SUBTHEME: S2 TRIPLE HELIX STUDY

UNIVERSITY-INDUSTRY-GOVERNMENT LINKAGES

Keywords: Networking, Linkages, ICT Firms, Innovation, Performance, Nigeria

TOPIC: **IMPLICATION OF FIRMS' LINKAGES ON INNOVATIVENESS: EVIDENCE FROM ICT FIRMS' SURVEY**

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INTRODUCTION

Firms are vehicles by which countries attain rapid technological growth, industrialisation and global competitiveness. In as much as government has the principal role to drive productive, technological, organizational and institutional changes by virtue of their legislative functions; many governments have invested heavily on their local firms to enable them rank high in global competition. Firms must equally make decisive and strategic decisions to respond and develop their core competences. However, in order to live up to expectation, firms have long realised that operating in isolation will not take them far. Networking and innovative capability is one of the key factors for developing countries to achieve world leading positions in different industrial sectors either by catching up with the international technological frontier (e.g. South Korea in steel, automobiles, and semi-conductors) or by engaging in brand new technological trajectories (e.g. Brazil in oil exploration in ultra-deep waters, forest biotechnology for pulp and paper, and bio fuels) Bell and Pavitt, 1993. The variety and structure of the firms' links to sources of information, knowledge, technologies, practices, human and financial resources have implications for the firm. Each linkage connects the innovating firm to other actors in the innovation system: government laboratories, universities, policy departments, regulators, competitors, suppliers, and customers. In a rapidly globalising world, the ability of countries, particularly Nigeria to be in the league of the Newly Industrializing Countries (NICs) such as Singapore, Taiwan, Hong-Kong, and China and the global ICT leaders lies in the extent to which innovations can be generated to suit the local environment in the sector.

The ICT industry in Nigeria consists of players involved in hardware and peripheral assembly and manufacturing; sales and services of hardware, peripherals and consumables; information technology consultancy and solutions providers; printers and photocopiers re-manufacturers and

recyclers ; educational and training services; software development and marketing; system engineering and systems support services; network service providers among others. From the Goldstar Directories of the major 5,000 companies in Nigeria (2007/08) the categories shown in Table 1 were made.

Thus, about 21% of the top 5000 companies in Nigeria are ICT firms. The number of employees of individual firm within a group range between 10 and 300. Some of these companies are situated in the popular Otigba cluster described by Oyeyinka *et al*. (2007) which consist of skilled entrepreneurs basically involved in computer hardware assembly technology, sales and services. The cluster had boosted the growth of the industry and the duplication of such clusters is recommended in other states of the country and even in other industry because it enhances technology-learning process and industrial growth.

Table 1:
Categories of ICT Companies in Nigeria.

S/No	ICT Firm's Nature of Activity	No in Group	Employees
1.	Hardware and peripheral assembly and manufacturing	2	252
2.	Sales & services of hardware, peripherals and consumables	289	5732
3.	Information technology consultancy & solutions providers	87	3108
4.	Printers toners & photocopiers re-manufacturers and recyclers	2	61
5.	Educational and training services	63	1961
6.	Software development and marketing	75	3368
7.	System engineering and systems support services	108	4349
8	Internet service providers	51	2038
9.	Internet Designers and Engineering Services	32	800
10	Telecommunication Engineers and Consultants	43	1300
11	Telecommunications Equipment & Systems sales & services	80	2800
12	Telephone (fixed wireless/mobile) service providers	14	560
13	Telephone (GSM) and accessories sales and repairs	42	1890
14	Telephone (pre-paid cards) operators	18	630
15	Telephone (wired/fibre-optic) service providers	2	129
16	Telephone (cable) re-broadcasting services	3	53
17	Office automation, business machine & equipment sales & services	72	2872
18	Satellite (VSAT) Communication engineering services	44	1760
19	Satellite (VSAT) Communication Equipment	30	1200
20	Telecommunication (non-telephony) service providers	5	192
21	Telecommunication consultancy services	3	40
	Total	1066	35095

Compiled by author using the top 5000 companies in Nigeria published in Goldstar Directory, 2007/2008

STATE OF THE ART ABOUT THE TOPIC

This paper is premised on social development theory (Kim, 1988; Jacobs & Cleverland, 1999, and Jacobs *et al*., 1997) having three interrelated aspects – knowledge, learning and application. Secondly is the process of technological learning which involves intra-firm processes as well as the relationship between firms and their environments (Mercelle, 2004; Lundvall 2004) leading to technological capabilities and possibly innovation in firms. In the study of firm processes in developing countries, most studies have explained technological capabilities in firms to be comprised of investment, production and learning mechanism (Lall, 1992; Biggs *et al*., 1995; and Aires 2005). Aires (2005) further divided learning mechanisms into adaptive innovation capability and networking capability. The first set of capabilities refers to the skills and information needed to identify feasible projects, locate and purchase suitable technologies, design and engineer the plant, and manage the construction, commission and start-up. The skills and knowledge needed for the subsequent operation and improvement of the plant are defined as production capabilities. Lastly, the learning mechanisms available to firms determine the extent to which they can augment their endowments of production and investment capabilities over time. We have in this paper subsumed this last component in 'networking', explaining the internal/external relationship, network and linkages of the firms. Thus, these capabilities are differentiated by their activity components. A study by Lee et. al., (2001) revealed that external networks and partnership-based linkages of firms to sources of finance had a significant influence on performance. Furthermore, a study by Cooke and Wills (2004) showed that government used networking to enhance business, knowledge and innovation performance. Linkage capabilities are required to leverage on high transaction costs and to gain grounds in narrow and inefficient markets. While networking in firms is not sufficient to bring about innovative capability, it is a crucial factor to strengthening their innovative capability (Sher and Yang (2005). Thus, through internal development supplemented by external network linkage, competitive positions of firms change as a result of shifts in both exogenous (e.g. technology cooperation and acquisition) and endogenous (e.g. R&D expenditure and manpower) factors (Keizer et al., 2002).

Impacts of networking capability development on firm's performance range from effects on sales and market share to changes in productivity and efficiency (Thatcher and Oliver, 2001). Important impacts at industry and national levels are changes in international competitiveness and in total factor productivity, knowledge spill over of firm-level innovations, and an increase in the amount of knowledge flowing through networks. The impact of networking capability accumulation can also be measured by the percentage of sales derived from new/improved products and number of patents. The features of linkage/networking in firms as adapted from Lall, Navareti, Teitel and Wignaraja, 1994 include external linkage with openly available information sources that does not require purchase of technology or intellectual property or interaction with the source; acquisition of rights to use patents and non-patented inventions,

trademark and knowledge from local/foreign firms, competitors, universities and government research institutes that do not involve interaction with the source; and acquisition of rights to use patents and non-patented inventions, trademark and knowledge from local/foreign firms, competitors, universities and government research institutes that do not involve interaction

RESEARCH FOCUS

This study attempted addressing the following questions: How does the networking activities of firm impact on their economic and innovation performances? What kind of networking or external linkage impact on the novelty of technological product and process innovation? To what extent does government support and policy impacts on the firms? And what type of ownership structure moderate the link between the use of specific external knowledge sources and firm performance?

METHODOLOGY

In this work, the Jacobs *et al*., (1997) theory describing development as a function of society's capacity to organize human energies and productive resources to respond to opportunities and challenges is visited. Jacobs *et al*. theory identifies the human resource as the driving force and primary determinant of development; other resource- money, materials, and mansion though important, are secondary. The researcher expands upon this theory with explicit reference to intra-firm technological learning processes (Kim, 1997; Oyeyinka, 1997; Biggs *et al.*, 1995; Akerele, 2003; Bell and Pavitt, 1993; Lall, 1987; Akinbinu, 2001) and interacting environmental factors which broadly speaking include policy, market and institutional frameworks as theorized by Fagerberg, 2004. All of these culminate to technological capability development in firms as well established in development studies literature (Bell and Pavitt 1993; Ernst *et al.*, 1998; Figueiredo 2007; Kim 1997; Kim and Nelson 2000; Lall 1992; Marcelle 2004). This work goes further to link the generation of technological innovations, profit and growth as resulting from the accumulation of technological capability of which networking is one (Figure 1). One of the primary concerns in this work is to identify the essential relationships that enhances the generation of technological innovation.

The study areas include Lagos, Port Harcourt, Kaduna and the Federal Capital Territory – Abuja in Nigeria (Figure 2). These cities were selected based on their predominant commercial activities, their age-long existence and the presence of most ICT firms involved in development/manufacturing, assemblage, repairs and maintenance of ICT hardware and software. This is because these firms have interrelated developmental activities which provide details on the nature of technological effort undertaken in the industry. The study employed the use of structured questionnaires and personal interviews to obtain primary data from purposively

sampled 185 ICT firms involved in production, engineering, maintenance of ICT hardware and software. The study achieved 85% response rate. Secondary data from reports, journals, internet, government publications and newspapers were also used.

A pilot test was conducted in Lagos with about 20 firms and three tertiary. The result of the pre-test was used to validate the research instrument. One major parameter for the study is linkages which include supplier firm linkages, subcontracting linkages and linkages with institutions that provide trouble-shooting, testing, training and product design assistance. It also includes external linkage with openly available information sources that does not require purchase of technology or intellectual property or interaction with the source. The firms were asked to indicate the number of existing linkage/networking they had in the years 2003 to 2007 with government laboratories (NLC_1), universities or polytechnics (NLC_2), ICT regulatory body (NLC_3), competitors (NLC_4), suppliers (NLC_5), and financial resources (NLC_6). The parameter was also measured using the intensity of firms' collaborative efforts with sources of Information and Knowledge, Sources of Technology/Process, Human Resources, Financial Resources, Government laboratories, Universities or polytechnics, Competitors, Suppliers and Policy institutions/Regulators on a five-scale rating of 5-Excellent, 4-Very Good, 3-Good, 2-Moderate, and 1-Poor. The firms were asked to indicate whether they were involved in outsourcing or subcontracting. Finally, the parameter was measured on a 3-item scale of the best description of firms' linkage and networking activities in the categories: (a) External linkage with openly available information sources that does not require purchase of technology or intellectual property or interaction with the source ; (b) Acquisition of rights to use patents and non-patented inventions, trademark and knowledge from local/foreign firms, competitors, universities and government research institutes that do not involve interaction with the source; and (c) Active innovation co-operation with other local/foreign firms and public research institutions, subcontracting and outsourcing of product, components, machinery, software (which may include purchase of knowledge and technology). To evaluate the impact of networking and linkage capability on firm's performance based on annual profit, the following model was considered as relevant:

Performance (P) of ICT firms was obtained individually in terms of annual turnover after tax; capital outlay; novelty of technological product innovation; novelty of technological process innovation; and number of patents granted to firms. All of these were considered individually as objective functions with several independent variables $NLC_{i,\ldots.n}$. Mathematically, this is expressed as:

$P = f(NLC) = \sum[f(NLC_{i,\ldots,n})]$

Where

P = Performance (measured in terms of annual profit in naira after tax, capital outlay, novelty of technological product innovation, novelty of technological process innovation and number of patents)

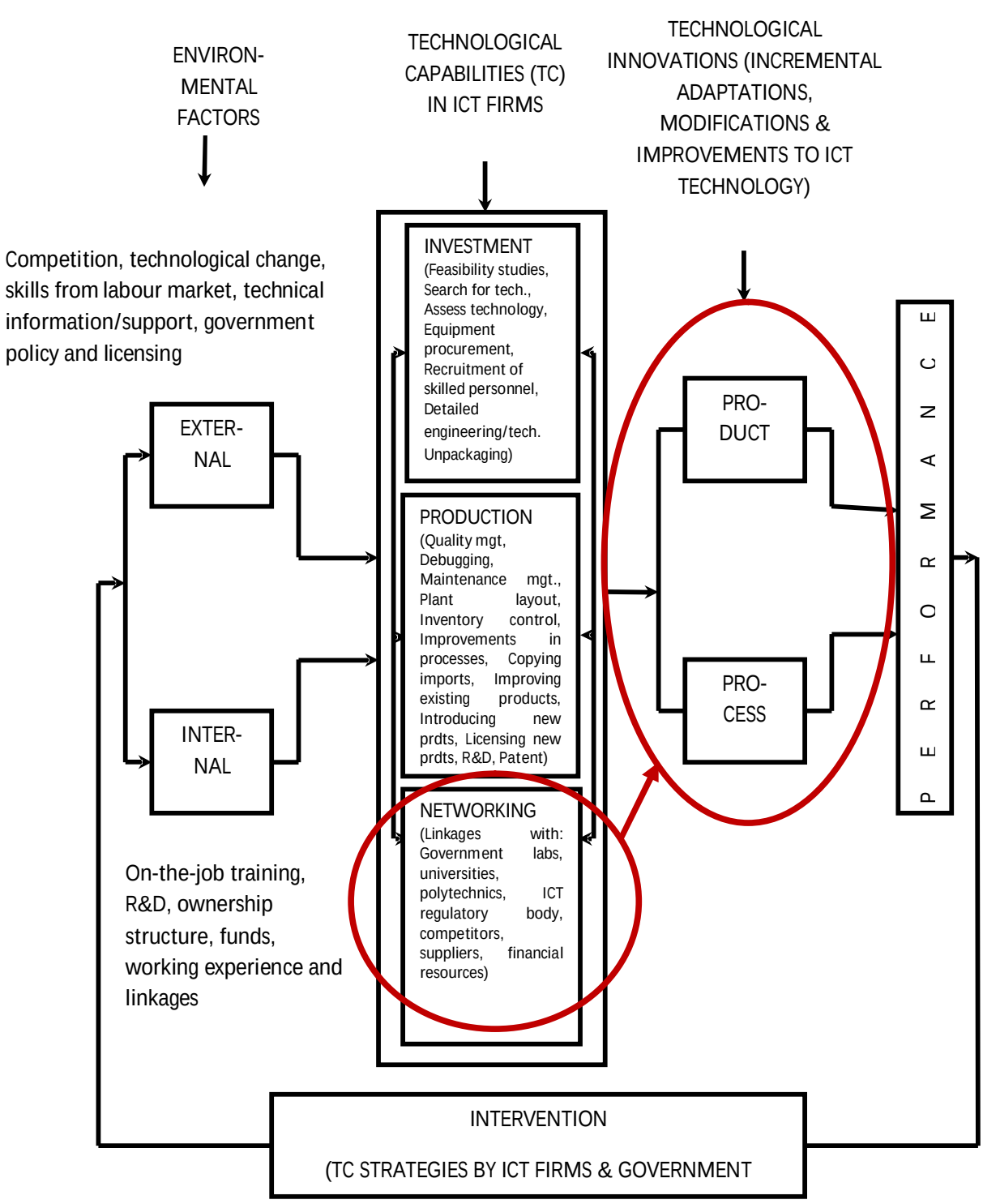

Figure 1:

Conceptual Framework showing link between networking and the development of technological innovations in firms

Source: Author

Nigeria is on Latitude: 10º00´ North of the Equator and Longitude: 8º00´ East of Greenwich. Estimated population is about 140 million. (2006 est.)

KEY:

Areas of Study

Figure 2: Map of Nigeria showing areas of study

NLC = Networking and Linkage Capability;
i = 1, 2, 3, ..., n

NLC_1 = government laboratories (based on the number of existing linkages and rating of the intensity of firm collaborative effort)

NLC_2 = universities or polytechnics (based on the number of existing linkages and rating of the intensity of firm collaborative effort)

NLC_3 = ICT regulatory body (based on the number of existing linkages and rating of the intensity of firm collaborative effort)

NLC_4 = competitors (based on the number of existing linkages and rating of the intensity of firm collaborative effort)

NLC_5 = suppliers (based on the number of existing linkages and rating of the intensity of firm collaborative effort)

NLC_6 = financial resources (based on the number of existing linkages and rating of the intensity of firm collaborative effort)

The data gathered were sorted, coded and analyzed using the Statistical Package for Social Science (SPSS) now known as the Predictive Analytic Software (PASW) and Excel. Descriptive method of analysis including means, percentages, cross tabulations, frequency counts and personal observations were used. Also inferential statistics specifically correlations, multivariate regression and factor analysis were used.

FINDINGS

The firms' profile and background information (Table 2) reveal that almost seven-tenth (68.2%) of the firms were fully owned by Nigerian individual(s); 23.6% operate as a joint venture between Nigerian and foreign individuals; while only 8.3% were operated by foreigners. This suggests that the industry have attracted some bit of investment from foreign firms which could generate technological learning especially because of the existing joint venture though at the very minimal (about one-fifth). The highest qualification of 122(77.7%) of the heads of engineering/maintenance and 79(50.4%) of the heads of production was found to be university degrees. However, their working experience ranged between 1-10 years (87.9% and 96.8% respectively). This result shows that while the industry could boast of qualified personnel, their working experience is not as impressive. About seven-tenth (111) of the firms were established between 1981 and 2000; another one-fifth (38) started operation between 2001 and 2006. The high proportion of the firms falling into about 29 years of age should account for higher working experience of the heads of departments which was not found to be the case in this instance. It then appears that some workers leave the business for more attractive jobs.

Impact of government policy and support on the firms

Correlation analysis revealed a strong relationship between government policy/support on networking and developmental activities of the firms. For instance, there exist a strong relationship between government policy/support and availability of funds for training ($t = 2.243$, $p<0.05$); availability of funds for research and development ($t = 2.412$, $p<0.05$); and linkages with other firms ($t = 2.884$, $p<0.05$).

Number of linkages

Descriptive statistics revealed that between 2003 and 2007, an average of 35.5% of the firms was engaged in networking with government laboratory (Table 3); 22.5% with universities/polytechnics; 52.7% with ICT regulatory body; 53.2% with competitors; and 76.7% with suppliers.

TABLE 2:
FIRMS' PROFILE

VARIABLE	PROFILE OF FIRMS	N = 157 (%)
OWNERSHIP STRUCTURE	Fully owned by Nigerian individual(s)	68.2
	Joint venture between Nigerian and foreign individual(s)	23.6
	Fully owned by foreign individual(s)	8.3
QUALIFICATION OF HEADS OF ENGINEERING/MAINTENANCE	Polytechnic	22.3
	university education	77.7
QUALIFICATION OF HEADS OF PRODUCTION	Polytechnic	49.7
	university education	50.3
FREQUENCY OF ON-THE-JOB TRAINING/SKILL DEVELOPMENT	Once a year	25.5
	Twice a year	33.1
	Every month	31.2
	Daily	10.2
STAFF STRENGTH	1-50	77.7
	51-100	12.1
	101-150	38.6
	151 - 200	1.9
	201 – 250	0.6
	350 – above	0.6
DATE ESTABLISHED	1900-1960	0.6
	1961-1980	4.5
	1981-2000	70.7
	2001 -2006	24.2
WORKING EXPERIENCE – HEAD, ENGINEERING/MAINTENANCE	1-10	87.9
	11-20	9.6
	21 and above	2.5
WORK EXPERIENCE – HEAD, PRODUCTION	1-10	96.8
	11-20	3.2
WORK EXPERIENCE - HEAD, R&D	1-10	85.7

Rating of firms' collaborative efforts

In Table 4, an average of 82.6% of the firms rated their collaborative efforts with government laboratory as 'poor'; 72.5% rated that of university/polytechnics as 'poor'; 58.5% rated that of policy institutions/regulators as 'good' and 'very good'; 47.6% rated that of competitors as 'poor'; while an average of 36.8% of the firms rated that of suppliers as 'very good' and 'excellent'. This implies that aside linkage and networking with policy institutions which rating was above average, every other collaborative efforts was poor.

Table 3

Object of Network/Linkage of Firms

OBJECT OF NETWORK (N=157)	YEAR/ FIRMS ENGAGED IN NETWORKING (%)*				
	2003	2004	2005	2006	2007
GOVERNMENT LABORATORY	32.9	32.9	39.4	33.4	38.7
UNIVERSITY/POLYTECHNIC	10.3	21.3	26.9	26.9	26.9
ICT REGULATORY BODY	48.4	53.6	53.8	53.8	53.8
COMPETITORS	56.2	56.8	51.0	51.0	51.0
SUPPLIERS	76.8	76.1	76.8	76.9	76.9

* Note that the firms had more than one object of linkage
Source: Author's Field Survey

Furthermore in Table 5, few (26.1%) of the firms had access to openly available information sources; 37.3% acquired rights to use patents while 36.6% had innovation cooperation with local/foreign firms. While these networking activities are desirable in firms to achieve global competitiveness, finding from this study reveal that they do not have significant association ($p>0.05$) with economic or innovation performance of the firms.

Table 4
Rating of Firms' Collaborative Efforts

COLLABORATING INSTITUTION	YEAR	RATING (%) N=157				
		POOR	MODERATE	GOOD	VERY GOOD	EXCELLENT
GOVERNMENT LABORATORY/RIs	2003	77.1	16.6	-	0.6	-
	2004	87.8	11.5		0.6	-
	2005	87.8	11.5		0.6	
	2006	82.2	16.6	0.6		
	2007	78.0	12.8	4.6	-	
UNIVERSITY/ POLYTECHNIC	2003	75.2	9.8	15.0	-	-
	2004	75.2	9.8	15.0	-	-
	2005	72.6	9.6	17.8	-	-
	2006	72.6	15.3	12.1	-	-
	2007	66.9	21.0	12.1	-	-
POLICY INSTITUTIONS/ REGULATORS	2003	10.5	16.3	39.9	26.8	6.5
	2004	10.5	16.3	39.9	26.8	6.5
	2005	9.6	15.9	28.0	35.0	11.5
	2006	9.6	30.6	13.4	35.0	11.5
	2007	9.6	25.5	18.5	29.3	17.5
COMPETITORS	2003	43.9	21.7	8.9	22.3	3.2
	2004	51.6	22.2	3.3	19.6	3.3
	2005	49.7	21.7	3.2	19.1	3.2
	2006	49.7	21.7	3.2	22.3	3.2
	2007	43.3	15.9	6.4	24.8	9.6
SUPPLIERS	2003	35.0	19.7	3.8	22.9	18.5
	2004	35.0	20.4	3.8	12.1	28.7
	2005	34.4	21.7	3.8	4.5	35.7
	2006	34.4	17.8	5.1	7.0	35.7
	2007	39.5	27.4	14.0	3.2	15.9

Source: Author's Field Survey

Table 5:
Nature of Networking Activity of Firm

NATURE OF NETWORKING ACTIVITY	PERCENT (N = 142)
openly available information sources	26.1
acquisition of rights to use patents	37.3
innovation cooperation with local/foreign firms	36.6
Total	100.0

Source: Source: Author's Field Survey

Table 6:

Factor Analysis of Firms' Networking Functions

Component Matrix (a,*, b)

Networking Functions	Component					
Networking/Linkage Parameters	1	2	3	4	5	6
1.No. of linkage with government laboratories and research institutions	.034	.689*	.299	-.100	-.367	-.261
2. No. of linkage with universities/polytechnics	-.508	.276	.442	-.147	.367	-.463
3. No. of linkage with ICT regulatory body	-.503	.349	.475	.244	.288	.233
4. No. of linkage with competitors	-.297	.595	.429	.257	-.082	.471
5. No. of linkage with suppliers	.149	.287	-.264	.620	.437	.020
6. Firm collaborative efforts with sources of information	.473	.000	-.244	.750*	.007	.050
7. Firm collaborative efforts with sources of technology	-.456	-.128	.367	.343	-.590*	.016
8. Firm collaborative efforts with human resources	-.508	-.518	.299	.460	.172	-.237
9. Firm collaborative efforts with financial resources	-.242	-.826	.274	.214	-.014	-.125
10. Firm collaborative efforts with government laboratory and research institutions	.020	-.508	.302	-.242	.052	.574*
11. Firm collaborative efforts with university/polytechnic	.243	-.100	.439	-.432	.349	.069
12. Firm collaborative efforts with policy institutions/regulators	.566	-.112	.434	.105	-.306	-.157
13. Firm collaborative efforts with competitors	.794*	.021	.495*	.064	.183	-.096
14 Firm collaborative efforts with suppliers	.761	-.019	.487	.161	.011	-.003

Extraction Method: Principal Component Analysis.
a 6 components extracted.
* The networking function having highest correlation along each component in the column is selected
b Only cases for which Networking activity of firm = innovation cooperation with local/foreign firms are used in the analysis phase.

Prevalence and importance of different types of linkages used by the ICT firms

Table 6 show the core networking activities ranked in order of importance using principal component analysis factor weights (0 to 1) that contributes to growth and competitiveness in the firms. These were firms' collaborative efforts with competitors (0.794), firms' collaborative efforts with sources of information (0.750), linkage with government laboratories/research institutions (0.689); and firms' collaborative efforts with sources of technology (0.590). This result has implication for achieving positive effects on sales and market share to changes in productivity and efficiency in firms.

Impact of networking activities on firms' economic and innovation performances

Multivariate general linear model using 95% confidence level of the Type III sum of Squares method was used to evaluate the impact of networking activities on firms' performance. The networking activities of the firms extracted from the principal component analysis using factor

analysis as described in Table 6 were set as independent variables or covariates. Furthermore, five performance proxies were set as dependent or response variables since the multivariate linear model allows for the use of two or more dependent variables in a single analysis. The five performance proxies include: estimate of annual profit after tax; capital outlay; number of patents granted to firm, novelty of technological product innovation and novelty of technological process innovation. In Table 7, the corrected model of the tests of between-subjects effects shows the summary of the impact of networking/linkage activities on the firms' performance. In the corrected model, estimate of annual profit ($t=1.050$, $p>0.05$) and capital outlay ($t=0.962$, $p>0.05$) showed a non-significant impact on networking/linkage. On the other hand, number of patents granted to firms ($t=3.230$, $p<0.05$), novelty of technological product innovation ($t=2.731$, $p<0.05$) and novelty of technological process innovation ($t=3.440$, $p<0.05$) showed a significant association and impact on networking/linkages in the firms. The value of R squared for the performance proxies – annual profit/sales turnover ($R^2 = 0.187$), capital outlay ($R^2 = 0.162$), number of patents ($R^2 = 0.685$), novelty of technological product innovation ($R^2 = 0.609$), and novelty of technological process innovation ($R^2 = 0.711$) is given at the bottom of the table. The values indicated the proportion of variation in each of the proxies explained by the multivariate general linear model (GLM). From the result, the proportion of variation in annual profit explained by the multivariate GLM was 18%; that of capital outlay was 16%; number of patents was 68%; novelty of technological product innovation was 60%; and novelty of technological process innovation was 71%. R square value is usually between 0 and 100% and is often referred to as the coefficient of determination. The low R^2 values of annual profit and capital outlay implied that the two proxies were not important predictors of networking/linkage in the selected firms. Meanwhile, the high R^2 values of number of patents granted to firms, novelty of technological product innovation and novelty of technological process innovation showed that these proxies were suitable and significant predictors of networking/linkage in the firms. The next section discussed the specific networking/linkage activities that impacts on the significant performance proxies.

Networking and linkage activities that impacts on number of patents

In Table 7, collaborative efforts with competitors ($t=2.132$, $p<0.05$) showed significant association with number of patents in firms. This implies that when a firm collaborate with their competitors, there is likelihood for more patents to emanate from such firm.

Table 7:
Multivariate General Linear Model Analysis (Tests of Between Subject Effects of Impact of TC on Performance

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	t	Sig.
Corrected Model	Estimate of annual profit after tax	5.437E16[a]	15	3.625E15	1.050	.370
	Capital outlay of business	1.830E17[b]	15	1.220E16	0.962	.541
	No. of patents granted to firm	58.203[c]	15	3.880	3.230	.000
	Novelty of technological product innovation	63.505[d]	15	4.234	2.731	.000
	Novelty of technological process innovation	68.803[e]	15	4.587	3.440	.000
No. of linkage with government laboratories and Research Institutions	Estimate of annual profit after tax	2.164E15	1	2.164E15	0.811	.420
	Capital outlay of business	4.164E15	1	4.164E15	0.562	.576
	No. of patents granted to firm	.024	1	.024	0.255	.799
	Novelty of technological product innovation	2.112	1	2.112	1.929	.058
	Novelty of technological process innovation	.000	1	.000	0.032	.982
Firm collaborative efforts with sources of information	Estimate of annual profit after tax	3.099E14	1	3.099E14	0.307	.760
	Capital outlay of business	1.966E12	1	1.966E12	0.000	.990
	No. of patents granted to firm	.144	1	.144	0.622	.536
	Novelty of technological product innovation	.601	1	.601	1.029	.307
	Novelty of technological process innovation	.230	1	.230	0.769	.444
Firm collaborative efforts with sources of technology	Estimate of annual profit after tax	7.467E15	1	7.467E15	1.507	.136
	Capital outlay of business	1.981E16	1	1.981E16	1.226	.224
	No. of patents granted to firm	.240	1	.240	0.804	.424
	Novelty of technological product innovation	.305	1	.305	0.733	.466
	Novelty of technological process innovation	.031	1	.031	0.281	.780
Firm collaborative efforts with government laboratory and Research Institutions	Estimate of annual profit after tax	6.165E15	1	6.165E15	1.370	.175
	Capital outlay of business	3.032E16	1	3.032E16	1.516	.134
	No. of patents granted to firm	.939	1	.939	1.588	.117
	Novelty of technological product innovation	4.695	1	4.695	2.876	.005
	Novelty of technological process innovation	11.660	1	11.660	5.484	.000
Firm collaborative efforts with competitors	Estimate of annual profit after tax	6.567E15	1	6.567E15	1.414	.162
	Capital outlay of business	1.164E16	1	1.164E16	0.940	.351
	No. of patents granted to firm	1.691	1	1.691	2.132	.036
	Novelty of technological product innovation	8.803	1	8.803	3.939	.000
	Novelty of technological process innovation	.065	1	.065	0.410	.683

Source: Author's field survey

a. R Squared = .187 (Adjusted R Squared = .017)
b. R Squared = .162 (Adjusted R Squared = -.013)
c. R Squared = .685 (Adjusted R Squared = .619)
d. R Squared = .609 (Adjusted R Squared = .527)
e. R Squared = .711 (Adjusted R Squared = .651)

Networking and linkage activities that impacts on novelty of technological product innovation

The specific networking/linkage activity that impacts significantly ($p<0.05$) on the novelty of technological product innovation in the firms include: firms' collaborative efforts with government laboratory and Research Institutions ($t= 2.876$, $p<0.05$); and firms' collaborative efforts with competitors ($t=3.939$, $p<0.05$). The implication of the result is that for firms to have novel technological product innovation, these collaborative activities must be in existence in the firms.

Networking and linkage activities that impacts on novelty of technological process innovation

The specific networking/linkage activity that impacted significantly ($p<0.05$) on the novelty of technological process innovation in the firms include: firms' collaborative efforts with government laboratory and Research Institutions ($t=5.484$, $p<0.05$). The implication of this finding was that technological and collaborative efforts with government laboratory and Research Institutions are significantly associated with having novel process innovation in the selected ICT firms and hence efforts should be directed at maintaining this activity in firms.

Linkage between ownership structure, use of external knowledge sources and performance

Three types of ownership structure considered in this study include: 'fully owned by Nigerian individual(s)', 'joint venture between Nigerian and foreign individual(s)', and 'fully owned by foreign individual(s)'. Regression and correlation analysis found no link between these ownership structures and the use of specific external knowledge sources. However, regression analysis established a link between ownership structure and novelty of process innovation ($t= 2.682$, $p <0.05$) as a performance proxy in the firms.

CONTRIBUTIONS AND IMPLICATIONS

Government policy/support cannot be overemphasised in other to achieve meaningful development in firm-level development of third-world countries. Linkage with policy/regulatory institutions, competitors and suppliers impacts on the innovativeness of the ICT firms. This implies that these types of linkages are more important to the firms as it contributes to positive effects on sales, market share to changes in productivity and efficiency. In addition, factor analysis using principal component analysis reveal that the most important linkage used in the firms was collaboration with competitors. This may be because to remain competitive, the firm needs to know what their competitors are doing and work towards being more innovative. Networking activities such as linkage with openly available information sources, acquisition of

rights to use patents and innovation cooperation with local/foreign firms explains little or no variance in economic or innovation performances in the firms. Linkages and networking activities of the firms explains variations in number of patents granted to firms, novelty of technological product and process innovation. Specifically, collaborative efforts university/polytechnic and competitors were found to be significant in determining the number of patents granted to firms. The result suggests a strong link between conducting research and development (R&D) and generating patents. It also suggests that subcontracting does not favour or enhance the generation of patents by firms. Furthermore, for firms to have novel technological product and process innovation, they need to increase their collaborative efforts with government laboratories and research institutions aside collaboration with competitors. Last but not the least; ownership structure is not a predictor of knowledge sources used by firms but there exist a strong link between ownership structure and novelty of process innovation as a performance proxy in the firms.

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