# AN INVESTIGATION INTO THE USE OF ICT IN THE NIGERIAN CONSTRUCTION INDUSTRY

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***SUMMARY:*** *The 2002 global ICT rankings by the International Telecommunications Union (ITU) ranked Nigeria 27th among 51 African countries and 153rd among 178 countries in the world. It was against this background that the paper investigated the state of ICT in the Nigerian construction industry to highlight the level of ICT penetration, its impact in the industry and the constraints to its adoption. The study identified the factors significantly impacting the level of ICT use, grouping them into those internal to the industry and those external to it. A total of 136 respondents to a questionnaire survey, comprising, contractors, consultants and academic researchers, provided empirical data for the analysis. The results showed that some internal factors, i.e., the type of business (whether contracting, consulting or academic), chief executive officers (CEOs)/senior managers' perception of the benefits of ICT and the years of computer literacy of the CEOs/senior managers were significantly correlated with the level of ICT use in the industry. However, none of the external factors were significantly correlated with the level of ICT use. The main uses of ICT in the industry are word processing, Internet communications, costing and work scheduling. The top five constraints to the use of ICT are insufficient/irregular power supply, high cost of ICT software and hardware, low job order for firms, fear of virus attacks and high rate of obsolescence of ICT software and hardware. A comparison with the results of similar studies in some industrialised and newly industrialised countries indicated that the proportion of firms using the computer is quite high for a developing like Nigeria. It also highlighted the large gap in access to electricity and other communications infrastructure between developed and developing countries.*

***KEYWORDS****: Information and communications technology, construction industry, Nigeria, international comparisons.*

## 1. INTRODUCTION

A major construction process demands heavy exchange of data and information between project participants on a daily basis (Maqsood *et al*., 2004). This makes the construction industry one of the most information-intensive industries, and requires close coordination among a large number of specialized but interdependent organizations and individuals to achieve the cost, time and quality goals of a construction project (Toole, 2003). ICT has been shown to be a vital tool in assisting the construction industry to cope with the increasing complexity of its products as well as the increasing demands of its clients and regulators (Betts, 1999), and to enhance construction productivity (Liston *et al.,* 2000). To assess the impact of ICT on construction in this regard, surveys on the use of ICT in the construction industries of various countries in different parts of the world have been carried out in recent times. They include surveys conducted in Canada in 1999 (Rivard, 2000), South Africa in 2000 (Arif & Karam, 2001), Sweden in 2000, Denmark in 2001 (Samuelson, 2002), Malaysia in 2001 (Lim *et al*, 2002), Turkey in 2001 (Sarshar & Isikdag, 2004) and Singapore in 2003, (Goh, 2005). Some of these surveys were based on modified versions of the IT Barometer survey instrument, which was originally developed for the Swedish construction industry in 1997.

While most of these surveys have been carried out in highly developed European countries and Asian "Tiger" economies, only the South African survey by Arif & Karam (2001) represents an emerging economy in Africa. This study attempts to bridge some of this gap by examining the state of ICT use of the construction industry of Nigeria, the second largest economy in Africa.

## 2. THE NEED FOR AND CURRENT USE OF ICT IN THE CONSTRUCTION INDUSTRY

The construction project chain is a lengthy process initiated and driven by the project promoter (client). According to Murray *et al* (2001), depending on the type of project, the chain may involve large numbers of skilled professionals and companies with, quite often, much repetition of activities and accumulation of paperwork. The main project participants in a typical construction project in Nigeria are the client and his/her team of professional advisers (consultants) on the one hand and the main contractor, subcontractors and suppliers on the other. Fig. 1 shows that the various participants deal with similar information, therefore that information needs to be passed along the chain from team to team. Thus, according to Murray *et al* (2001), the majority of the participants require access to the majority of the project information at one time or another.

| | **ROLE PLAYERS** | | | | | |
|---|---|---|---|---|---|---|
| **DOCUMENTS** | Client | Architect | Quantity surveyor | Engineers | Contractor | Subcontractors and suppliers |
| Drawings | o | • | o | • | • | o |
| Specifications | o | • | o | • | o | o |
| Bills of quantities | | o | • | • | o | o |
| Budget | o | o | • | o | o | o |
| Contracts | o | o | • | • | • | |
| Planning | o | o | • | • | • | • |
| Personnel control | | | • | o | • | • |
| Materials control | | | • | o | • | • |
| Equipment control | | | • | o | • | • |

**LEGEND**

• **-Produces documents** o **–Requires information from document**

*FIG. 1: Information Producer-User Matrix for a Typical Project Chain - Source: Adopted from Murray et al (2001)*

The construction industry is currently experiencing a paradigm shift from traditional paper-based to digitally based information exchange, which other industries such as aircraft manufacturing and banking have adopted and benefited from long ago (Rivard *et al*., 2004). This shift has been aided to a large extent by the drastic reduction in computer hardware and software prices and the increased power, usefulness and popularity of computers over the last few years (Rivard *et al*., 2004). As more and more computers are connected through the Internet to form the worldwide web, thus allowing firms located on different streets or in different cities, provinces, countries, or even continents to readily exchange information, the reach and benefits of ICT to industries and organizations have indeed become global.

The use of ICT can impact on the traditional processes of organization in construction and result in change in organisational processes, working methods and culture (Ruikar *et al*., 2005). In this regard, some benefits of ICT critical to the performance of the construction industry are to reduce the time for data processing and communicating information, and to improve communications for effective decision-making and coordination among construction participants (Peansupap & Walker, 2005) to enhance construction productivity (Liston *et al*, 2000). This is possible because the Internet-based tools of ICT allow communication between even remote users and enables them to share files, comment on changes and post requests for information (De Lapp *et al*., 2004).

The common types of software used in construction include word processing, spreadsheet, CAD and Internet software (Goh, 2005). These software are used for administration, communication, marketing, desktop publishing, presentation and project management (Doherty, 1997; Arif & Karam, 2001). While architects, engineers and contractors use CAD mostly for design, drawing and presentation (Rivard, 2000; Arif & Karam, 2001; De Lapp *et al*., 2004), quantity surveyors use it for measurement, preparation of bills of quantities, estimating and presentation. The engineering analysis software for specific branches of engineering includes

Microstran, and MathCad (Doherty, 1997). With 3D modeling capacity in modern structural design software, designing complex structures is now facilitated where previously this was almost impossible (Walker & Hampson, 2003). For quantity surveying, there are WinQS32, QS Plus2001, QsCAD, CATO, and Masterbill among others (Willis *et al*., 1994; Adetola, 1998; Murray *et al*., 2001), which not only speed up but also enhance the accuracy of quantity surveying functions from approximate estimating to final accounts. A detailed description of many of the available software for architects, engineers, quantity surveyors and contractors can be found in Murray *et al*. (2001).

In addition to these applications of ICT to what may be termed the traditional domains of the construction industry, there are some emerging new areas of ICT innovations. They include knowledge management (KM), electronic document management (EDM) and e-business. ICT facilitates the transfer of knowledge and information between project teams, enabling the development of new knowledge for innovation (Gann, 2000). The development of an EDM system for project management can save considerable time and cost for document transfer (Tam, 1999); while e-business provides an efficient infrastructure for remote consulting services to consultants and contractors who desire to provide their services through the Internet (Mangini & Pelli, 2003). Details of the applications of KM can be found in Egbu *et al*. (2001) and Egbu & Botterill (2002), those of EDM in Tam (1999, Björk (2002), Sulankivi *et al*. (2002), and Bäckblom *et al* (2003*)* and those for e-business in Issa *et al*. (2003), Mangini & Pelli (2003) and Rivard *et al.* (2004).

## 3. THE CONSTRUCTION INDUSTRY IN NIGERIA

Construction contributes some 7% of the GDP in most OECD countries and up to 12 to 14% in Japan and Korea (Gann, 2000), while in developing countries (according to Dharwadker, 1979) investments in construction projects could be as high as 50-60% of national budgets. In Nigeria, the construction industry was the dominant contributor to the nation's GDP in the 1980s, accounting for about 70% of the GDP (Planning Committee on the National Construction Policy, 1989). This made the industry very strategic to Nigeria's development efforts. Unfortunately, however, the industry has been bedevilled by a combination of low demand and consistent low productivity and poor performance over the years (Olomolaiye, 1987; Aniekwu, 1995; Okuwoga, 1998; Adeyemi *et al.*; 2005). This has reduced its contribution to the national economy to a mere 1% of the GDP in 2002 (AfDB/OECD, 2004).

The industry is made up of an organised formal sector and an unorganised informal sector. The formal sector comprises foreign and indigenous companies, which are classified into small, medium and large scale according to their level of capitalisation and annual turnover. The few large firms (mostly foreign), which constitute just about 5% of the total number of contractors in the formal sector, control about 95% of the construction market, giving the small firms just about 5% share of the market.

## 4. THE SURVEY

The 2002 global ICT rankings by the International Telecommunications Union (ITU, 2003) ranked Nigeria very low as 27$^{th}$ among 51 African countries and 153$^{rd}$ among 178 countries in the world. Following these rankings, Oladapo (2006) has reported that the construction industry in Nigeria has during the past few years increased its use of ICT. However, very little is known about the impact of the technology on the industry and the prospects for its widespread penetration of the industry. This is because very few reports exist of research in ICT in developing countries, including Nigeria (Pamulu & Bhuta, 2004). Against this background, the objectives of the survey were to

- Assess the use and impact of ICT,
- Evaluate the factors influencing the adoption and use of ICT and
- Highlight the obstacles to and the prospects for its use in the Nigerian construction industry.

To achieve these objectives, the survey investigated the availability and use of computer hardware and software as well as communication systems among construction firms and architectural, engineering and quantity surveying consultants.

For the purpose of this study, the factors influencing the use of ICT were grouped into those internal to the industry and those external to it. The internal factors were classified (according to Chieochan *et al*., 2000) into organisational characteristics (including the type of business, size, ownership and age of the firm) and management characteristics (including the academic qualifications, years of professional experience and

computer literacy, form of computer training, level of computer literacy and the attitudes of CEO/senior managers to ICT). The external factors were classified into general political, economic and social factors (including infrastructure such as power supply and the availability/affordability of ICT software and hardware), and specific factors such as customer/client and supplier demands as well as the influence of competition and technological demands.

## 4.1 Study Methodology

The study utilised a modified form of the IT barometer questionnaire used in the studies referred to earlier. A questionnaire survey of contractors, architectural, engineering and quantity surveying consultants, and academic researchers was carried out between June and September 2005 in South West Nigeria where the majority of the consultants and contractors are based. The questionnaire used a five-point Likert-type scale to measure a range of opinions from "Very weak" to "Very strong", "Very low" to "Very high", etc. as the case may be. The significant agreement or otherwise with the notion being tested was determined by adopting the mid-point value of the index (that is 3) as the hypothesized mean (Coakes and Steed, 2001). This implies that any result significantly different from this uncommitted or unsure value was assumed to be either positive or negative to the notion being tested (Pullin and Haidar, 2003).

A sample size of 210 comprising construction firms, architectural, engineering and quantity surveying consultants, and academics randomly chosen was used to ensure a confidence level of at least 99% in accordance with the recommendations of Rea & Parker (1997). Out of the 210 questionnaires distributed by hand, 141 were retrieved. Five (5) of the returns were found to be too badly completed to be useful for the analysis and were therefore discarded**.** This brought the responses effectively to 136, representing a response rate of 64.8%. This response rate is considered adequate as, according to Ellhag and Boussabaine (1999) and Idrus & Newman (2002), a response rate of 30% is good enough in construction studies. The data were analysed using the percentile method, mean score ranking, correlation analysis and the importance index. Correlation was used instead of regression because the purpose of the analysis was not prediction but simply to show the relationship between ordinal dependent and independent variables (Tabachnick & Fidell, 1996). The formula for the importance index is given by El-Haram & Horner (2002) as follows:

$$\text{Importance index} = \left(\sum_{i=1}^{5} w_i \times f_{xi}\right) \times \frac{100}{5n} \qquad (1)$$

where $w_i$ is weight given to $i$th response; $i$= 1, 2, 3, 4, or 5 is response frequency; $f_{x1}$ = very weak/low, and $f_{x5}$ = very strong/high and $n$ is total number of responses.

## 4.2 Respondents' Profiles

The majority of the respondents' organisations (53.8%) have been in existence for over 20 years and were therefore well established. Only 18.5% have existed for less than 10 years. Most of the respondents (61.5%) have been in their organisations for more than 5 years. This indicates that the respondents were very familiar with their organisations and were well placed to provide useful data for the survey.

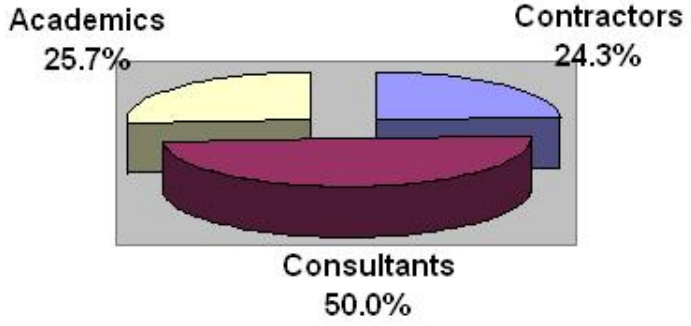


*FIG. 2: Categorisation of respondents by type of business*

Fig. 2 shows the respondents' profiles by the type of business while Fig. 3 categorises the respondents by their professional backgrounds. Of the 136 respondents, 33 (24.3%) work in construction firms, 68 (50%) as

consultants and 35 (25.7%) as academics. They comprised 29 architects (21.3%), 43 engineers (31.6%), 41 quantity surveyors (30.1%) and 23 others (16.9%) made up of estate surveyors and town planners.

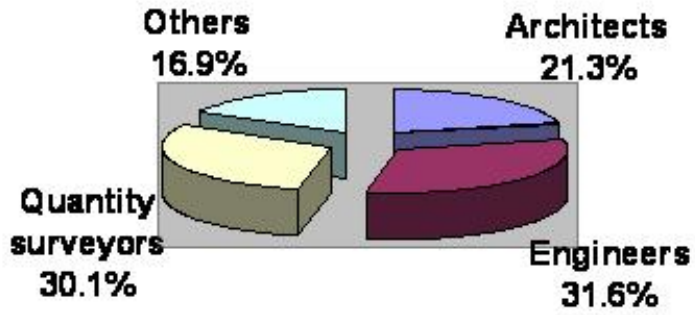


*FIG. 3: Categorisation of respondents by profession*

Fig. 4 shows that 47% of the respondents had over 10 years of professional experience. As many as 25% had less than 5 years, while only 7.6% had over 25 years of experience. They had qualifications ranging from higher national diplomas (7.5%) to doctorates (43.3%).

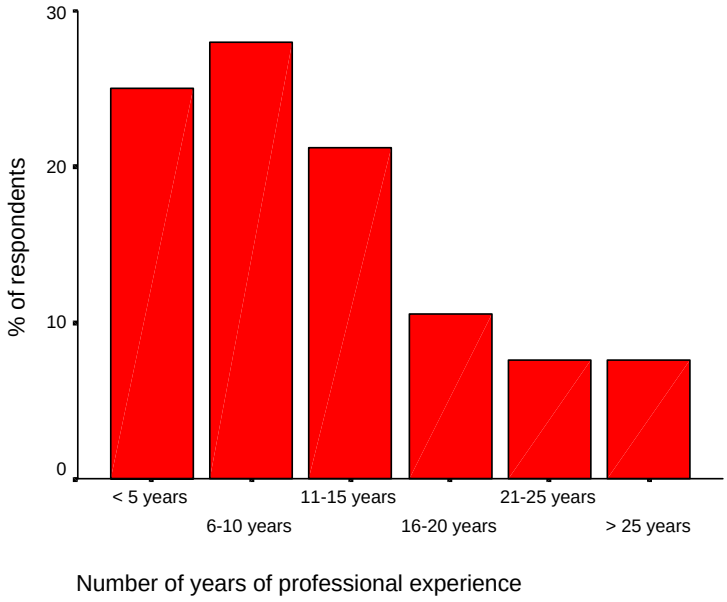


*FIG. 4: Professional experience of respondents*

In Fig. 5, a majority of the respondents (53.7%) indicated that they have been computer-literate for 1-5 years, while only 14.9% have more than 10 years of computer literacy and 1.5% have none. The majority of the respondents (56%) considered their levels of computer literacy above average while 7.5% considered them below average.

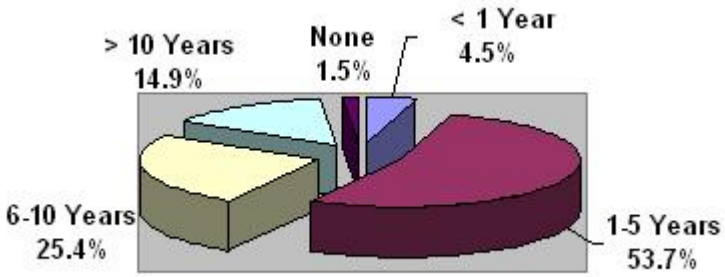


*FIG. 5: Respondents' years of computer literacy*

Table 1 shows some modes of acquisition of computer literacy available to respondents. Private lessons ranks 1 as the most common mode of acquisition while the least common mode is learning at school. This, according to Oladapo (2005), is a reflection of the very low ICT contents of construction education in Nigeria. The high ranking of the self-taught mode as the second most common mode accords with the global trend of self-learning by many ICT users as suggested by Steinmueller's (2001).

*TABLE 1: Mode of acquisition of computer literacy*

| Mode | Mean Score | Rank |
|---|---|---|
| Learnt at school | 2.99 | 5 |
| Private lessons | 4.10 | 1 |
| In service training given by employer | 3.29 | 3 |
| CPD training by professional bodies | 3.18 | 4 |
| Self-taught using computer manuals | 3.80 | 2 |

The least common mode is learning at school. This, according to Oladapo (2005), is a reflection of the very low ICT content of construction education in Nigeria. The fact that the self-taught mode is ranked 2 seems to support Steinmueller's (2001) suggestion that many ICT users are self-taught.

## 5. SURVEY RESULTS

The results of the survey are analysed and presented in this section with respect to availability and use of computer hardware/software, the benefits and impact of ICT, the factors influencing the adoption and use of ICT, the constraints to ICT use, the current level of ICT use and the future prospects for ICT use. The SPSS package was used for the analysis.

### 5.1 Availability and Use of Computers and Communication Systems.

The use of ICT in the construction industry can be naturally classified into communication systems and technical decision support systems. According to Doherty (1997), the communication domain involves all the common means of communication which are now computerized, while the technical decision support domain involves computer applications other than for communications. In this section, the types of computers, operating systems and software used by the respondent firms are examined. Table 2 shows that the most common type of computer is the desktop (used by 91.9% of the respondents). Notebook computers (used by only 17.6% of the respondents) are not yet popular in the industry. The three most common operating systems in use are Windows XP (59.6%), Windows 2000 (55.1%) and Windows 98 (47.1%).

Microsoft Word 2000 (67.6%) and Microsoft PowerPoint (59.6%) are the most common word processing and presentation software respectively. The software available for architectural/engineering design and drawing are CorelDraw, AutoCAD and ArchiCAD. The AutoCAD, used by 73.6% of the firms, is the most common. WinQs (41.5%) is the most common software for quantity surveying measurement and estimating. A few of the firms (2.4%) also use software developed in-house in addition to the standard quantity surveying software. Only 45.6% of the firms indicated they use a project planning software (Microsoft Project).

In the communication realm, computers and web-based technology offer the potential for great advances in transferring information accurately and quickly, in some instances approaching the goal of real time information flows (Marosszeky, 2002). This has made the use of the Internet and computer-aided communication very essential for closer collaboration among construction project partners. Table 3 shows that 66.9% of the firms surveyed are connected to the Internet which they use mostly for e-mail. None of the firms surveyed indicated that they had their own websites.

*TABLE 2: Computer Systems in Use*

| System | % using it |
|---|---|
| **Types of Computers** | |
| Desktops | 91.9 |
| Laptops | 60.3 |
| Notebooks | 17.6 |
| **Word Processing and Accounting Software** | |
| MS Word 2000 | 67.6 |
| Word Perfect | 36.8 |
| MS Excel | 55.9 |
| **Presentation Software** | |
| MS PowerPoint | 59.6 |
| Adobe PageMaker | 44.9 |
| MS Outlook | 43.4 |
| **Architectural/Engineering Design and Drawing Software** | |
| CorelDraw | 51.4 |
| AutoCAD | 73.6 |
| ArchiCAD | 45.8 |
| **Quantity Surveying Measurement and Estimating Software** | |
| WinQs | 41.5 |
| CatoPro | 17.1 |
| MasterBill | 19.5 |
| QS Elite | 12.2 |
| Snape Vector | 9.8 |
| In-house software | 2.4 |
| **Project Planning Software** | |
| MS Project | 45.6 |

*TABLE 3: Electronic communication systems in use*

| Communication system | % using it |
|---|---|
| Internet | 66.9 |
| Intranet | 19.1 |
| Voicemail | 12.5 |

## 5.2 The Benefits and Impact of ICT

The respondents were asked their opinions on the benefits of the use of ICT to their organisations on a scale ranging from “Very high” to “Very low”. Table 4 shows the ranking of the benefits using the method of importance index. The most important benefits derived from the use of ICT are improved quality of work, the

ease of doing complex tasks, time saving and increased productivity. These perceived benefits arguably translate into greater efficiency and seem to support Toole's (2003) view that ICT is one of the most powerful process innovations for increasing operational efficiency.

*TABLE 4: Ranking of the Benefits of Using ICT*

| Benefit | Importance index | Rank |
|---|---|---|
| Improves quality of work | 94.0 | 1 |
| Makes complex tasks easier to perform | 93.4 | 2 |
| Saves time | 93.1 | 3 |
| Improves productivity | 92.4 | 4 |
| Enhances public image | 89.4 | 5 |
| Saves cost | 84.3 | 6 |
| Facilitates decision making | 83.4 | 7 |

## 5.3 Factors Affecting the Adoption and Use of ICT

The analysis of the factors was to measure the strength and direction of the association between the internal and external factors (independent variables) shown in Fig. 1 and ICT use (dependent variable) in the construction industry. Using pair wise correlation analysis, the results obtained are shown Table 5.

*TABLE 5: Spearman's Correlation Between Level of ICT Use and Independent Determinants*

| Determinants | Spearman's coefficient of correlation | Significance (2-tailed) |
|---|---|---|
| **Internal Factors** | | |
| Size of firm/organisation | .016 | .860 |
| The business of the firm | .236** | .007 |
| Age of the firm | .154 | .086 |
| Ownership (Foreign and /or indigenous} | -.051 | .572 |
| Business organisation (Partnership, limited liability, etc.) | .101 | .268 |
| Academic qualification of CEO | .098 | .271 |
| Years of professional experience | .160 | .070 |
| Years of computer literacy | .250** | .004 |
| Level of computer literacy | .010 | .911 |
| Attitude of CEOs/senior managers to ICT | .261** | .003 |
| **External Factors** | | |
| Customer/client demands | .093 | .305 |
| Technological demands | -.158 | .079 |
| Influence of competition | -.082 | .363 |
| Availability/affordability of hardware/software | .098 | .267 |
| Availability of power | .079 | .382 |

**Correlation is significant at the .01 level.

There is significant positive correlation between the level of ICT use (the dependent variable) and three of the independent variables, i.e. the business of the firm (contracting, consulting or academics), years of computer

literacy of the CEO/senior managers, and the attitude of the CEO/senior managers to ICT (whether they see the need for ICT or not). Although these correlations are not very strong, the fact that the attitude of the CEO is the strongest means that the effects of the other factors are largely dependent upon the importance the CEO attaches to ICT. Also, the fact that none of the external factors is significant seems to suggest that the organisational and management characteristics of firms largely determine the level of ICT use by firms.

## 5.4 Constraints to the Use of ICT

The respondents were asked to express their opinions on the impact of 13 factors as obstacles to the use of ICT in the Nigerian construction industry on a scale ranging from "Very weak" to "Very strong". Table 6 shows the analysis of their responses using the importance index. The top three constraints to the use of ICT in the Nigerian construction industry are inadequate/erratic power supply, high cost of computer hardware and software and lack of sufficient jobs. It is not surprising that inadequate/erratic power supply is way ahead on the list of obstacles as electricity supply in Nigeria has been unreliable, leading to high production costs for companies, which are forced to procure and run their own power generating facilities (AfDB/OECD, 2004). Respondents seem to have overcome their initial widespread fear of the replacement of humans by computers as the fear of mass job losses in the industry (ranked 10) and the fear of ICT making professionals redundant (ranked 12) are no longer given prominence.

*TABLE 6: Ranking of the Constraints to the Use of ICT*

| Constraint | Importance index | Rank |
|---|---|---|
| Inadequate/erratic power supply | 87.1 | 1 |
| High cost of hardware and software | 67.3 | 2 |
| Lack of sufficient jobs | 66.6 | 3 |
| Fear of virus attacks | 63.2 | 4 |
| High rate of obsolescence of hardware/software | 62.9 | 5 |
| Inadequate ICT content of construction education | 61.5 | 6 |
| High cost of employing computer professionals | 58.6 | 7 |
| Lack of appreciation of ICT by firm's management | 53.5 | 8 |
| Security/privacy fears | 53.1 | 9 |
| Low return on investment | 50.4 | 10 |
| Fear of mass job losses in the industry | 50.4 | 10 |
| Fear of personnel abuse | 49.7 | 11 |
| Fear of ICT making professionals redundant | 35.7 | 12 |

## 5.5 The Current Level of Computer Use and Future Prospects

A majority of the organisations surveyed (98.5%) use computers. Most of them (59.7%) have been using the computer for 1-10 years, while only 38.8% have been using it for over 10 years and 1.55 for less than 1 year. Some common uses of the computer are word processing (74.3%), Internet communications (66.9%), costing (51.5%), scheduling (50.0%), accounting (44.1%) and design (33.8%).

Fig. 7 shows the various uses of the computer among contractors, academics and architectural, engineering and quantity surveying consultants. The results indicate that quantity surveyors (85.72%) use the computer the most and contractors and architects (66.7%) the least for word processing. For design, architects (83.3%) use the computer most, followed by engineers (50.05%); and quantity surveyors (4.8%) the least. Quantity surveyors (90.5%)lead the pack in costing, while contractors lead in accounting (66.7%) and scheduling (66.7%). These results are not surprising because traditionally design is a core function of architects and engineers, while quantity surveyors rarely engage in design. On the other hand, cost management is the core function of quantity surveyors just as work scheduling is a core function of contractors. Academics rank second in both word

processing and Internet use as research and publications are among their core functions. This seems to suggest that the professions tend to computerise more their core functions and activities.

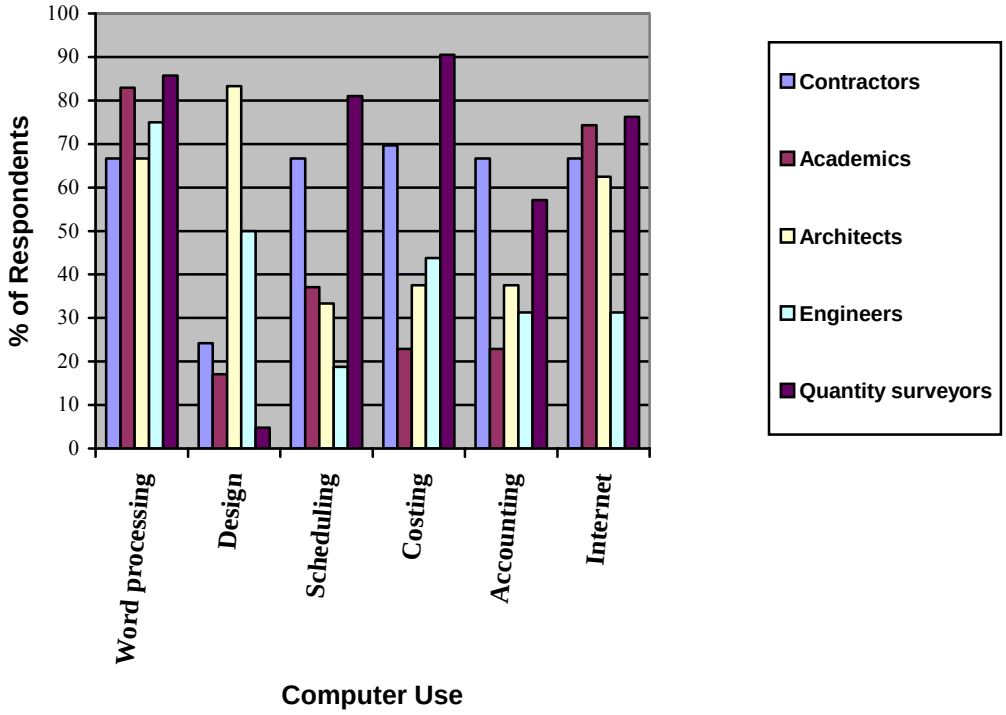


*FIG.7: Uses of the Computer in the Nigerian Construction Industry*

The few organisations (1.5%) which are currently not using the computer indicated that they have plans to use ICT in the future when they see the need for it, that is, when the sizes of their firms demand and they can afford the cost of investment in ICT. When asked to rate the possibilities of some ICT applications not currently used in the Nigerian construction industry, the respondents believed that e-tendering (86.0%), electronic cost data service (64.5%), videoconferencing (47.1%) and teleworking (28.7%) have very good prospects for widespread use in the near future. They also had a high expectation of the level of ICT diffusion in the future (mean score of 4.22 on a scale of 1 to 5).

## 6. COMPARISON WITH OTHER STUDIES

Some of the major findings of this study are compared in this section with the findings of similar studies in Canada, Sweden, Denmark, Malaysia, Turkey and Singapore. While Malaysia and Turkey and are, like Nigeria, emerging economies, Canada, Sweden, Denmark and Singapore are highly developed industrialised economies. The aim of the comparison is to show how these countries' Digital Access Index (DAI) rankings by the International Communications Union (ITU) are reflected in the ICT penetration of their construction industries and highlight major similarities and differences. Table 7 shows the national and construction industry ICT statistics for the selected countries. It is important to note in this comparison that the national statistics cover the same year (2002) for all the countries while the construction industry statistics are for different years from 1999 (Canada) to 2005 (Nigeria).

Sweden is ranked 1 while Nigeria is ranked 153 in global ICT use among 178 countries (ITU, 2003). In the comparison in Table 7, Sweden leads in two of the three ICT indicators, i.e. Internet users per 10000 and main telephone lines per 100, and is second in the 3rd (PCs per 100). On the other hand, Nigeria comes last among the 7 countries in all the three indicators. In the construction industry statistics, Sweden leads (with Canada) only in the use of CAD by firms (76%). Denmark, which is 2nd among the seven countries in the country statistics, leads in the percentage of firms connected to the Internet (99%), and firms having Internet home pages (67%). The fact that Nigeria (98.5%) is ahead of Sweden (88.0%), Denmark (88.0%), Singapore (97.6%) and Turkey (95.0%) in the use of computers by firms may not be a true reflection of the inter-country differences in this

indicator. This is because of the time lag between the survey period in Nigeria (in 2005) and the periods in Sweden (in 2000), Denmark (in 2001), Singapore (in 2003) and Turkey (in 2001). Therefore, a true measurement of the differences between the countries can be made only on the assumption that the ICT status of the construction industries surveyed has remained largely unchanged up to 2005 (Goh, 2005). As this assumption seems very far-fetched in the light of the rapid rate of global ICT growth, the differences highlighted in Table 7 must therefore not be viewed in absolute terms.

The Internet connectivity rates reported in 2002 were 835% for Sweden (Samuelson, 2002) and 94% for Malaysia (Lim et al., 2002). The fact that Malaysia, a developing country like Nigeria, surpassed Sweden in this respect poses a real challenge to the construction industries of developing countries not to be despondent about their current low level of Internet access. The high level of computer usage in the Nigerian construction industry (98.5%) seems to suggest that despite the very poor state of the ICT infrastructure of many highly indebted developing countries, especially electricity and telecommunications, they can still avail themselves of the benefits of ICT to construction albeit at much greater costs than obtain in the developed world.

Table 8 compares the uses and benefits of ICT as well as the obstacles to its increased use in the construction industries of some of the selected countries for which data were available. While the top two uses of ICT are similar in Canada, Sweden and Singapore (i.e. “invoicing” and “bookkeeping”), the results for Nigeria (“word processing” and “Internet communications”) are completely different. “Bookkeeping” (or “accounting”) is ranked 5th in Nigeria among six uses. This shows that in Nigeria the use of computers is still at the rudimentary stage where a basic application like word processing is the most prominent, while the other countries have advanced to the stage of application to more technical business functions. In the rankings of the benefits of ICT, Sweden differs sharply from the other countries. “Better quality of work” (or “improved quality”) and “work done more quickly” (or “saves time”) are among the top three benefits in all the countries except Sweden where they are ranked 7th and 6th respectively.

In Canada, Sweden and Singapore, the number one obstacle to the increased use of ICT is “need to continually upgrade” hardware and software, followed by “investment cost is too high”. In Nigeria, “inadequate/erratic power supply” is overwhelmingly the number one obstacle, followed by “high cost of hardware and software” (or “investment cost is too high”). “Need to continually upgrade” (or “high rate of obsolescence of hardware/software”) is ranked 5th in Nigeria. The fact that power supply is not a problem in any of the countries, except Nigeria where it is the most prominent reflects the wide gap in ICT infrastructure which, according to Chinn & Fairlie (2004), exists between developed and developing countries. The gap in access to infrastructure, including electricity and telecommunications infrastructure (see the figures for main telephone lines per 100 in Table 7), contributes a lot to the global digital divide between developed and developing countries. For example, the disparities in telecommunications infrastructure alone account for 40.7% of the gap between the US and Sub-Saharan Africa in the use of PCs (Chinn and Fairlie, 2004).

*TABLE 7: International Comparison of Results*

| NATIONAL STATISTICS (2002) | | | | | | | CONSTRUCTION INDUSTRY STATISTICS (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Population (in millions) | PCs per 100 | Internet Users per 10000 | Main telephone lines per 100 | DAI | Rank | Firms using the computer | Firms connected to Internet | Use of LAN | Use of CAD | Firms with Internet home page |
| Sweden | 8.94 | 62.13 | 5730.74 | 73.57 | 0.85 | 1 | 88.0 | 83.0 | NI* | 76.0 | 60.0 |
| Denmark | 5.37 | 57.68 | 5128.15 | 68.86 | 0.83 | 2 | 88.0 | 99.0 | 80.0 | 74.0 | 67.0 |
| Canada | 31.41 | 48.7 | 4838.61 | 64.32 | 0.78 | 10 | 99.0 | 90.0 | 62.0 | 76.0 | 38.0 |
| Singapore | 4.16 | 62.20 | 5043.59 | 46.29 | 0.75 | 14 | 97.6 | 94.0 | 66.7 | NI | 45.2 |
| Malaysia | 24.53 | 14.68 | 3196.74 | 19.04 | 0.57 | 46 | NI | 94.0 | NI | NI | 24.0 |
| Turkey | 69.63 | 4.31 | 617.59 | 27.17 | 0.48 | 70 | 95.0 | 19.0 | 90.0 | 64.0 | NI |
| Nigeria | 120.08 | 0.71 | 34.98 | 0.58 | 0.15 | 153 | 98.5 | 66.9 | 0.0 | 58.8 | 0.0 |

*NI…….No information

**Sources of country statistics**:

ITU (2003) at http://www.itu.int/newsarchive/press_releases/2003/30.html
ITU (2005) at http://www.itu.int/ITU-D/ict/statistics/

**Sources of construction industry statistics for Tables 7 & 8**:

| | |
|---|---|
| Sweden/Denmark | Samuelson (2002) |
| Canada | Rivard (2000) |
| Singapore | Goh (2005) |
| Malaysia | Lim *et al*. (2002) |
| Turkey | Sarshar & Isikdag (2004). |

*TABLE 8: Ranking of Uses/Benefits of and Obstacles to the Adoption of ICT in the Construction Industry*

| | Canada (1999) | Sweden (2000) | Singapore (2003) | Nigeria (2005) |
|---|---|---|---|---|
| Uses | 1. Bookkeeping<br>2. Invoicing<br>3. Specifications<br>4. Bills of quantities<br>5. Costing/budgeting | 1. Invoicing<br>2. Bookkeeping<br>3. Tendering<br>4. Marketing | 1. Invoicing<br>2. Bookkeeping<br>3. Work description<br>4. Tendering<br>5. Technical calculations (design) | 1. Word processing<br>2. Internet communications<br>3. Costing<br>4. Scheduling<br>5 Accounting |
| Benefits | 1. Better quality work<br>2. Work done more quickly<br>3. Better financial control<br>4. Better communications<br>5. Faster and simpler access to common data | 1. Better financial control<br>2. Simpler/faster access to common information<br>3. Better communication<br>4. Possibility of sharing information<br>5 Easier to handle large amount of data | 1. Work done more quickly<br>2. Better quality of work<br>3. Faster access to information | 1. Improves quality of work<br>2. Makes complex tasks easier to perform<br>3. Saves time<br>4. Improves productivity<br>5 Enhances public image |
| Obstacles | 1. Continual demand for upgrading<br>2. Investment costs too high<br>3. Greater know-how required from staff<br>4. Overabundance of information<br>5. Risk that IT leads to inefficiency | 1. Need to continually upgrade<br>2. Investment cost is too high<br>3. Greater know-how required from staff<br>4. Overabundance of information<br>5. General attitude that old ways of doing things have worked well throughout the years and changes are unnecessary | 1. Need to continually upgrade<br>2. Investment cost is too high<br>3. Incompatible software | 1. Inadequate/erratic power supply<br>2. High cost of hardware and software<br>3. Lack of sufficient jobs<br>4. Fear of virus attacks<br>5. High rate of obsolescence of hardware/software |

## 7. CONCLUSION

The study assessed the level of usage of ICT in the Nigerian construction industry via a questionnaire survey of CEOs and senior managers in 136 organisations comprising construction companies, architectural, engineering and quantity surveying consultancies as well as academic/research institutions. It examined the current status of ICT use and highlighted the prospects for its widespread penetration of the industry in the near future. Some of the major findings are that

- Contrary to expectation, the level of use of computers is very high (98.5%) for a developing country like Nigeria. Between the professions, the main use of computers differs along the lines of the core functions of the professions, with architects leading in the computerisation of design (followed by engineers), while quantity surveyors lead in costing and contractors lead in accounting and work scheduling.
- The most significant determinant of the level of ICT use is the attitude of CEOs/senior managers to the benefits of the technology, i.e. their appreciation of the usefulness of ICT. The findings show that internal factors (such as the organisational and management characteristics of firms), and not external factors, largely determine the level of ICT use by firms in the Nigerian construction industry.
- The top three benefits of ICT as perceived by the respondents are "improves quality of work", "makes complex tasks easier to perform" and "saves time".
- A comparison with more developed countries shows that in Nigeria the use of computers in the construction industry is still at the rudimentary stage where a basic application like word processing is the most prominent, while in Canada, Sweden and Singapore computer use has advanced to more technical business applications. Also, the fact that inadequate supply of electricity is the most critical obstacle to increased use of ICT in the Nigerian construction industry but is not considered a problem in the more developed countries reflects the very large gap in ICT infrastructure between a developed country like Canada and a developing country like Nigeria, for example.
- In spite of the current rudimentary state of computer use and the low level and poor state of communications infrastructure, most of the respondents were very optimistic about the future of ICT use in the Nigerian construction industry. They had a high expectation of the use of such innovations as e-tendering electronic cost data service, videoconferencing and teleworking in the near future.

It is expected that these results will guide policymakers in Nigeria and other developing countries to identify where to concentrate their efforts to promote increased use of ICT, especially in the construction industry. In this regard, for example, maximum results could be achieved through a combination of improvement in ICT infrastructure and the education of decision makers on the benefits ICT. While it might appear too late to change the attitudes of most present-day decision makers, increased investment in ICT education in the developing world today (as advocated by Murray *et al*., 2001) could produce the future crop of leaders who will ensure optimum use of ICT in their organisations. Also, for the construction industry in developing countries to maximise the returns on investments in ICT, it must go beyond basic applications of ICT like word processing, design and costing to more technical business applications like e-business, electronic data management, teleworking and e-business.

It is hoped that this study will be repeated in the next five years to measure any quantitative and qualitative improvements in ICT diffusion in the Nigerian construction industry and see if the respondents' optimism is well placed.

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