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**Determinants of E-business Adoption: Evidence from
Firms in India, Nigeria, Uganda**

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DETERMINANTS OF E-BUSINESS ADOPTION: EVIDENCE FROM FIRMS IN INDIA, NIGERIA, UGANDA

Banji Oyelaran-Oyeyinka and Kaushalesh Lal*

Abstract

In this paper we employ firm-level data collected in three countries to analyze factors determining the adoption of internal e-business technologies in developing countries. The main objectives of the study are: identification of clusters based on technology adopted, classify firms in each cluster, investigate factors that resulted in technology adoption, and finally, analyse these factors within a multivariate framework. The variables that emerged significant display considerable variety across countries including size of operation, export performance, profitability, value addition, skill intensity, academic qualification of managing directors, learning processes, and technological collaboration with foreign firms. We found bi-directional relationships among several factors but the study could not identify all the causal relationships due to lack of time series data.

Keyword: SMEs, e-business, developing countries, ICTs, adoption, cluster, learning

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1.0 INTRODUCTION

Information and Communication Technologies (ICTs) has been applied across diverse organisations and institutions such as business establishments, non-profit organisations, educational institutions, and governmental agencies. The rate of diffusion has been extremely rapid in some sectors, while the range and penetration of application of ICTs has evolved over the years. For instance, applications in educational institutions, until early 1990s, were limited mainly to complex computations in science, technology, and mathematics and related departments. During the 1990s, universities and academic institutions adopted distributed computing, email, and the Internet. The twenty-first century began with online access of databases, research output, and online learning. Similar developments have taken place with increasing complexity in the industrial application of ICTs across sectors.

Until the 1980s, firms in the main utilised in-house technologies such as CAD/CAM, and CAE. During the 1990s, firms took advantage of new advances in ICTs and started using network technologies for intra-firm co-ordinating activities. Large corporations succeeded in connecting plants located in far places to create greater networks and reduce transaction costs. During this period, several industry-specific ICT tools were developed and adopted by firms. For instance in garments manufacturing, specific tools for marker making, cutting of fabric, and computerised embroidery were developed by several companies such as Gerber Garment Technology and Laser Lectra. In the beginning of twenty-first century, there has been widespread adoption of ICTs for inter-firm commercial and non-commercial transactions.

While industry-specific manufacturing technologies have been developed, the application of networking technologies such as the Internet cuts across business organisations and other institutions. Due to the unprecedented developments in communication and Internet technology, new trajectories of network technologies have emerged. They vary from the simplest forms such as email to more complex uses such as portal-based technologies. These technologies are not activity-, firms- or industry- specific. However their adoption is influenced by firm- and industry-specific factors. Presently there is relatively widespread use of ICTs by firms in developing as well as developed countries in all business activities.

Before proceeding further, we distinguish between electronic commerce (e-commerce) and electronic business (e-business) technologies. An OECD (2002) study, focusing on e-commerce, defines it as "... the sale or purchase of goods or services, whether between business, households, individuals, governments, and other public or private organisations, conducted over computer mediated networks. The goods and services are ordered over those networks, but the

payment and the ultimate delivery of the good or service may be conducted on or off-line” (pp89). The study examines the application of ICTs in commercial activities, which is one of the business processes. Whereas e-business encompasses applications of ICTs in all business processes such as office automation, production processes, co-ordination with other plants, customer relation management, supply chain management, and management of distribution networks (Lal, 2004).

Following the debate on the so called productivity paradox in the early 1990s in developed countries and in mid -1990s in developing countries, empirical studies of ICT impact showed the numerous benefits of the adoption of ICTs. For instance, it has been demonstrated in the literature that the adoption of ICTs in general and e-business in particular leads to a reduction in co-ordination costs and promotes efficient electronic markets (Damaskopoulos & Evgeniou, 2003; Lee & Clark, 1997). Damaskopoulos and Evgeniou in their study of East European and Cyprus SMEs found that most of the sample firms (over 900) established their web sites to take advantage of cost reduction, easy search of new markets, and to augment competitiveness. The study reported that the percentage of firms that created their web sites due to the above reasons vary from 67% in Poland to 86% in Cyprus. The study concluded that “...e-business affects first the boundaries of the firm with the market in which it operates”.

Hodgkinson & McPhee (2002) have examined the impact of the adoption of web enabled technologies on the export market development by SMEs in Australia. A study by Teltscher (2002) deals with the fiscal implications of e-business, while Drew (2003) investigates the causes and consequences of the adoption of e-business by SMEs in East of England. Following an analysis of the total value of transactions conducted through electronic means and its implication on fiscal policies of developing and developed countries, Teltscher (2002) observed that “...an increasing number of e-commerce businesses are small entrepreneurs...” and “... the fiscal impact of international e-commerce is likely to be felt more strongly in the developing countries...”. The findings of Drew (2003) suggest that SMEs are placing e-business at the centre of their technology strategy. The majority of the sample firms reported that the driving force behind the adoption of e-business has been opportunities for growth and the need to keep up with competition. Hodgkinson & McPhee (2002) conclude that international networking by SMEs brought knowledge to the region that facilitates intra-firm learning. The study further suggests that adoption of the Internet by SMEs is higher, albeit marginally (68.8%) than large firms (66.7%).

In the context of developing countries, several studies (Moodley, 2002a; Moodley, 2002b; Goldstein & O'Connor, 2002; Goldstein, 2002) have examined the adoption of e-business by manufacturing firms. Moodley (2002a) did not find sufficient evidence to support the argument that export-oriented apparel firms in South Africa gain more in adopting e-business due to its promise of improved market penetration and its direct link to international competitiveness. Moodley's (2002b) findings on the automobile industry are similar in South Africa.

Goldstein & O'Connor (2002) summarised the findings of several studies and concludes "...as multinational corporations integrate the Internet into their cross-border business operations, firms from developing countries run the risk of exclusion from global value chains if they cannot establish electronic ties with their major business partners." They also argued that despite these general remarks an evident need persists for detailed sectoral analysis of the adoption of e-business. A case study of one of the top automobile firms (Fiat) by Goldstein (2002) suggests that the company has been very successful in optimising supply-chain management in Brazil while it has not been able to do so in India. The study further reveals that the use of the Internet by the company in India (Fiat India) has been limited to knowledge management, R&D, and marketing.

Most of the studies that have analysed the causes and consequences of the adoption of e-business have selected firms controlled by size-of operation and product mix of firms. Given the paucity of such studies in developing countries, we intend to analyse the factors that influenced the adoption of internal e-business technologies. Internal and external e-business technologies are discussed in Section 3. The main objectives of the study are:

- identification of clusters based on choice of technology
- to classify firms in each cluster
- to investigate factors that resulted in the adoption of a particular technology
- to analyse these factors within a multivariate analysis framework

The remainder of the paper is organised as follows. Section 2 presents data sources and information about sample surveys. Methodology and theoretical framework used in the study are discussed in Section 3, while hypotheses are formulated in Section 4. Statistical results are presented and analysed in Section 5. Findings of the study are summarised in Section 6.

2.0 DATA AND SAMPLE SURVEY

Data were collected from three developing countries, namely: Uganda, Nigeria, and India. However, their needs and capacity for technological absorption differ significantly, therefore, we analysis the data for each country separately. In addition, the intensity of adoption of e-business tools differs considerably in each country and for this reason, a common unit of analysis could not be used. Rather, once we have analysis for each country, a comparative perspective was carried out. Firm-level information for the year 2002 was collected through a semi-structured questionnaire between June 2002 and January 2003. Indian samples were collected from three sectors namely: garments manufacturing, electrical and electronic goods manufacturing, and auto-component manufacturing. Ugandan firms were selected from auto-component and food and beverages sectors, while engineering and electronic goods manufacturing sector dominated Nigerian sample firms.

Most of the garments manufacturing firms in India are export-oriented while the firms in the other two sectors were domestic market-oriented. The average employment in the garment sector firms was 227 persons while in auto-component manufacturing and electrical and electronic goods sectors were 188 and 90 employees respectively. The average size of operation of export-oriented sector was Rs. 1096.598 million whereas it was Rs. 1719.700 and Rs. 1025.543 million is auto-component and modern sectors respectively. The average size of employment of Indian firms was 167 workers and size of operation was Rs. 1266.204 million. Firms in Uganda and Nigeria did not report their market preference. The average size of employment in Uganda was much less compared to India and Nigeria. It was 2 persons in auto-component sector while on average there were only 4 persons employed in foods and beverages sector. The average size of employee reported by Ugandan firms was 3 persons. There were few firms that reported data for size of operation. Based on 11 firms' data the average size of operation was 1800 million Shilling in auto-component sector whereas it was 1600 million Shilling, based on 12 firms' data, in food processing sector. The average size of operation of Nigerian firms was 1.98 million Naira, while average size of employment was 9 persons.

The sample size of Indian firms were 79, 72, and 80 in garments manufacturing, auto-component, and electronic goods manufacturing sectors respectively. While we obtained data from 45 auto-component manufacturing Ugandan firms, the sample size of food and beverages sector was 39 firms. We collected data from 105 Nigerian firms.

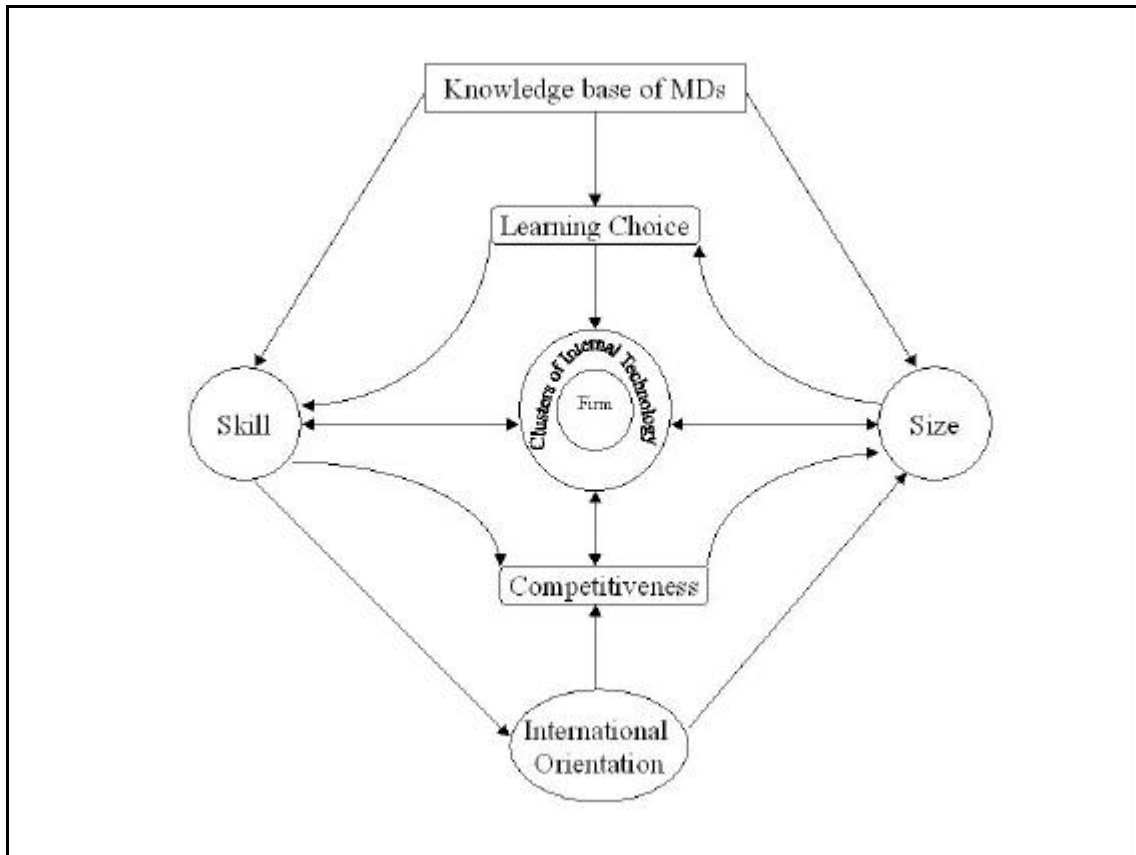
3.0 METHODOLOGY AND THEORETICAL FRAMEWORK

In this study, firms have been clustered depending on the e-business technologies that are internal to firms. To start with, we proceed by defining what we mean by internal and external technologies. E-business technologies are not stand-alone technologies. They have two components. One that are acquired, managed, and controlled by firms such as Personal Computers (PCs), servers, networking equipment and so on. These are called as internal technologies. There is another component without which internal e-business cannot function comprising mainly communication network available to the rest of society and firms alike. The management of communication network is beyond the control of individual firms and hence they are defined as external technologies. The internal e-business tools that are considered in this study are: TELEPHONE, MIS, EMAIL, INTERNET, CAD/CAM, CAE, and FMS.

A survey of firms at the country level revealed that the type of technology used varies significantly even after controlling for sectors. For instance e-business technologies used by electrical and electrical goods manufacturing sector in India are significantly different from the ones employed in Nigeria. In fact in Nigeria and Uganda several firms were using only the most rudimentary tools while some have exploited quite advanced ones. In view of this heterogeneity of technologies used by firms it was not possible to cluster all sample in two or three groups. Therefore, we have clustered firms in each country separately. Although firms have been grouped in three clusters in each country, the type of e-business technology in a cluster differs significantly from one country to another.

This analytical technique has been used to group firms in clusters. The statistical tool is used to identify relatively homogeneous group of firms based on selected characteristics, and the internal technologies employed. The algorithm requires information on the number of clusters. A composite index is computed based on the known characteristics. The criteria for convergence are such that the variance of the composite index within a cluster is minimum and between the clusters it is maximum. Finally cluster membership of each case is identified and stored. We have used cluster membership as a dependent variable in identifying the factors that led to the adoption of these internal technologies. The theoretical framework used in this study is presented in Figure 1.

Fig. 1: Theoretical Framework



The direction of the arrow represents the influence of the variables. It can be seen from Fig. 1 that the knowledge base of the managing director (MD) is a crucial factor. It is the knowledge base of MD's that decides the suitability of the workforce of their business. A technically knowledgeable manager is able to evaluate more accurately the kind of skills required for a particular business. The knowledge base of MD's affects the skill composition of the workforce. Learning modes such as formal training or learning by doing are also expected to be significantly influenced by MD's because qualified MD's are in a better position to assess the nature of training to be provided to existing workers. Firms with higher skill intensity and formally trained workers that have previously used new technologies are expected to adopt more advanced e-business technologies.

The adoption of new technologies is a function of the competitive environment in which a firm operates. The competitive environment in turn is affected by the skill intensity of firms and international orientation such as export intensity and technological collaboration with foreign firms. The Fig. 1 shows that competitiveness and international orientation influence the performance of a firm. Performance of firms and the choice of technology mutually reinforce

each other. It is shown in the figure that there is a circular relationship between adoption of new technologies and the other factors. In order to identify such relationships, time series data are required. Since our data is only for the year 2002, the choice of internal e-business technology will be analysed in a single equation framework.

4.0 HYPOTHESES

The Literature on new technology suggests that its diffusion depends on the existing technological capabilities and infrastructure in a country. However, there are certain common driving forces such as profitability, skills required for successful use of technology, market preferences of firms, and competitive environment. In what follows, general hypotheses about common factors have been formulated.

4.1 Educational Level of Managing Directors (EDU_MD)

The actual data on entrepreneurs' qualification were collected and it was converted on a three-point quantitative scale. In the case of India, undergraduates, graduates, and postgraduates were assigned the lowest rank, that is, 1 whereas managing directors with bachelor of engineering (BE) degree were given higher rank that, is, 2. A number of MD's had additional professional degrees such as master of business administration (MBA); this group have been given the highest rank, that is, 3. This type of quantification of MD's' education was not possible in the other two countries because the nomenclature of degree/diploma earned by MD's were totally different. In these countries, MD's with primary and secondary education were ranked as 1 while technical diploma holders were given rank 2. A postgraduate degree in science and a bachelor's degree in engineering are considered similar in Nigeria. Hence MD's with these qualifications were classified together and assigned the highest rank, that is, 3. There were few MD's that were science graduates; they have also been included in the last category. In effect, there are wide variations in formal educational qualifications across countries even though all the three are former British colonies with fairly similar educational system. The level of industrial development is a factor determining the skill workforce of the sectors including that of the chief executive of firms.

The importance of entrepreneurship has been given a pivotal place in Schumpeterian and neo-Schumpeterian literature of technological change. Empirically, the role of entrepreneurs' qualification has been analysed by many scholars. The findings of several studies (Earl, 1989; Cohen, 1995; Lal, 1996) suggest that entrepreneurs' knowledge and qualification play a very important role in influencing the degree of adoption of ICTs. Drawing upon the theoretical literature and findings of the several empirical studies, we expect that the academic qualification of MD's would play an important role in adopting internal e-business technology.

4.2 Skill Intensity (SKILL)

Like MD qualification the level of education of workers varies significantly among the three countries, it was therefore not possible to use a common definition of skill intensity. It has been proxied by the number of BE workers employed in India while the number of postgraduate degree holders has been taken as a measure of skill intensity in Uganda. Nigerian sample firms were drawn from the modern sector and for this reason, we employed the same proxy of skill as in India.

One of the implications of the adoption of new technologies particularly ICTs is the change in the skills composition of the workforce. Several studies (De Laine et al., 2000; Kolling and Schank, 2002; Sabourin, 2001) have examined the role of skilled workers as a determinant of adoption of advanced technologies. The study by De Laine et al. (2000) found that the proportion of skilled workers in total employment has increased in Australia since 1978. The authors conclude that there is a strong positive association between technological change and the share of employment of skilled workers. Kolling and Schank (2002) in their study of Germany and other OECD countries concluded that during 1994-1997 the technological change experienced in plants has been skill-biased. Sabourin (2001) found in the study of Canadian manufacturing firms that recent technological change has been led by communications technologies and controls system. Findings of the study suggest that new skills are required to work with new machines and new skills are required to manage ICT led production processes. In view of the theoretical and empirical evidence a positive relationship between adoption of new technology and skill intensity is hypothesised.

4.3 Value Added (VAL_ADD)

Value added has been measured as Rs. Million in Indian firms. The sample firms in other countries did not report data on value addition. Hence it was not included in the analysis. Theoretically the association between value addition and the adoption of new technologies should be positive. This is due the fact that new ICT-based production technologies allow modularity and flexibility in product designs that in turn might result in higher value addition. Higher value addition might result in garments manufacturing due to reduction in wastage of fabric and other raw material. Computerised marker making techniques are able to save fabric to a great extend. A study by Hoffman and Rush (1988) suggests that adoption of microprocessor based technologies can save up to 6 to 10% of the manufacturing costs. Since the sample firms consist of garments manufacturing firms, it is expected that firms that adopted more advance internal e-business technologies experienced higher value addition.

4.4 Size of firm (SIZE)

It was reported in Rs. million by Indian firms. Most of the firms in other two countries did not report sales turnover. Hence different measures of size were considered in different countries. Sales turnover was used as a proxy of size in the case of Indian firms while total number of workers represented the size in Uganda and Nigeria.

Size of operation is considered a major driving force behind any technological change or innovation by firms. Size of operation has implication for financial support for acquiring new technologies and adopting them successfully. Size of operation also has implication for the capacity utilisation of these technologies. This is a very crucial factor for small and medium sized enterprises (SMEs) who cannot afford capacity under utilisation of new technologies. There has been several studies (Siddharthan, 1992; Lall, 1983; Lal, 2002) found a positive relationship between innovative activities and size of operation of firms. Lal (2002) study suggests that size played an important role of new technologies in Indian SMEs. Size is hypothesised as a crucial factor that influenced decision of MD's of sample firms regarding acquisition of type of internal e-business technologies.

4.5 Export Intensity (EXPORTS)

Only Indian firms reported exports data, which was measured in Rs. million. The variable has been excluded from the analysis of Uganda and Nigeria. Conflicting findings with respect to exports and adoption on advanced technologies have been reported in the literature (Lal, 2002; De Laine et al., 2000). Lal (2002) did not find evidence to support the argument that export intensity influences the adoption of new technology, whereas De Laine et al. (2000) study concluded that the intensity of new technology adoption is positively associated with the export intensity in Australian firms. Several reasons have been cited for conflicting results. It is argued in the literature that firms do not always adopt advanced technologies to meet challenges in the international markets. If the domestic market is not protected, it becomes imperative for firms to upgrade technology for their survival in this market. In that case technological advancement may not be related to the export intensity of firms. Although the Indian market is no more a protected market, the entry of foreign firms in the SMEs sector is not very high. Firms that are operating in the domestic market may not be facing quality competition as severe as firms that are operating in international markets. Moreover, very advanced e-business technologies may be more beneficial to export-oriented firms. Hence, it is hypothesised that e-business technologies are positively related to the export performance of firms.

4.6 Profitability (PROFIT)

The profitability of firms has been computed as a percentage of profit after tax to sales turnover. The data on profitability were not reported in Uganda and Nigeria and hence the variable has been excluded from the analysis of these countries. An empirical study by Phan (2003) finds that Intel improved its position in profitability chain after implementing e-business solutions. It is expected that the use of e-business technologies is likely to reduce costs in activities other than manufacturing. This in turn should be reflected in higher profit margins. It is more likely to be true for SMEs where firms do not invest in any new technology unless they anticipate immediate returns on investments. Unlike large corporation, SMEs prefer to adopt technologies that have a lesser gestation period. In view of the fact that the sample firms in this study are SMEs, it is expected that higher profit margin is a driving force behind the adoption of e-business technologies.

4.7 Learning Opportunity Variables

Several developing countries have made efforts to modernise their manufacturing capacities by taking measures such as setting up export processing zones, and special economic zone. Setting up an industrial zone requires several other related activities. These are: easy access to financial market, availability of raw material, custom clearance for EPZ, and access to labour markets. Accessibility to labour markets can be attained by incorporating industrial training institutions within economic zones. Government of India for the last two decades has set up several economic zones with modern training institutions in different part of the country. This study aims to explore the effectiveness of formal training as well as on –the-job training. These two modes of training have been included in the analysis. Opinion of MD's on these variables has been measured on a binary scale. Rank 1 has been assigned to “important” and 0 otherwise.

4.7.1 Formal Training (TRAIN)

Formal training can be acquired by training institutions within and outside economic zones. The duration of training provided by institutions located in industrial zones is about one-two year while outside zones usually it is four-year degree course in India. The major difference between the two type of training lies in the nature of training. While training institute in industrial zone focus more on practical aspects of manufacturing, other institutes focus on theoretical aspects. As far as we know we are unaware of studies that investigated the impact of formal training of workers on the adoption of new technologies, and there have been even fewer studies that focussed on formal training and performance of firms. A recent study by Oyelaran-Oyeyinka (2004) explored the impact of formal training on performance of firms. The results of the study

suggest that firms that employed more formal trained workers performed better than others those employing largely informal training. Formal training in the efficient adoption and operation of e-business technology is increasingly more relevant because of its fast changing nature. Hence a positive relationship between the type of internal e-business technology adopted by firms and formal training is expected.

4.7.2 Learning by Doing (LEARN)

Another form of skill acquisition could be through learning by doing. This mode of skill acquisition is one of the most prevalent and in firms. Learning by doing form of training may not be very effective and useful where there is a paradigm shift in technological development. The technological change which was brought about by advances in ICTs is regarded as a paradigm shift. Therefore, theoretically learning by doing should not have significant impact on the adoption of e-business technologies. However, there are several activities in new manufacturing configurations that do not require formal training that progress rather by imitation. This study investigates the role of formal training in the adoption of ICT led technologies, it is expected that this form of skill acquisition might affect the adoption of internal e-business technologies.

4.8 Sources of Competitiveness

The last decade of the twentieth century was characterised as the era of liberalisation and globalisation. Almost every country made efforts in this direction. Conflicting arguments have been advanced for and against globalisation. Proponents of globalisation argue that the process will lead to factor-price equalisation and access to product and services produced anywhere in the world. Opponents suggest that the process will result in exit of small firms in developing countries, as they are not capable of competing with large multinational corporations that have access to very advanced technologies. Irrespective of positive and negative aspects of globalisation, the process is on and has induced competitiveness in domestic as well as international markets. In order to assess the impact of competitiveness on the adoption of e-business technologies, few sources have been analysed in this study. The sources of competitiveness were measured on a five-point scale in the form of opinion expressed by MD's of firms. The value "5" means a particular source is most important and 1 means it is not important.

4.8.1 R&D activities (R&D)

The sample firms did not have the kind of resources to establish their own R&D units outside of the production shop floor. However, several firms, possessed the capability to make appropriate changes in product designs. For instance, in garments manufacturing designs of products are changed every season particularly in international markets. It may be difficult for firms to survive in export markets if they are not capable of implementing new designs. This means that firms engage in some forms of innovative activities in order to remain competitive. For electrical and electronic goods sector, products are altered very frequently and new design features are added. Many times the changes require the reconfiguration of manufacturing processes. Hence firms in this sector need to be innovative to accommodate the changes in product designs. Production technologies based on ICTs allow the reconfiguration of production processes. We hypothesize that MD's of firms that adopted more advanced internal e-business technology assign higher weight to innovative activities.

4.8.2 Brand Name (BN)

It is generally perceived that brand name is not very important for small-scale enterprises. Sample firms, however, might assign importance to brand name. In auto component and garments sectors, firms were usually suppliers of final product manufacturing company or departmental store. In both the cases, firms do not have any incentive to giving importance to brand names. However, during the survey it was noticed that few firms were supplying auto component to several companies in their own brand name. The MD's of such firms were of the opinion that brand name was important for them. In electrical and electronic goods sector, several firms were manufacturing final products. Brand name is expected to be important for such firms. Given the characteristics of sample firms, it is expected that MD's who assigned high importance to brand name adopted more advanced e-business technologies.

4.8.3 Technological collaboration with foreign firms (TEC_COL)

Access to latest technologies is very crucial for firms to remain competitive. Technological collaboration with foreign firms is one way to access new technologies. Technological collaboration with foreign firms has been made much simpler in almost every country for the last one decade as a fallout of liberalisation. It may not be imperative only for export-oriented firms but equally important for firms dealing in the domestic market. Several scholars (Stiglitz, 1989; Evans and Wurster, 1997) have emphasised that ICTs play an important role in exchanging information, knowledge, and product designs between manufacturers and suppliers

of technology. One of the major contributions of ICTs in the business environment is the better co-ordination of manufacturing activities. Hence a positive relationship between types of internal e-business tools adopted by firms and technological collaboration is hypothesised.

5.0 STATISTICAL RESULTS

It was not possible to analyse all the three countries data together due to differences in unit of measurement of financial data. As indicated in Section 3, cluster analysis was used to group sample firms based on internal e-business technology used by them. After identifying cluster number of each firm, the data were analysed using ordered probit regression analysis. Ordered probit was used because the dependent variable, i. e. cluster number, is a discrete and ordinal variable. Firms were divided into three clusters in each country. These are labelled as basic e-business tool using firms, moderate users, and advanced e-business technology using firms. Although firms in all the countries have been clustered in three groups, the type of internal e-business technology used by firms in each country differ significantly. For instance, the three clusters for Indian firms are: email and MIS, URL and CAD/CAM, and portal using firms whereas telephone users, MIS, and email and Internet using firms form three clusters in Ugandan firms. Three groups of internal e-business technologies used by Nigerian firms were telephone, MIS and email, and FMS, CAD/CAM and Internet.

The analysis of Indian firms is presented in Tables 1 and 2 while Tables 3 and 4 present the results of Ugandan data. Descriptive statistics and probit analysis results are presented in Tables 5 and 6 for Nigerian firms.

5.1 Indian firms

Univariate analysis of the variables discussed in Section 4 are presented in Table 1. Mean value of variables classified by their cluster characteristics along with chi-square statistics and level of significance are shown in the table. It is shown that MD's education, skill intensity of firms, size of operation are significantly associated with the type of e-business technology adopted by firms.

Table I: Descriptive statistics of variables (Indian firms)

Intensity of e-business adopted →	Low level of e-business using firms	Moderate users	Advanced e-business using firms	Chi-square Statistics	Sig.
Variables					
Owner's Education	1.348	1.957	2.083	43.116	0.000
Skill intensity	0.880	2.087	4.625	105.285	0.000
Value addition	182.621	405.425	926.211	462.000	0.465
Size of operation	850.400	1811.022	3931.917	429.219	0.015
Exports	698.645	1067.786	2140.463	106.000	0.228
Profitability	7.408	8.668	10.538	377.593	0.167
Learning process					
Training	1.375	1.652	1.375	6.213	0.184
Learning by doing	2.071	2.00	2.208	3.544	0.896
Sources of Competitiveness					
R&D	1.913	2.174	2.042	5.755	0.675
Band name	2.022	1.652	2.375	5.938	0.654

Note: Figures in columns 2, 3, and 4 are mean values of variables.

The results presented in Table 1 suggest that other variables were not significantly associated with the level of e-business technology adopted by firms. Subsequently the data were analysed in multivariate framework. The results presented in Table 2 show four specifications of the probit model. We had to estimate four equations because of multicollinearity among independent variables. As can be seen from theoretical framework, several variables used in the analysis reinforce each other.

The parameter estimates and corresponding t-statistics of the variable included in Eq. I suggest that the three variables; namely: skill intensity, export intensity, and profitability emerged significant in influencing the intensity of technology adopted by firms. After dropping these variables and size of operation in Eq. II, value addition also emerged significant. The results of Eq. III and IV suggest that MD's education and size of operation are also crucial determinants of e-business technology adoption. The results of the analysis of Indian firms suggest that types of learning processes and sources of competitiveness did not influence the use of internal e-business technology. One of the possible reasons for learning processes being insignificant could be the availability of large numbers of private training institutes that focus on practical training as well as work experience in form of apprenticeship. It is mandatory for training institutions, which provide industrial training, to attach trainees with a firm in the last year of training. Keeping in mind this aspect of learning process, MD's of Indian firms might have shared the same opinion about learning processes. In the test, the learning process has not emerged significant. Two sources of competitiveness, i.e., R&D activities and brand name were included in the analysis. The opinion of MD's on sources of competitiveness does not vary

significantly across cluster of firms. The possible reason could be that firms may be suppliers of main companies and hence these sources of competitiveness are not relevant for them.

Table II: Determinants of adoption of e-business in Indian firms

Dependent variable: Intensity of e-business adoption				
Equations	I	II	III	IV
Independent Variables				
1. Owner's Education	0.2428 (1.196)	0.1086 (0.712)	0.1856 (1.285)	0.7042 *** (5.605)
2. Skill intensity	0.3224 *** (2.955)			
3. Value addition	-0.0009 (-.298)	0.0038 *** (6.528)		
4. Size of operation	0.0006 (1.040)		0.0008 *** (6.195)	
5. Exports	0.0006 *** (4.282)			
6. Profitability	0.1350 ** (2.557)			
7. Learning process				
Training	0.3652 (1.342)	0.1892 (0.868)	0.1915 (0.906)	0.2062 (1.046)
Learning by doing	.0589 (0.533)	0.0052 (0.061)	-0.0006 (-0.007)	-0.0244 (-0.337)
8. Sources of Competitiveness				
R&D	-.0219 (-0.222)	0.0379 (0.450)	0.0329 (0.392)	0.0511 (0.661)
Band name	.0298 (0.257)	-0.0282 (-0.359)	0.0005 (0.007)	0.0749 (0.998)
Log Likelihood Function	-77.3864	-99.2534	-101.6262	-132.4832
Significance	0.000	0.0000	0.0000	0.0000

Note: *** → Significant at 1 %; and ** → at 5 %; Figures in parenthesis are t-values.

Emergence of MD's education as a significant determinant of the adoption of new technologies is in accordance with Schumpeterian and neo-Schumpeterian literature. MD's with appropriate qualification and skills are in a better position to assess the type of technology to be adopted. They are also aware of the potential benefits of new technologies more precisely than others. MD's qualification is more important in technology-intensive sectors such as electrical and electronic goods and auto component manufacturing because internal e-business technologies are very complex in these sectors compared to labour-intensive sector. The emergence of MD's qualification as an important determinant in adopting intensity of e-business technologies supports the hypothesis of the study.

The results show that skill intensity significantly influences the choice of technology. Recent technological changes in ICTs are regarded as skill-biased (Kolling and Schank, 2002; Doms et al., 1997). The main reason for a skilled workforce in managing ICT led production process is the versatility and programmability characteristics of these technologies. In this skill-based regime, a worker needs to understand how to change parameters of an assembly line, without recourse to superiors. For instance, different parameters of an assembly line are needed for manufacturing different type of printed circuit board (PCBs) in electronic goods manufacturing sector. The emergence of skill as an important determinant of e-business technology adoption is in accordance of existing literature and the hypothesis of the study.

The study also finds evidence to support the argument that adoption of e-business technologies results in higher value addition. Major source of higher value addition could be the reduction in wastage of input particularly in the garments sector. In other sectors it might be due to efficient production processes. For instance, ICT led production technologies allow the use of more advanced integrated circuit (Very Large Scale Integrated) compared to manual assembly lines. Use of VLSI in electronic sectors is expected to contribute to higher value addition. The study findings also support the hypothesis of the study that size of operations has bearing on the adoption of new technologies.

Results presented in Table 2 suggest that export intensity and profitability significantly influenced the degree of adoption of internal e-business technologies. The findings are in line with the existing literature. One of the reasons for export being a determinant of e-business technologies could be the presence of garment manufacturing firms. Majority of sample firms in this sector are export-oriented. It is imperative for such firms to adopt new technologies so that they can incorporate the changes in designs without much reconfiguring production processes. This kind of flexibility is achieved in production processes with the use ICT led technologies. Profitability is associated with exports because usually profit margins in international markets are higher than in the domestic market. Results are supportive of other studies (Lal, 2002; De Laine et al., 2000).

5.2 Ugandan firms

The descriptive statistics of the variables along with measure of association with intensity of the adoption of e-business technologies in Ugandan firms are presented in Table 3. The table does not report the role that financial variables played in influencing the use of new technologies. This is because there were very few firms that provided data on sales turnover and profitability. It can be seen from the table that academic qualification of MD's did not emerge significant.

Table III: Descriptive statistics of variables (Ugandan firms)

Intensity of e-business adopted →	Low level of e-business using firms	Moderate users	Advanced e-business using firms	Chi-square Statistics	Sig.
Variables					
Owner's Education	1.7	1.6	2.0	2.152	0.708
Skill intensity		0.130	0.429	20.971	0.000
Size	2.257	5.783	4.286	40.407	0.001
Profitability		52.200	93.795	23.112	0.000
Learning process					
Training	0.003	0.947	0.857	46.692	0.000
Sources of Competitiveness					
Technological collaboration	1.424	3.522	2.286	39.667	0.000

Note: Figures in columns 2, 3, and 4 are mean values of variables.

In contradistinction with the result of Indian sample firms, opinion variables have been important in the selection of new technologies. Subsequently data were analysed in multivariate framework. Like India firms, it was unavoidable to use four specifications of the probit model, which results more or less substantiate the findings of the univariate analysis. The results are presented in Table 4.

Table 4 shows that managing directors' education is immaterial in types and the degree of adoption of internal e-business technologies. This is not only contrary to existing literature of entrepreneurship and innovation but also rejects the hypothesis of the study. This phenomenon can be attributed to the characteristics of Ugandan firms. The sample firms are from the auto-component manufacturing and food and beverages sectors. Although auto component manufacturing is not a low-technology sector, the sample firms involved manufactured products that require low technology. These products are largely fabricated metal doors, windows, gates and exhaust pipe welding and for this purpose e-business technology tools adopted by firms are very basic. The potential benefits of these tools are well known and need not be assessed before they are adopted. Hence the education level of MD's did not play any role in selecting e-business tools.

Table IV: Determinants of adoption of e-business in Ugandan firms

Dependent variable: Intensity of e-business adoption				
Equations	I	II	III	IV
Independent Variables				
1. Owner's Education	-0.0004 (-.488)			
2. Skill intensity	1.5709 *** (4.504)			
3. Size	0.0558 (0.687)	0.1675 *** (2.635)		
4. Profitability	0.0008 (0.803)		0.0012 ** (1.926)	
5. Learning process Training	0.0003 (0.373)			2.6619 *** (7.034)
6. Sources of Competitiveness				
Technological Collaboration	0.3219 * (1.829)			
Log Likelihood Function	-41.9985	-55.1381	-55.0612	-31.1559
Significance	0.0000	0.0003	0.0002	0.0000

Note: *** → Significant at 1 %; and **→ at 5 %; *→ at 10%; Figures in parenthesis are t-values.

The variables that have significantly affected the adoption of internal e-business technologies are: skill intensity, size, profitability, learning process, and technological collaboration with foreign firms. Although the emergence of skill intensity as an important factor confirms hypothesis of the study, it is surprising because firms were using e-business tools in peripheral activities. One of the possible explanations could be that many of the sample firms were suppliers of auto manufacturing companies, that need to co-ordinate effectively with their buyers. Consequently they might have employed more qualified persons for not only using e-business tools effectively but also for producing better quality components.

Results presented in Table 4 also show that the profitability of firms that adopted more advanced tools is higher than others. This could be because of the combination of the two industrial sectors, namely food and beverages, considered labour intensive and auto-component, which is capital intensive. The literature on profitability and new technologies suggests that profitability of firms that adopt new technologies in core activities might be higher than those that adopt them in peripheral activities. Since none of the sample firms were using new technologies in core activities, sector-specific characteristics might have resulted in this behaviour. Another possibility could be that

better co-ordination with suppliers and buyers might have resulted in higher profitability in firms that were using email and Internet.

The findings of the study are unique in terms of learning processes and technological collaboration with foreign firms. Although most of the sample firms did not provide data on market preferences, it appears that firms engage in technological collaboration to improve performance in international markets. Apparently firms adopted e-business tools that facilitated business co-ordination. The results support the hypothesis of the study. There are a number of firms owned by individuals with considerable business links with groups outside the country. These links constitute avenues for the acquisition and learning relatively more advanced technologies. Another group are foreign nationals and their partners who are establishing ICT-based businesses in the country based on the perceived lacuna in the local knowledge base. These and other developments such as training in ICTs use by international NGOs open up opportunities for firms to learn.

5.3 Nigeria

The univariate analysis of Nigerian firms is presented in Table 5, and quite clearly the results are different from the other two countries. Despite the fact that Nigerian sample firms were selected from a knowledge and capital-intensive sector, academic qualification of MD's did not emerge significant in influencing their technological choice.

Table V: Descriptive statistics of variables (Nigerian firms)

Intensity of e-business adopted →	Low level of e-business using firms	Moderate users	Advanced e-business using firms	Chi-square Statistics	Sig.
Variables					
Owner's Education	2.35	2.80	2.50	4.497	0.343
Skill intensity	0.97	1.83	4.00	36.748	0.000
Size	7.8	12.5	12.5	58.428	0.010
Reason for e-business adoption					
Internal competition	1.53	2.0	1.0	3.302	0.509
Learning process					
Training	0.42	0.91	1.0	8.260	0.016

Note: Figures in columns 2, 3, and 4 are mean values of variables.

The univariate analysis results also suggest that internal competitive environment had no effect on the adoption of new technologies. Like India and Uganda, data for Nigeria were also analysed using ordered probit analysis. The results are presented in Table 6. Four different specifications of the probit model were tried for the same reasons given earlier. The results of the multivariate analysis are somewhat different from the univariate analysis.

Table VI: Determinants of adoption of e-business in Nigerian firms

Dependent variable: Intensity of e-business adoption				
Equations	I	II	III	IV
Independent Variables				
1. Owner's Education	0.0005 (1.003)		0.0008 * (1.900)	
2. Skill intensity	0.3468 ** (2.263)			
3. Size	-0.0004 (-0.011)			
4. Reason for e-business adoption				
Internal competition		0.0008 * (1.902)		
5. Learning process				
Training				1.5659 *** (2.737)
Log Likelihood Function	-29.7843	-33.0439	-32.8629	-21.5664
Significance	0.0145	0.0448	0.0362	0.0020

Note: *** → Significant at 1 %; and ** → at 5 %; * → at 10%; Figures in parenthesis are t-values.

From the table, MD's qualification emerged significant though the level of significance remains at 10%. Other factors that have influenced different levels of adoption of internal e-business technologies are: skill intensity, domestic competitive pressure, and learning processes. The one surprising result is that size has not played any role in influencing the degree of adoption of new technologies. The emergence of MD's academic qualification as a significant factor is not only in line with existing literature but also supports the hypotheses of the study. Since the Nigerian sample was taken from engineering and electronic goods manufacturing, the e-business tools are used in both peripheral and core activities. This places a demand on the MDs to be aware of the intricacies of e-business tools in order that potential the benefits are fully reaped.

The analysis of the Nigerian data suggests that skill intensity significantly influenced the adoption of e-business. Arguments that were advanced in case of Indian firms might be extended to justify the emergence of skill intensity as a significant factor in Nigeria also. The results also show that the internal competitive environment also influenced the different levels of e-business technology adoption. This might be due to the relatively large number of foreign

firms operating in Nigeria in this sector. These foreign firms are usually equipped with considerable tacit advantages and are in a better position to compete in developing countries. Local firms in Nigeria might have strengthened their competitiveness by adopting more advanced e-business tools. The finding supports the argument that the adoption of new technologies is not always aimed at external competitiveness.

Local private ICT firms have taken advantage of the vast market particularly in the big metropolis such as Lagos and Ibadan where much of the sample firms are based. Firms require internal capability upgrading in the use of new technologies in order to raise product quality and in the mastery of simple process techniques that are increasingly requiring computer enabled precision. Ordinarily firms approach several organizations for their diverse requirements because the range of services required in firms could not be provided by one service provider. In ideal situations, multiple sources of support, such as productivity centres, RDIs and universities as well as consulting organizations should be available. The limiting factor is as much the few numbers of training centres as it is the resources and capability of the available training centres and firms themselves. To some extent firms need to develop a level of internal assets depending on the scale of their operation as we earlier observed. The idiosyncratic nature of firm-level process tends to put a limit on the relevance of external resource centres in all but the most exceptional cases.

5.4 Comparative Analysis

The statistical results presented in Sections 5 suggest that sector-specific factors significantly influence the degree of adoption of internal e-business technologies. For instance, the type of e-business technology adopted by higher technology sector such as electrical electronic goods manufacturing is highly influenced by the knowledge base and qualification of MD's. However, the emergence of MD's skill in Indian sample firms draw largely from garments manufacturing, which is a labour intensive, suggests that the role MD's knowledge become important when a firm adopt more advanced technologies. Another contrast in the findings of Indian and Ugandan firms is that MD's knowledge was important in auto component sector in India while it was insignificant in case of Uganda. We suggest that this is also because Ugandan firms use e-business technologies for peripheral activities whereas Indian firms adopted in core functions also. Again the level of technology corresponds with the complexity and sophistication of products. While Indian firms are engaged in relatively higher quality export products, the Ugandan firms produce low-level products for the domestic market.

The skill intensity of firms have emerged significant in all the three countries which implies that one of the prerequisites of the successful adoption of e-business technologies is the knowledge

and ability of users of new technologies. Comparative analysis also suggests that country-specific factors also resulted in varying degree of e-business adoption. For instance, learning processes and sources of competitiveness were irrelevant for Indian firms while they were highly significant in influencing the e-business adoption pattern in Uganda and Nigeria. This could be reflection of technological and human development infrastructure present in these countries. Another contrast is that MD's of Ugandan assigned more importance to technological collaboration with foreign firms while it was not important for MD's of Nigerian firms.

Financial variables such as size of operation, export intensity, value addition have emerged significant only in Indian sample firms. Profitability was important in India as well as Uganda. This is not to suggest that financial variables were unimportant in other two countries. In fact they were not included in the analysis due to very limited availability of data in Ugandan and Nigerian firms. Availability of financial information might reveal more precise assessment of their importance on the adoption of internal e-business technologies.

6.0 SUMMARY AND CONCLUSION

The study identifies and analyses the factors that were determinants of the intensity of the adoption of internal e-business technologies. A distinction is made between external and internal e-business technologies. The external technologies are those that are needed for e-business but beyond control of individual firms. Whereas internal e-business technologies are those that are acquired, implemented, and managed by firms. The data for the study come from three developing countries; namely: India, Uganda, and Nigeria. Sample firms belong to electrical and electronic goods manufacturing, garments manufacturing, auto component manufacturing, and food and beverages sectors. The survey was conducted during June 2002 and January 2003. All the sample firms fall in the category of small and medium sized enterprises.

Data for each country were analysed separately. Two tiers of analytical techniques, i.e. cluster analysis and ordered probit analysis were used to identify the determinants of adoption of internal e-business technologies. Sample firms were first grouped into three clusters, i. e., low, moderate, and advanced technology users. Clustering of firms is based on the type of internal e-business technology adopted by firms. Each firm was assigned a number that represented a cluster identification to which a firm belongs. This was used as independent variable in ordered probit analysis. Financial and other firm-specific variables were included in the analysis.

The variables that emerged significant in influencing the intensity of e-business technology differ from one country to another. For instance, the determinants of e-business adoption in Indian firms were size of operation, export performance, profitability, value addition, skill intensity, and academic qualification of managing directors. On the other hand, the intensity of e-business adoption in Ugandan firms was influenced by skill intensity, size, profitability, learning processes, and technological collaboration with foreign firms. The factors that emerged significant in affecting Nigerian firms are: knowledge base and academic qualification of managing director, skill intensity, internal competition, and learning opportunities.

Findings of the study reflect the existence of technological infrastructure and human skills and capabilities present in each country. For instance, fairly good network of training institutions is present in various economic zones that have been set up for the last two decades in various part of India. That might be the reason that managing directors of Indian firms did not assign much importance to training opportunities. This may not be the case in Uganda but less so in Nigeria where a vibrant private ICTs business services sector has emerged although less advanced and organized than India. One of the major implications of study is the required emphasis on formal

training in addition to on-the- job training. This can be achieved through private-government partnership. Governments can provide logistic support to private institutions to set up training centres in industrial clusters. The advantage of having training centres in close proximity of manufacturing firms is to facilitate practical training to trainees.

Another implication of the study is the need to provide technological and marketing support to firms in developing countries so that they compete in international markets. This can be achieved by setting up export promotion councils separately for each sector. Export promotion councils can help small firms in exhibiting their products, providing information on markets trend, and by tendering legal services in case of disputes. Export promotion councils can play a major role in augmenting export performance by acquisition and implementation of latest manufacturing technologies. Some measures need to be taken to encourage competitive in domestic markets. Strengthening competitiveness in domestic market is expected to have impact on global competitiveness of firms.

As discussed in theoretical framework, there are bi-directional relationships among several factors that emerged significant determinant of e-business technology adoption. The study has not been able to identify all the causal relationships due to lack of time series data. Needless to mention that simultaneous equations model are more appropriate for those situations. It may be noted the study has identified the factors that influenced one component of e-business technologies. Further research is needed to identify and analyse the determinants of external e-business technologies.

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