the environment changed significantly. The new actors included retailers, importers of computer computers and notably, builders of computer clones. The retailer's market activities changed and involved more activities such as direct importation of computer parts (which was limited to a few privileged firms before this time), components and accessories for direct sales, repairs and servicing of computer and all sort office equipments. The popular "Tokunbo"[15] business is a development that cuts across every sector of the economy in the country and the Otigba cluster has been a hub of the computer imports. The sales of fairly-used imported computers and refurbishment of old ones by system upgrading is as common as the sales of brand new products.

By the end of 2003, the cluster had grown in market size and undergone a major structural change, in which there are, more computer shopping malls, and street software vendors. Accompanying this, the hustle and bustle of buyers and eager sellers and the ever-present human and auto mobile traffic congestion along the major streets that leads into the market. The cluster had also attracted buyers and traders from neighbouring African countries thereby serving as a hub for ICT transactions in Africa. The cluster has, within the last 5 years through individual efforts by vendors and operators, transformed into an international ICT market that serves not just the Nigerian demand alone, but also countries in West-African sub region and other African nations.

From the current study, the major business activities and elements of productive capacity are computer cloning, reprocessing (upgrading) technology and sales of branded ICT products. This has been made possible by the vendors and operators within the cluster who are mainly graduates of computer science, computer engineering and business administration. Remarkably, 55% of respondents are university graduates, 15% are graduates of the polytechnic, 20% are technicians while the rest 10% are the unskilled ordinary traders.

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[14] Notable among this is the Police Women Association POWA Shopping Complex with 100 office spaces at 30/31 Otigba street. This initiative stimulated the entrepreneurial spirit of the computer and allied products vendors and operators considerably.

[15] "Tokunbo" is an ethnic Yoruba word meaning "imported". This term assumed a specific business meaning to denote the importation of second hand electronic goods, components and parts; and motor vehicle parts. Second hand consumer goods, appliances as well as industrial machinery and replacement

From the records collected from the main trade association there is a continuous stream of self employed entrepreneurs coming into the cluster. Over 5000 enterprises (employing more than 10,000 workers) were recorded to be operating by the end of year 2004 and measured in terms of employee size; they were mostly micro & small enterprises (MSEs). This is a huge increase (42%) from the estimated 3,500 micro and small enterprises (MSEs) that directly employed more than 6,000 people in 2003. The cluster has now started to witness the arrival of bigger players from the formal sector[16]. There is considerable learning and diffusion of tacit knowledge through apprenticeship. The competition is keen and driven by pricing as a major factor, as can easily be gleaned from the weekly advertisements of diverse products and services in the national dailies by firms in the cluster.

However, what has emerged in the face of poor state support and sometime hostile municipal government posture is cooperative competition mediated by the formation of the Computer and Allied Products Association of Nigeria (CAPDAN). This organization has gained legitimacy as an umbrella association by addressing the considerable institutional constraints to its membership solving problems of the cluster, namely, security and infrastructure.

A notable organizational difference when compared with traditional clusters in Africa is the level of inter-firm cooperation in evolving joint action to foster the growth of the cluster. This is attributed largely to the preponderance of educated entrepreneurs with ties from schools and strangers facing common threats of fierce competition (from Asia) and poor state support. There is an unusually surprising cooperation between small emerging enterprises and larger firms in the IT sector all operating within the cluster. In this atmosphere, a new competitive market structure emerged with free flow of price information, technological support and major market strategy information. OCV has produced many trained personnel some of who are now self-employed within the cluster while the others set up businesses outside the cluster but maintaining linkages with the cluster for procurement and technical support.

A major impetus for cooperation alongside market competition is the fierce threat posed by importation from the Asian market. The major sources of imports are China, Malaysia and Dubai in the Middle East. Entrepreneurs have responded to this in novel ways. One is by establishing technical and production channels with firms in these countries. This has led to greatly encouraged informal exportation and importation (Trans-border trade) with price been the major factor of competition. There are other local market strategies deployed by the operators. This includes weekly advertisement and promotion on daily news papers, enhanced

parts has become a multi-billion dollar business dollar in Nigeria although precise figures are difficult to come by.

distribution network and good customer services. Unlike the Taiwanese experience the state has been largely absent until very recently.

However private response has been far more significant. For instance, with the growth of these businesses, more financial institutions and banks have been locating in and around the cluster to take advantage of the high volume of money resulting from the rapid economic development of the area. In addition, IT training centres have equally located around the locality despite the space constraint.

The enterprises have progressively deepened their knowledge of the core technical activity of this cluster, which is computer assembling process technology. The key learning mechanism has been largely through apprenticeship and the inter-personal exchange of tacit knowledge. There is a preponderance of knowledge and skills in trading in computers, servicing, and repairs of computers and intricate allied products. Collective action within the cluster is in the form of inter-firm credit facilities, technical support in the form of knowledge sharing, joint warehousing of goods, and active membership of Computer and Allied Products Association of Nigeria (CAPDAN), the cluster's association. CAPDAN has provided an effective platform for addressing issues affecting the cluster.

[16] "It is the place to be now or you go under …", noted an IT hardware company executive locating to the cluster from the highbrow part of Lagos city.

3. METHODOLOGY

3.1 Study Area and Research Process

The study was conducted at the computer village located in Ikeja, Lagos. It comprises eight streets with Otigba as the most popular because of its size and volume of business activities that is carried out daily. The activities in ICT cluster involve the sales, servicing and repair of information and communication technology products and components. A core group are involved in the production of cloned systems from imported components[17]. Lagos which was the former capital city of Nigeria is a sprawling combination of towns with a population in the excess of 7 million people[18].

The study was carried out to evaluate the enterprises in terms of size capacity, development, modes of operation, performance and sustainability as well as constraints to growth of the cluster. The data collected were both primary and secondary data. The primary data were obtained through questionnaires while the secondary data were obtained through Participatory Research Appraisal (PRA) using structured interview guide. The information retrieved includes: input sources, source of technology (process and product technology), availability of infrastructure, level of technical support, financial support, market access, and the level of cluster collaboration.

450 questionnaires were administered to enterprises within the cluster and the retrieval rate was about ninety percent. There are over 3,500 enterprises registered with the umbrella association CAPDAN. Along with these is a legion of street operators numbering about 1,500. Therefore the questionnaires were administered randomly ensuring that those who keep more than 2 or 3 outlets within the cluster do not get interviewed twice. The involvement of CAPDAN officers was crucial to the success of the survey particularly in encouraging its members to accept and respond which was an initial obstacle encountered from many of the enterprise owners.

[17] The cluster is located at the heart of Ikeja and bordered by unity road, Awolowo road and Oba Akran Avenue. It has been variously described as the ICT hub of West Africa, potentially the biggest ICT market in Africa and the silicon valley of the West African sub region. According to the report by Bamiro (2003), the cluster has an area of 325 square kilometres in between the streets.

[18] It 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.

The second phase of the study was the case study of 10 enterprises, which were purposively selected among the initial 450 respondents. They were so selected with a view of getting a more complete picture of the operations within the cluster. They were within the micro, small and medium category of enterprises ensuring thereby that the operations, limitations, and constraints of each are captured by the study. Thus 4 enterprises were selected in micro enterprise category while 3 each were selected in the small and medium categories. In other to understanding the dynamics of the cluster, its competitiveness and constraints, some secondary data were obtained through the records of the enterprises and we also used as a guide an earlier report prepared by (Bamiro, 2003).

3.2 Basic Demographics

The Otigba Computer Village (OCV) is an example of self-starting and self-sustaining small enterprises that is in some cases family-owned. The SSEs have operated on the classic advantages of flexibility, compact management structure, and low transaction costs. They rely to a large measure on own savings and tend to access much of the information they require on products and services through informal social networks within and outside the cluster. How long this sort of organizational arrangement will be sustained in unclear but for now this has been a strong source of advantage for the cluster enterprises. The cluster entrepreneurs tend to specialize in different aspects of computer production, repairs, maintenance and sales. The recent increase in the awareness of the usage of computers has also led to high demand by all sectors of the economy and provided growth impetus for this cluster. This has thus provided a mass of market for various types of computer hardware and accessories. The cluster therefore generates locational externalities which also led to forms of inter-firm collaboration that have raised the cluster's collective competitiveness.

The composition of the cluster is presented in Table 2. The sample surveyed comprises 392 enterprises employing a total of 3029 workers. There are nine main types of activities in which 71% of the enterprises are involved. These enterprises are divided into micro, small and medium enterprises. While 24.9 percent of the enterprises are regarded as micro enterprises, 73.8 percent and 1.3 percent are small enterprises and medium enterprises respectively[19]. Most of the

[19] We define Large firms as those with 100 workers and above, medium firms as those with 20 - 99 workers, Small firms as those with 5 - 19 workers, and Micro firms as those with less than 5 workers, Oyelaran-Oyeyinka, B. (2006 forthcoming) *Learning to Compete*
Institutions Technology and Enterprise in African Development, Ashgate Publishing Limited, Aldershot..

enterprises were only recently established largely in response to global trend of increasing participation of developing countries in computer hardware trade and assembling. In fact about 95 percent of the enterprises in the cluster were established after 1995, making them all less than 10 years old. Over this period, their growth and performance have been impressive. The cluster had an average employee size of 6 persons in 2000 increasing to the average employee of 8 per firm by 2003, Table 3. However, the story of the Otigba cluster is not just about employment generation.

Table 2: Composition of the Otigba Computer Hardware Cluster

Type of Hardware	**Number of Firms**	**Number of Employees**
Peripherals	7	379
Computer Accessories	269	2014
Typewriters/Mobile Phones/Camera components, parts and accessories	26	191
Maintenance and Repairs	3	22
Services/Marketing	17	141
Sales	16	129
Branded Computer/Equipment	33	313
Production and Installation	2	16
Networking	6	55
Total	392	3029

Source: Author's Field survey (2005)

Table 3: Trends in Total Employees

	2000	2001	2002	2003	2004
Mgt staff	2.5	2.7	2.8	2.8	2.8
local tech staff	2.5	2.5	2.5	2.7	2.8
Foreign tech staff	1.0	0.9	0.9	0.7	0.9
other unskilled	2.5	2.6	2.8	3.1	3.2
Average total	6.1	6.4	6.9	7.6	7.6

Source: Author's Field survey (2005)

The literature on the development and activities in clusters suggest that enterprises in clusters tend to exhibit growth dynamism and productivity. The table shows this to be the case as reflected in the turnover and profitability profile of the enterprises. Both indices have increased in the past years and average profitability in the cluster which was 39.5 percent in 1999 increased to 44.37 percent in 2004. This is also reflected in the proportion of outputs that was exported which maintained an upward trend in those years. While only 24. 5 percent of output

was exported in 1999; more than 38 percent was exported in 2000. When examined by the size of the enterprises, larger enterprises tend to be more active in the export market. For example, while 40.7 percent of small scale enterprises engage in exports, 53.6 percent of medium scale enterprises engage in exports.

The performance of the enterprises also reflects the entrepreneurship skills of the largely Nigerian owners. Our findings reveal that 88 percent of the enterprises are wholly owned by Nigerians while 10 percent are wholly owned by foreigners. The remaining 2 percent are joint ventures between Nigerians and foreigners. Entrepreneurship tends to be driven by the level of educational attainment of the entrepreneurs. More than 90 percent of the entrepreneurs have formal schooling beyond secondary school level. While 62 percent of these owners have education up to the university level, an additional 30 percent have technical education after their secondary education. This is a very important factor given that all aspects of computer business are highly technical and therefore require considerable above average skills.

Table 4: Trend in Profitability Turnover and Export

	Profitability	Turnover (%)	% of output exported
1999	39.48	107.50	24.51
2000	34.75	82.14	23.98
2001	36.63	64.83	27.41
2002	39.24	192.50	33.37
2003	41.85	87.25	35.48
2004	44.37	58.00	38.99

Source: Author's Field survey (2005)

3.3 Structure of the Market in the Cluster

The cluster demonstrates a classic feature of a market in flux where products of different kinds and manufacturing origins are found, Table 5. The market comprises three broad product types grouped according to manufacturing origin, namely: Foreign Branded Products, Local Branded Products, and the Unbranded or Clones.

Foreign-branded systems

The f*oreign branded computer products* are dominated by IBM, Compaq, Dell, Toshiba, Sun Microsystems and Gateway. They are imported into the country from three main sources:

a) direct importation by end-users (most especially the multinational companies through their international network);

b) direct importation of new or "fairly-used" systems (second hand: referred to in the local parlance as '*Tokunbo*') by individuals for their own use and for sale by operators in the cluster; and

c) local vendors (there is a considerable number of them with several years of experience) appointed by foreign brand manufacturers and given responsibility for marketing, sales and technical support services.

Table 5: Structural Composition of the Computer Hardware Cluster

Type of Hardware	Description	Manufacturer
Foreign-branded computer	New/second hand; desktops and laptops	IBM, Dell, Toshiba, Compaq
Locally Branded computers	New	Zinox, Omatek. Nigerian companies
Locally made unbranded	PC Clones, assembled to order	Otigba enterprises
Computer Components	CPU Casings, motherboards, processors, CD-ROM drives, hard disk drives, Floppy disk drives, USB flash, Zip drives, mouse, keyboards, Random Access Memory (RAM), monitors.	
Peripherals, Network components and software packages		

Source: Author's Field survey (2005)

The second hand or so-called "fairly-used" branded systems, most especially notebooks, are becoming increasingly popular due to their relatively low cost and reasonable period of good service. The importance of second hand computers is an important starting point for a large number of entrepreneurs who import "fairly-used" systems which are serviced and sold. The business is sustained largely due to the comparatively low cost of such systems which are sought by those who either cannot afford new systems and do not necessarily look for the latest brand in the market[20].

Locally-branded systems

For example, second hand notebooks currently sell for ₦90,000 to ₦120,000 while prices for new ones such as Dell, HP/Compaq, IBM and Toshiba range between ₦170,000 and ₦300,000. 1 US$ = N170 on the open market (mid-2005) at the time of this survey.

The Zinox Technologies Ltd. (jointly owned by *Stan Tech*, Nigeria, *Mustek*, South Africa, and *Alhena*, France) led the way in the local production of what can be regarded as *locally branded computers*. The firm has the WHQL certificate for its range of products – desktops, notebooks, servers - launched in October 2000. The Zinox Computers assembly plant, located in Lagos, has at present (2005) an operational capacity of 200 to 350 computers per day with plans to increase capacity in response to market demand. The firm's computers have a number of components and parts – power circuits, casing, keyboard, and packaging - fabricated abroad to the company's design[21]. Zinox plans to expand its market not only in Nigeria but also gain significant export market in the West African sub-region. To this end the firm is planning additional investment aimed at digitising its current technology in order to increase production capacity, raise productivity and product quality.

The Federal Government of Nigeria has given an explicit policy support to the efforts of locally branded systems. Immediately after the launching of the Zinox series of locally branded computers in Nigeria, the Federal Government in 2002 directed all its ministries, agencies and parastatals to purchase the firm's products. Following Zinox pioneering efforts other actors such as the United Information Technologies (UNITEC), Omatek Computers and Beta Computers have entered the Nigerian market with different branded products. The products of these new entrants were also recently endorsed by the Federal Government. The support given by the government was based on the employment effect of the industry on science and engineering graduates who have not been able to find jobs. The second rationale was the desire of Nigeria to acquire capability in the manufacturing process of the computers and other computer related products that were being assembled in these firms. Omatek, a fully Nigerian-owned firm, has developed and deployed into the market, an innovative keyboard that is local currency (Naira)-enabled and is also capable of handling three major Nigerian languages.

UNITEC was floated by nine highly successful computer vendors who brought their experience in handling foreign brands over the years to bear on the establishment of a joint local assembly plant. UNITEC had plans to embark on local manufacture of some critical electronic components in 2004[22].

[21] According to Mr. Stan Ekeh, the MD/CEO of Zinox: "…regarding competition, we made it clear from the onset that our competitors are the world market leaders - Compaq, the HP, and the Dell. That is the class we fall into. …Those companies are still holding most of the major accounts that we are gradually cutting into. With time, we'll be there …"

[22] According to Mirilla, the Managing Director of UNITEC: " …the investment will increase our local content dramatically, enable us to develop a technology foundation upon which other technologies can be grown… the plant should assist us to help other companies to do their prototyping in electronic and computer engineering field…"

The local brands are competing against established foreign brands largely on price. However, the strategy of the local brand manufacturers is predicated on matching the foreign brands in terms of quality, and by adapting the systems to the local environment particularly to cope with the incessant power outages and excessive humidity.

Unbranded/Cloned Computers

The Otigba cluster dominates the clone market in the country. The major attributes of such clones are their relatively low cost compared to foreign or local brands. Commenting on local clones, a major assembler remarked as follows: " …Although the quality of branded systems are better, both clones and branded products are in high demand. Multinational companies prefer branded systems while 85% Nigerians prefer cloned systems due to price differential..... The computer market will thrive if government regulates the quality of computer components being imported into the country."

The present competition in the market seems to be between the local branded and unbranded cloned products on the one hand and the foreign brands on the other hand. However, clones have started to penetrate the traditional turf of branded desktop systems with big corporations and banks now patronizing Otigba to purchase desktop clones, components and accessories. IT consultants now readily recommend clones in areas that are not too sensitive, such as simple workstations. The competition in clone assembling is very fierce leading to some operators switching to other IT-based areas[23].

[23] The chief executive of IT World noted as follows: "---This business of cloning is no longer as profitable with customers not wanting to buy original software… if we sell components we only give one month guarantee but if you proceed to make systems you have to provide a one year warranty liability all for additional ₦300. On Risk-Reward basis it is not worth it….Thus, as a strategic shift we are moving away activities to non-PC areas such as video-editing products, ID cards photo printing, CD/Multimedia specialty printer machine…"

4.0 LEARNING PATH: CAPABILITY FOR PRODUCTION AND ASSEMBLY AT THE OTIGBA CLUSTER

The analysis of the productivity capacity of the cluster involves a brief assessment of the following factors impacting on production capacity: *Origin of the entrepreneurs, the skill levels of workers, the availability of intermediate inputs, available technology,* actual *patterns of joint action, benchmarking practice, and physical infrastructure.*

In what follows each of these factors is examined in turn.

4.1 Origin of the entrepreneurs

A major reason for the migration of high skills to this essentially knowledge-based cluster leading to the high growth of the cluster was high unemployment among graduates coupled with the unprecedented growth in IT usage in Nigeria and countries along the West African Coast. Graduates and undergraduates with different backgrounds came to the cluster determined to make the most of the opportunities of an increasingly growing IT business. The most experienced seem to be former employees of large IT firms who have acquired considerable IT capabilities. Entrepreneurs often start as a small family-based business with funds from own savings or from friends and relatives. Some operate as street vendors until they accumulated sufficient funds to rent shop space because institutional lending is hardly possible. There are three sets of systemic institutional bias against small businesses identified in this cluster. First, government policy had for long favoured the establishment of large state-owned enterprises in which the government invested considerable efforts and resources but with little returns. Although there have in principle been small business initiatives, the efforts have not translated to real support to SMEs. Second, while the Nigerian government has over the years formulated industrial/sectoral policies, there has been no explicit differentiating mechanism across size and product groups. For instance, while there is now an ICT policy, it is not specific on product groups and ways in which to foster their growth. Support from the state has for now been reactive. Three there are no initiatives to facility firm entry which is the reason for the pervasive smallness of the enterprises in terms of starting capital. Box 1 illustrates the typical path of an entrepreneur into the cluster.

Box 1: Entrepreneurship Trajectory at OCV

The case of Victor, the Managing Director of *Rofem Cybernetics* illustrates the typical trajectory and entrepreneurial spirit of owners of some of the highly innovative enterprises in the cluster. Victor had his first degree in Business Administration from the Ahmadu Bello University, Zaria, Nigeria in 1999. He purchased his first computer when he was an undergraduate student. Dissatisfied with the performance of his 286 laptop and curious about the technology, he started pulling the system apart and assembling the various components back successfully after based on his reading of computer manuals and publications. He gained confidence and became an expert of some sort. Having upgraded his laptop he sold it to one of his lecturers after some persuasion. This singular sale unexpectedly started him on his journey to computer business as the news of the sale made him popular with other lecturers who approached him to supply them similar systems. To satisfy this initial demand, he travelled to Lagos (a distance of about 800km from Zaria) to shop for fairly used or serviceable laptops. According to Victor,

with the unexpected increase in demand for computers in the university, I had no alternative but to establish a computer sale and service shop in Zaria and hire a few people to help me in its operation since I was still an undergraduate. The shop still exists and has grown."

After graduation Victor moved to Lagos and enrolled for a short course in e-Technology at NIIT, an international IT training outfit. This sharpened his technical skills in computer software, hardware repairs and servicing, particularly in the more intricate laptops and notebooks:

"*At this point I faced the dilemma of either accepting the fairly good job offer by a bank or launching fully into the computer business. I chose the latter and came to the Otigba Cluster to establish* Rofem Cybernetics *as a computer sales and service enterprise with specialization in notebooks and laptops of all brands – Compaq, Toshiba, Dell, IBM and even the less known brands*"

With a staff of ten, Victor has been closely following the developments in computer technology. He has been actively engaged with moving from notebook sale and service operation to assembling his own brand of notebooks using imported parts and components but with casings and keyboards to be manufactured through him by a company in Asia based on his own design. His company has several clients from Nigeria and outside Nigeria including Benin Republic, Senegal, Kenya and the Republic of Congo.

Source: First Field survey (2004)

4.2 Types of Technology in Use

With respect to technology, the core technology at this stage of development of the cluster is the computer hardware assembly process technology. It is pertinent to note that the components and parts merchandise that takes place in the cluster is geared towards providing inputs into computer system assembling, repairs, servicing, networking, etc. by enterprises not only in the cluster but also for computer practitioners spread over the country and beyond. Thus, computer assembling operation is central to the discussion of technology as the driver of the businesses in the cluster while also providing a useful framework for the discussion of other elements of productive capacity as well as the environment created by the product market, government policy, institutions and business associations.

Learning to Build Capability in Computer Assembly Process

There are two basic routes for capturing *user requirements* – either through direct specification by the purchaser of the intended usage of the computer towards the production of a customized system for the customer. The second approach is that the computer firm determines usage requirements/capabilities of the system to be mass produced to meet the perceived needs of a broad spectrum of potential buyers, usually based on regular market survey. The first route is

typical of the computer clone business as it operates in the cluster while the latter is the mode of operation of firms producing branded systems in the formal sector.

The user requirements – defined by the user or by the producer – form the basis of the system design to meet the requirements. The *system design* involves the specification of the hardware components (motherboard, processor, RAM size, various drives, Hard disk capacity, casing, etc.) and software configuration to satisfy both compatibility and system functional requirements. This is a critical step as there are diverse makes of components of different capacity, operational characteristics, durability, price, and so on in the market with some incompatible with others.

For example, the HP RAM may not be compatible with the GIGAPRO motherboard. This is where the clone assemblers in the cluster depend on tacit knowledge from past successful system configuration. There is an element of trial and error in the use of non-standardized components. This distinguishes a brand manufacturer from a clone manufacturer. The former has standardized components and parts for the assembly process based on established system design while the latter, in order to satisfy the varying customer requirements, sometimes juggles with various available components to produce a functional system at minimal cost.

The system design leads to the specification of parts and components for the assembly process. One of the advantages of the cluster is the ready access of clone assemblers to varieties of components in the cluster. Apart from easy sourcing of components within the cluster, the assembler can easily return malfunctioning or inappropriate parts at the assembly stage. The *hardware assembly* involves the coupling of the various components. This is basically a skilful manual operation to ensure proper fit. This is followed by the installation of the *operating system software* to drive the various hardware units. In clone assembling, 'trial' versions of variety of *applications software* (e.g. Microsoft Office suite, CorelDraw, Photoshop, etc.) are usually installed to save cost. Cloned systems from the cluster are usually Internet ready. This is in contrast to branded systems which leave the assembly line to the market with some pre-installed applications software except the Microsoft Office Suite. Users of branded systems often have to purchase separately any additional applications software for installation on their systems.

The final stage is the testing of the assembled system. If the system works as designed, it is packed and ready for delivery. If there is any problem, the assembler may have to revisit the system design. According to Biodun Marquis, Chief Executive Officer of Pragmatic Technology, the company that unveiled Nigeria's first branded notebook, *"It is important that products are of the highest standards and quality because nothing can damage a brand name more than inferiority or unreliability effect and perception. A good product will always sell*

itself. In developing new products, it is important that comprehensive tests, especially with regards to our local environment, are carried out before introduction to the public. Our products are tested for a minimum of six months before going public."

4.3 Capabilities to Learn: The Role of Skills and Knowledge in the cluster

Every aspect of computer business – trading or production – requires, in varying degree, technical knowledge of computer hardware and software. This point was buttressed by one of the respondents who noted that 'many businesses owned by computer illiterate managers have since gone under due to their inability to meet up with the constant demanding and dynamic trends in the global computer industry'. So, what skills or competencies are required?

Clearly, an understanding of basic computer knowledge is required for successful entry into any of the ICT-driven businesses in this cluster. The required deepening will then be dictated by the area of interest which can be categorized into: trading in components and parts, hardware assembling, hardware servicing, hardware repairs, and software.

Trading in computers and allied products requires a reasonable level of marketing skills matched with astute business acumen. Trading requires close monitoring of the technology market due to the rapid rate of obsolescence of equipment and process characteristic of the IT sector. The trader needs to keep pace with the continual changes as they unfold in the world computer industry. Incidentally some leaders in the cluster tend to share their knowledge of the market trends with the smaller players while some of the latter rely on 'spying' on what the leader is currently stocking to determine what components to import. The leaders are relied upon to bring in bulk items such as casings, keyboards, mouse, speakers, and monitors for sale to the small players. But nearly 70% of the operators travel abroad to purchase fast moving and relatively light items such as RAM, hard disks, processors and motherboards. Such components are usually air-freighted to the Murtala International Airport, which is a few kilometres from the Otigba cluster. Close to 800 different suppliers from China, Dubai, Taipei, Singapore, Japan, United States, and some other Asian countries are involved. Most operators closely guard their sources of supply in an attempt to gain market advantage.

A trader must be able to determine when to buy and when to quickly get rid of inventory. Information is critical to the success of the business. Most of the more dynamic traders in the cluster now use the Internet for information and business transactions. The mobile phone has also become an important tool for the operators in reaching to suppliers abroad and in the words of one of them: 'to connect the world'. Equally important is a close monitoring of the Nigerian

foreign exchange market due to heavy dependence on importation and the sensitivity of buyers to prices.

Computer hardware assembling is mainly fitting and screwing operations due to the present high level of standardization of parts and components in the industry. It involves a number of technical tasks that is based largely on tacit knowledge and learning[24].

In the past, characterized by less standardization, assemblers had to do a bit of cutting and soldering to get parts to fit. Nowadays critical components are standardized and come with manuals to closely guide installation. Assembling capability is now relatively easier to acquire. A number of enterprise owners and individuals (including undergraduate students in tertiary institutions) acquire such capability through apprenticeship in the cluster. As noted by the Chairman, Zinox Computers Ltd., the first manufacturer of branded systems in the country, "*…people start as clone assemblers until they become branded. You learn the cloning process before you start talking about branding. Even our Partners in South Africa started to clone before branding.*" Thus, cloning capability acquisition is usually the first step in the journey towards upgrading to brand manufacturing in computer production. For a firm's product to be regarded as branded, it is normally issued with the WHQL certificate for the product. WHQL (Windows Hardware Quality Lab) Certification is the global industry standard for computer hardware manufacturers. WHQL is more a certification of product than process by Microsoft. Four firms – Zinnox Computers (jointly owned by *Stan Tech*, Nigeria, *Mustek*, South Africa, and *Alhena*, France), Omatek Computers, United Information Technologies (UNITEC), and Beta Computers - have entered the Nigerian market with different branded computer systems. Branding is therefore achievable in Nigeria; but it remains to be seen if firms in the cluster would or be encouraged to pull resources together to upgrade from cloning to branding. The competition between the locally branded systems and the foreign ones (e.g. Compaq/HP, Dell, IBM, Toshiba, etc.) is keen in the volume-driven computer market. This discussed further in the latter part of this paper.

Hardware servicing involves cleaning operation using blowers and suction pumps to get rid of accumulated dust. It may also involve dis-assembling and replacement of components to upgrade the system. Thus, servicing involves some elements of system design and assembling.

[24] Fixing the processor with it's cooling fan onto the motherboard; adjusting the necessary jumper settings on the motherboard; attaching the drives (CD-ROM, Floppy disk, Hard disk, Zip disk etc.) to the appropriate parts of the CPU casing; fastening the motherboard to the CPU casing; connecting the drives to the motherboard with the controllers; connecting the appropriate interface cards (e.g. VGA, Modem, Sound card) to their appropriate slots on the motherboard; starting up the computer and installing the desired operating system; installation of the required application software.

It is a capability acquired by service technicians mainly through apprenticeship under experienced firms in the cluster.

Hardware repair involves a good knowledge of software and hardware relationship, good diagnostic capability to establish the state of the system, and knowledge of components and their compatibility characteristics. Most operators in the cluster depend on tacit knowledge to undertake repairs. Some are not able to easily distinguish between software related problems and problems that arise from hardware malfunction. This often results in extra work, lost time and expensive repairs. The hardware repairs capability varies considerably in the cluster with the successful operators being mainly those with strong technical background. It is also an area that involves wide consultation among operators when repairs become problematic. Computer repairs are relatively easier than printer and monitor repairs. Only a few firms are engaged in the latter due to the specialized nature of such highly standardized and technology-intensive accessories. Some of the operators involved in printer and monitor repairs trained in the formal sector before establishing in the cluster.

Software installation is relatively easy since all an installer has to do is follow closely the installation procedure provided by the developer. What is critically absent in the cluster is software development capability; most especially applications software. It is a knowledge intensive activity with relatively small capital investment, but a non-existent activity in the cluster despite the growing demand for applications software in the country. Not surprising, respondents emphasized the need to pursue the acquisition of applications software development capability in the cluster in order for the cluster to become 'Total ICT solutions provider'. As indicated earlier most clone assemblers use what they have referred to as 'trial' versions of proprietary software. These trial versions are a lot cheaper but have been a source of serious discord between clone assemblers and software giant such as Microsoft as well as the Nigerian Copyright Commission (NCC). The so-called 'trial' software has been classified as pirated software by NCC and Microsoft (Nigeria). CAPDAN, the cluster's umbrella association stepped in to demand considerable reduction in the rather high price for original software from Microsoft. However efforts have been made by the NCC to resolve the dispute between CAPDAN and Microsoft.

Overall, the cluster has both attracted and generated diverse skills. Some of the operators came in with minimal skills and have upgraded themselves through training in the cluster as apprentices while some others have taken advantage of training provided by some of the training schools located in and around the cluster. Some operators have even attended a few

function-specific courses conducted by the popular Lagos Business School to upgrade their management skills.

4.4 Availability of Intermediate Inputs

As indicated above, intermediate inputs for the assembling, repairs and servicing of computers and accessories, either in the cluster or outside of it, are imported mainly by a few firms in the cluster. The cluster has become the IT hub for the country for sourcing diverse computer components and accessories. Enterprises in the cluster enjoy the following advantages: one, easy sourcing of components due to close geographical location to the suppliers; two, competitive prices arising from stiff competition between suppliers, with pricing as its main tool; and three, special financing of purchases due to good relationship between sellers and buyers in the cluster. There is fierce competition between sellers in the cluster which is evident from the plethora of newspapers advertisements of ICT components, parts and accessories.

Significantly, there is the emergence of backward integration through local production of some computer parts and accessories in the country. Omatek Computers, one of the new producers of branded PCs in the country has launched into the local production of casings and speakers. 70% of the casings and speakers produced by the firm are at present used internally on its PC assembly line while the rest enter the Nigerian market. The company is planning to expand production to capture the Nigerian market.

It is also pertinent to note that some of the firms in the formal sector have re-designed some critical components in response to local realities. Zinox re-designed the power unit of its branded systems to withstand the erratic power supply and low voltage in the country. The keyboard has also been modified to incorporate the local currency sign – the Naira with symbol ₦. These re-designed components are however manufactured abroad and brought to the country.

4.5 Benchmarking

Benchmarking is mainly at the level of the few formal firms producing branded computer products in the formal sector. The WQHL certificate, as mentioned earlier, is the industry standard for assembled computers. Assembled clones in the cluster are not subjected to any standardization either of the process or the product. Branded systems are more expensive than clones but tend to last longer. The cost of maintenance is also much higher due to standardization of parts. Such parts are usually more expensive when available but are oftentimes unavailable in the local market thereby complicating servicing and repairs. The advantages of clones are derived from their cheap purchase price, flexibility in assembling, and

ease of maintenance. The components of clones are readily available and cheaper. Some have observed that inasmuch as users protect their systems with Uninterruptible Power Supply (UPS) and stabilizers, cloned systems can last as long as branded. The observed tendency in the implementation of networked systems in most organizations in the country is the use of branded systems as servers to safeguard the database while clones are used as workstations. Most, if not all, cybercafés in the country use such configuration.

5.0 INTER-FIRM LEARNING AND COLLABORATION

The strength of clusters lies in the quantity and quality of inter-firm learning and collaboration that exist between members. This is because, these collaboration generate positive externalities that reduces the average transaction costs which individual enterprises may not be able to generate by themselves. In the same vein, lack of cohesiveness can limit the capacity of SSEs' to defend their collective interests and effectiveness. The type of linkages whether horizontal or vertical determines the overall performance in the cluster and can ultimately make them more competitive and better. Our findings from the Otigba cluster reveal that there is a high level of cooperation existing within the cluster. More than 97 percent of the enterprises indicate that they cooperate with other firms within the clusters while 78 percent and 99 percent of the enterprises collaborate on subcontracting and usage of industrial associations respectively.

We further examined the changing horizontal and vertical linkages among the enterprises. Starting with the horizontal linkages, firms reported that there has been tremendous increase in the level of cooperation with other firms and no firm indicated that there was a strong decrease in this relationship. The relationships also translated to more usage of industrial associations. The industrial associations are formed in order to foster unity and embed social capital that can be tapped into by the members. Although 19 percent of the firms indicated that there was no change in this relationship over the past five years, while 76 percent of the firms indicated that there has been an increase in the usage of industrial associations (Table 6). Most of the horizontal linkages identified are in joint marketing, quality improvement and information exchange where 87 percent, 83 percent and 80 percent of the enterprises respectively indicated the existence of relationship with other firms has increased over the past five years. However a significant proportion of the enterprises have not increased collaboration with other firms. For example, in the case of joint labour training, 26.9 percent of the enterprises indicated that the relationship remained the same over the last five years (Table 6).

Table 6: Perceptions of Firms on Changing Horizontal and Vertical Linkages (%)

Horizontal Linkage between SSEs						
	Strong increase	Increase	Remain the same	Decrease	Strong decrease	Total
Cooperation with other firms	41.61	50.67	7.38	0.34		100
Usage of industrial association	19.73	56.12	19.73	3.74	0.68	100
Horizontal Linkage						
Exchange of info & experiences	31.37	49.02	16.99	2.61		100
Quality improvement	29.09	54.18	14.55	2.18		100
Joint labour training	18.65	43.65	26.98	8.73	1.98	100
Joint marketing	35.49	51.54	11.73	0.93	0.31	100
Backward linkage with supplier of input						
Exchange of info & experiences	32.48	53.7	13.83			100
Quality improvement	24.14	67.24	8.28		0.34	100
Speeding up delivery	30.69	51.38	14.83	3.1		100
Joint labour training	17.04	38.52	31.48	10.74	2.22	100
Joint marketing	40.26	44.73	10.86	3.83	0.32	100
Backward linkage with sub-contractors						
Exchange of info & experiences	22.63	60.95	15.69	0.73		100
Technological upgrading	22.09	58.53	18.99	0.39		100
Quality improvement	20.77	59.62	18.46	0.77	0.38	100
labour training	16.47	40.96	31.33	10.04	1.2	100
Joint marketing	35.23	46.26	13.52	2.14	2.85	100
Forward linkage with main buyers						
Exchange of info & experiences	53.27	42.68	4.05			100
Quality improvement	38.13	48.44	13.44			100
Setting up of product specification	36.24	50	10.4	3.36		100
Organisation of production	23.16	46.67	26.67	3.16	0.35	100
Forward linkage with foreign buyers						
Exchange of info & experiences	31.03	58.62	10	0.34		100
Quality improvement	21.45	60.73	16.73	1.09		100
Joint labour training	23.11	30.28	33.86	8.37	4.38	100
Joint marketing	26.64	50.19	20.08	2.32	0.77	100

Source: Calculated from UNU-INTECH field survey data, 2005

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There is evidence of considerable vertical linkages. There are two main types of vertical linkages, forward linkage and backward linkage. We find that firms in the cluster engage in two types of backward linkages which are collaboration and cooperation with suppliers and contractors. There is considerable cooperation between the firms and the suppliers and contractors in all areas of operation including information exchange, quality improvement and others.

The same is the collaboration that exists in the case of buyers both for domestic and foreign buyers. More than 80 percent of the firms indicated that cooperation in the past five years has increased tremendously between them and the buyers of their products. The lowest cooperation exist in the case of joint labour training for foreign buyers and even in that situation cooperation has increased in more than 53 percent of the firms.

6.0 THE ROLE OF PRIVATE INSTITUTION: SUPPLANTING THE STATE

Firms build linkages on four broad types of relationships: family and ethnic cohesion, buyer-supplier relations, geographical proximity and finally, ownership, investment, or organisational membership, (Perry, 1999). Cooperative relationship may be created through trading ties, personal connections, and links with collective institutions or a combination of these sources. Linkages have roots in business opportunities and external pressures and function “through time-space economies, not sustained solely by historical forces alone", (Perry, 1999). In developed export clusters, local networks are increasingly being integrated into global systems, creating new forms of industrial governance, (Schmitz, 1998); (Vargas, 2000). Ethnic and family ties are prominent in African clusters, (Forrest, 1995); (Brautigam, 1997); (Dykam and Van Dijk, 1997); (Pedersen, 1997). According to (McCormick, 1997), Asian business success in Kenya owe much to the extensive family networks formally and informally utilised, and exploited to resolve a diverse range of problems from managerial, technical to marketing and financial. Perpetuation of kinship and ethnic dominance in business is sometimes overt. In south eastern Nigeria, Igbo businessmen reduce transport and other costs through cooperation in trading by pooling resources to send a member of the group to make purchases in Asia, (Oyelaran-Oyeyinka, 1997).

An important horizontal collaboration that has become increasingly important is industry or business association, (Schmitz, 1998); (Perry, 1999). An industry association is a network of firms co-ordinated by a third party association or federation. They are established independently of any one of the firms and have vested in them, powers to guide, cajole, aid and abet participating business firm. This kind of network is influential and active in a variety of ways in developed and developing countries. (Romijn, 2001) cites the role of associations in mediating in contractual problems between firms and clients, and their role in acting as intermediaries between large clients and small manufacturers. Manufacturers associations also act as contractual guarantors by enforcing group, rather than individual responsibility in contract performance.

There are several IT-based associations in the country including the Computer Association of Nigeria, Institute of Software Practitioners of Nigeria, Internet Service Providers Association of Nigeria, and Association of Telecommunications Companies of Nigeria. A number of events brought to the fore the counterproductive nature of the existence of different IT-based organizations pursuing their various narrow interests. Individuals, corporate bodies and some institutions of government expressed their concern and brought up the need for synergy among

the disparate groups within the IT industry. This finally led to the formation of the Nigerian Computer Society (NCS) as an all-embracing IT body for Nigeria. All IT professionals - individual and corporate – have been registering with NCS while operating in their various interest groups. Some members of CAPDAN at the Otigba cluster are registered with NCS. Suffice it to note that NCS has been using its political leverage to pursue diverse issues of relevance to IT development in the country. Since 2002, there has also been further tariff reduction due to the pressure from the associations. The locally-branded computer assemblers and NCS have advocated for zero duty on computer hardware components for computer assembly, repairs and servicing on one hand and on the other hand increased duty on imported computer systems. Such joint action outside of the cluster is expected to influence government policy beyond the capability of CAPDAN.

Joint action in this cluster takes four main forms: one, inter-firm credit facilities; two, technical support; three, joint warehousing of goods; and four, participation in CAPDAN, the cluster's umbrella association.

CAPDAN has worked closely with the Police and other security agents to provide security for its members through surveillance of the streets; the use of electronic surveillance cameras have been installed in key locations and closely watched by security personnel with capability to detect and respond quickly to any criminal activities or distress call. This has reduced considerably cases of theft or disturbances in the cluster.

CAPDAN has also taken up some critical issues such as software piracy, street trading and infrastructure affecting the cluster. As indicated earlier, CAPDAN has started negotiation with Microsoft on the issue of software piracy[25].

Also, through the intervention of CAPDAN, the Ikeja Local Government has now provided space in a new location for the street traders in the cluster. The elimination of street trading will reduce the usual vehicular traffic problems in the area and enhance security.

For its long term development, CAPDAN has also applied for land allocation at Abuja, the capital city of Nigeria. The Association planned to develop such land into another ICT cluster to meet the growing government-driven demand for ICT products and services.

[25]This step was not unconnected with the following observation of Prof Nwauche, Director, Nigerian Copyright Commission, in a recent interview, and we quote: "…, I am going to have a meeting with the Otigba people to talk to them; to encourage them to come as a group to Microsoft and negotiate with them

7.0 CONCLUSIONS AND IMPLICATIONS FOR POLICY

From a few shops selling imported computer systems and allied products in late 1990s along the Pepple Street located in Ikeja, the industrial centre of Lagos State in Nigeria, the Otigba ICT cluster emerged within five years with close to 2,000 shops spread over six streets. The development of the cluster was a salute to the courage and entrepreneurial spirit of the operators as government intervention was, and still is, minimal. The cluster is characterized by a wide array of computer hardware and allied products on display, computer shopping malls, street software vendors, the hustle and bustle of would-be buyers and eager sellers and the ever-present traffic jam along the streets. This attests to the growing market for ICT products in the country estimated at several billions of Naira per annum. Customers of the cluster are drawn from all over Nigeria and, most significantly, from across the West African Coast – from Benin Republic to Senegal. Otigba has become the IT hub for the Economic Commission of West African States (ECOWAS) region to satisfy the IT needs of diverse customers while already attracting the attention of big component manufacturers such as Intel, the world's largest chip maker. The cluster, often referred to as the Ikeja Computer Village, though dominated by merchandise of imported products and with limited production activities, is now perceived (based on media reports and several casual government pronouncements) as Nigeria's Silicon Valley.

Analysis of the productive capacity of the cluster showed that the core technology driving the various ICT-activities and other elements of productive capacity was computer assembling process technology. This has been easily acquired by the operators through apprenticeship and tacit knowledge. The cluster, providing direct employment for more than 6,000 people, also possessed the skills set to handle trading in computers, servicing, and repairs of computers and intricate allied products. Joint action within the cluster was in the form of inter-firm credit facilities, technical support in the form of knowledge sharing, joint warehousing of goods, and active membership of Computer and Allied Products Association of Nigeria (CAPDAN), the cluster's association. CAPDAN has provided an effective platform for addressing issues affecting the cluster.

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so that their jobs are not destroyed, so that the market itself is not closed…if they reach an agreement, it means the Otigba people must only sell the original given to them by Microsoft to sell".

The cluster has great potentials for process, product, and functional upgrading which are expected to be greatly enhanced through institutional support in the following forms: government provision of infrastructural support, stable macroeconomic policy (stable foreign exchange and favourable import duty regimes), financial institutions attuned to the requirements of micro and small enterprises (MSEs) for long-term financing, and educational and training institutions supporting the development of requisite technical and managerial capability.

7.1 Impact of the Cluster

The impact of this cluster cannot be easily measured as it manifests in employment generation (direct and indirect), practical IT knowledge acquisition and diffusion into the economy, and international trade. The direct employment in this cluster at enterprise level varied from 2 to 20 with most having about ten staff. The total direct employment has been estimated at 5,000 to 6,000. Added to this is the army of apprentices and street operators freely operating in the cluster as contact men with impressive knowledge of the IT business – software sales, minor repairs, market information. This category of indirect employment is also in thousands. Undergraduates and unemployed graduates have been trained in their hundreds in this cluster through apprenticeship with most setting up in other parts of the country. The availability of cheap computers and computer components has also been source of support for consultants, individual clone assemblers, and computer technicians spread over the country. It is not an exaggeration to say that this cluster accounts for the highest employment in the IT industry in the country.

The cluster is also playing a vital role in the transmission of practical IT knowledge in addition to nurturing potential entrepreneurs. This is through the involvement of a number of enterprises in the cluster with the Students Industrial Work Experience Scheme (SIWES) being operated by the universities and polytechnics in the country. Under SIWES, science and technology-based students are sent to industry for practical exposure in their areas of study. The cluster has become a popular place for student placements and they have been making positive impacts on the development of technical skills while some of the students have imbibed the entrepreneurial spirit freely exhibited in the cluster. Some of the present operators in this cluster had their first contact with IT through this route.

The cluster has also attracted cross-border trading between Nigeria and most countries along the West Africa sub-region. This is a positive development for the Economic Commission of West African States (ECOWAS) in its drive towards the economic integration of the sub-region.

7.2 Prospects for Cluster Upgrading

How can this dynamic cluster upgrade? Three areas of strategic upgrading that hold great promise have been identified in this study: process upgrading, product upgrading and functional upgrading.

Process upgrading would involve finding ways to improve on the clone assembling process which has been affected by the lack of standardization of some components. In the process of becoming cost leaders in the highly competitive computer system production, most enterprises have shown less concern for the quality of parts and components used in the assembling process. The assembly process is highly informal, there are no standards kept, no record of the components used for the finished product, no serialisation or record keeping of the product; consequently, the assembled product is faceless.

It is still possible to satisfy the varying requirements of customers by using standardized components whose performance characteristics are well established. This might lead to the production of more durable and still relatively cheap systems[26]. Other operators need to be exposed to the inherent advantages of standardization on product quality and long-term cost advantage. The emergence of 'combo' casings is going to help in increasing component standardization[27].

The operators in this cluster have so far relied entirely on individual efforts in the acquisition of computer technical capability. There is as yet no government intervention in this respect in the cluster. The nearest government institution that could possibly assist is the Industrial Training Fund (ITF) with its mandate targeted at industrial skills upgrade. ITF has over the years been funding industrial training of undergraduates under the SIWES, the undergraduate industrial training programme referred to earlier. It could initiate and fund appropriate industry-based training targeted at the operators in the cluster.

The second possible upgrading strategy is *product upgrading* in respect of which there are already some positive indicators. The operators in the cluster have so far concentrated on cloning desktops. This is the easiest in the computer product line including notebooks, minicomputers, mainframes, super computer. Cloning a notebook is more complex due largely to a high degree of non-standardisation of designs and parts such as motherboard, keyboard,

[26] De-Goal Ltd., one of the leading firms in the cluster, as with others is already moving in this direction with standardized components from specific sources.
[27] A Combo casing comprises integrated casing, mouse, keyboard and speakers. A Combo casing is even cheaper than purchasing the individual components in the casing. Pcgreen, a computer components manufacturer, has started to produce such casings and they are already in the Otigba cluster.

mouse, casing and monitor. Added to this is the relatively 'micro-level' of operation, which tasks the skill of the assembler.

Functional upgrading which involves increasing value-added by changing the mix of activities conducted within the cluster is indeed possible. Possible areas identified by some operators in this cluster are: backward integration to produce some of the less technology-intensive computer components, acquisition of the VSAT technology, repairs of mobile sets, and applications software development.

The software industry, most especially applications software, is a growing sector in the country. Analysts have identified several areas of opportunities for application software in virtually all sectors of the economy, from educational sector to the more sophisticated banking and finance sector. Software solutions account for close to 40% of the several billions being invested on IT in the banking and finance sector. There are no software firms in the cluster despite the widespread handling of software by those involved with the assembling, repairs and servicing of computers. Yet, some classes of problems with computer systems are software related. This is a major weakness of most of the operators in the cluster. Software development is knowledge intensive. Incidentally there are several schools around the cluster providing training in software development. The observation is that the cluster does not offer any particular attraction for developers who are to be found mainly in other parts of the city. This may soon change.

7.3 Potential for cluster upgrading

The potential for the upgrading of the productive capacity of a cluster is central to the theoretical model adopted in this study. The following three potentially viable routes to upgrading the Otigba cluster have been identified:

a) Upgrading the clone assembling process is possible through training of assemblers in the use of standardized components whose performance characteristics are well established. The emergence of 'combo' casings, integrating otherwise separated components such as casing, mouse, keyboard and speakers, will help in this direction. This will lead to the production of more durable and relatively cheap systems and the possible convergence to branding.

b) Product upgrading is expected to take the form of upgrading from the present cloning of desktops to the more intricate process of assembling cloned laptops/notebooks.

c) Functional upgrading which involves increasing value-added by changing the mix of activities conducted within the cluster is indeed possible in the following areas: backward integration to produce some of the less technology-intensive computer components, acquisition of the VSAT technology, repairs of mobile sets, and software development. These activities are geared towards the development of the cluster into a

one-stop provider of ICT solutions. Backward integration will require strong financial support due to its capital intensity. VSAT technology is already in the country and it is possible to acquire it through training in some of the existing specialised training outfits. Some mobile sets repairs capability already exists and will have to be built upon to capture the growing market for such service. Software development is knowledge intensive. Fortunately there are several schools around the cluster providing training in software development.

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