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A Study of Innovation Activities in Software Firms in Nigeria

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ABSTRACT

Software firms in Nigeria were in the business of buying and selling software products about two decades ago but are now developing customized software products. Hence, this study sought to examine the extent to which selected software firms in Nigeria have built their innovation capability to engage in software innovations activities. Using appropriate methods, the study analyses data obtained from 73 software firms located within three geopolitical zones in Nigeria (North-Central, South-West and South-South). The results showed (on a five-point Likert scale) that the software firms to a great extent engaged in Human-Centered Designs (3.6) and User-Experience (3.5) software innovation activities and to a moderate extent in User-Interface (2.9) activities. The study also revealed that 91.8%, of the selected software firms engaged in the development of entirely new applications, 65.8% improved on existing applications, 20.5% applied entirely new software methodology, 76.7% improved on existing software methodology, 57.5% introduced entirely new software services, 78.1% slightly improved on existing software services, 87.7% initiated entirely new software designs, while 11.2% slightly improved on existing design interface. The software firms were classified to be on the innovation capability maturity (ICM) level 3 (out of five maximum levels) which implies that the software firms in Nigeria are at the supported innovation level. The study recommends that firms focus on user-centric designs, ensure adequate engagement of users in software development and encourage the acquisition of new HCI knowledge for the effective incorporation of newer interactive features, intuitive interfaces, and customized options for user satisfaction.

Keywords:
Innovation; Human-computer interactions; Innovation capability maturity, software industry; Nigeria

BACKGROUND TO THE STUDY

The contribution of the information and Communication Technology (ICT) sector to economic growth cannot be denied. This sector has emerged as the fastest growing industry especially with the advent of the software industry. The software industry has made tremendous impact in both developed and developing countries including Nigeria. For instance, in Nigeria, the demand for customized software products (CSPs) by most public and private organizations has attracted annual earnings for the Country which has been estimated at over $20 billion (Mohammed and Ephraim, 2018). It is assumed that this was whnt led to the exponential growth of the Nigerian software industry (NSI) from the initial stage of buying, selling and installing foreign software products to the firms in the industry now developing CSPs locally. Sa'ad and Jakwa (2022) noted that the NSI has contributed over 0.05% of the global CSPs to the software market.

However, the sustainability of the NSI hinges on the software firms' ability to innovate. Innovation is crucial for worldwide competitiveness among firms (Kiveu *et al*., 2019) particularly in a dynamic environment like the software market (Zubairu *et al*., 2020). Although innovations in the software industry differ from innovation in other industries, the goal for innovating is the same. Furthermore, the innovation process differs as software firms engage in the development software products that are unique and intangible (Rose and Furneaux, 2016), involving complex and critical phases that rely on innovation to revolutionize the development process and design interactive software product that are user-friendly (Qian *et al.*, 2023).

According to Sharda (2016), software development is completely a design event, where the socio-technical theory establishes that it as an interaction between the computer software and the users. That is, the human-computer interactions (HCI) reciprocated in the relationship between the humans that use software and the software itself (Michael *et al*., 2023). The sociotechnical theory considers the interwoven relationship between the computer hardware, software, people, organization and the social environment (Ogunyemi *et al*., 2018). Where the software is acknowledged as a sociotechnical system that functions on a hardware device, used by people in an organization within a social environment (Ogunyemi *et al*., 2018). Hence, software sociotechnical systems are practiced as the human-computer interactions (HCI) principles categorized as human-centered-design (HCD), usability/user experience (UX) and the user interface (UI).

A software product is only a partial solution to an existing problem, getting people to adopt and use the product in order to solve their problem completes the cycle (Ogunyemi *et al.,* 2018). Thus, the goal of every software user is to derive satisfaction while using the software product (Rusu *et al.,* 2015). Satisfaction comes with the use of simple interfaces that are easy to learn, navigate and fun to use (Berni and Borgianni, 2021). This is tested not according to the competencies of the software developers but according to the users' experience to use the software product (Ogunyemi *et al.,* 2018). Hence, the UI is to be designed as an interactive screen between the user and the software product where the colors and typography are seen and the initial display of the functionality of the product displayed (Sharma and Tiwari, 2021). This is one of the most important elements of a software product that determines the quality of the software product (Sridevi, 2014). Because a poorly designed interface may hinder the users from tapping into the computational power of the software product and make a well-designed software product to fail, leaving the users confused, unforgiving, and frustrated (Sridevi, 2014). Invariably, the HCD practices are to empower the intended software product users to lead the software design process by asking relevant questions, sharing insights and describing the flow of the product activities so that software firms can successfully incorporate all the intended solutions into the development of the software product (Ogunyemi *et al.,* 2018). Therefore, there is the need to examine the extent to which software firms in Nigeria have engaged with these practices as the study of Ogunyemi *et al*. (2018) revealed that software firms in the country had engaged to a small extent in HCI practices.

HCI practices are classified as innovation activities for software firms in developing countries especially in Africa. Although. software firms in developed countries have been engaging in HCI practices for over a decade. The practices are new to developing countries (Ogunyemi *et al.,* 2016).

The newness of these practices in Nigeria justifies the classification of the HCI practices as innovative. Also, based on the Oslo Manual (2018) (OECD, 2018) where it was defined that innovation is the introduction of "new or improved product or process (or combination thereof) that differ significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process) (OECD/EuroStat 2018). This implies that the HCI practices are software innovations that are newly introduced for the development of new software product, practices as new software development process or introduced for the improvement of an already existing software products or introduced to improve the firms' software development processes that differs significantly from previous software products or software development processes and that has been made available to potential software users (organizations) or brought into use by the software firms (process).

LITERATURE REVIEW

Innovation in Software Development

Innovation is seen be a major driver of success and growth in both small, medium or large firms (Chinhanga, 2018). The need for firms to innovate has become critical for their survival, sustainability, and for the future growth of the firm especially in a highly competitive market even for firms in the software industry (Divisekera and Nguyen, 2018). Innovation is defined as "the intentional introduction and application within a job, work team or organization of ideas, processes, products or procedures which are new to that job, work team or organization and which are designed to benefit the job, the work team or the organization" (West and Farr 1990, Sözbilir, 2018). This implies that software firms that intentionally introduce and apply new processes (procedures) into their software development processes to develop new software products for any economic sector are innovative in their development approach that would benefit their job and the firm at large. That means, software firms' intentions to introduce and apply the new HCI practices into their software development process are innovative. Hence the HCI practices are the innovation activities innovative software firms engage in to develop interactive software products that are acceptable by users.

Unfortunately, most software firms are developing software products without taking into cognizance the human cognitive abilities to use the products (Bullinger *et al.,* 2002; Ogunyemi, *et al.,* 2018). Thus, innovative software firms are to intentionally introduce the practices of designing an interactive UI revolutionizing the processes with innovative activities to develop universal design that are easy and understandable, creating style guides for each UI component, and develop consistent and familiar designs for different applications, following user-centered approaches (Bourimi *et al*., 2010; Ogunyemi *et al*, 2018). This is very vital for the firms so that the time, efforts, skills and creativity invested into the product would not be futile. Based on the law of usability, software products are not developed for with the concept that people would use the product but that the targeted audience have the experience to use the product.

Hence, the innovation activities to test users' experiences are to: organize remote or in-person usability test, organize easy contents discovery and navigation, incorporate stakeholders' requirements, review experts' documents and products to ensure full adherence and compliance to global standards, early and continuously prototypes developments and conducting quality and performance rating for each software products. Furthermore, the innovative firm's engagement in HCD practices such as: conducting research to understand users, tasks and environment, involving users at all developmental stages, designing based on users' experience, using iterative and incremental development process and ensuring that the organizing teams have multidisciplinary skills, makes the innovative software product interactive (acceptable to users and other stakeholders).
The innovation activities in software development are broadly discussed as thus:

i. **The User Interface (UI):** This needs a keen attention by the software firms as software development anchors on the human factor to develop interactive user interface. Interfaces are the platforms for interaction between the users and the computer system and it determines the overall performance of the software product (Bennett *et al.* 2012; Punchoojit and Hongwarittorrn 2017). The UI is the screen on which the users are able to interact with the software products having the expectation that the product would perform to

achieve the desired task. On the screen is the visual design of the software product where the colors and typography are seen and the initial display of the functionality.

ii. **User Experience (UX):** is also known as usability. Norman (1995) described UX "as the experience between a human being and a system", with the intention to understand users' needs, and create simple interfaces that are easy and fun to use (Berni, and Borgianni, 2021). The HCI principle is primarily to understand the quality of the interaction brought about by the usability concept, its definition and measurement. Usability concept according to Rusu *et al*. (2015), from the ISO 9241 (ISO 9241-11, 1998), is the extension of a software product developed to effectively and efficiently achieve the desired goals of the software user producing the desired satisfaction for the users. The authors defined UX, as users' perception and response derived from the use or anticipated use of the software product. A major practice is usability testing which measurement involves the testing of the users experience to use the software product in order to know whether the targeted users can use the product not necessarily testing whether people will use the product (Dillon, 2000; Ogunyemi *et al*, 2018). This usability measures can be initiated from the start of the project to provide insights on how to measure the effectiveness, efficiency and satisfaction of the users as well as to ensure their needs for the actual software product is clear and successfully conveyed. Also, the involvement of the system stakeholders is necessary to determine the satisfaction rather than just testing only the actual users' satisfaction. However, the design of sociotechnical systems can be very challenging (Bourimi *et al*., 2010; Carayon 2006; Ogunyemi *et al.*, 2018) due to human factor issues such as the emotional element of users' which attributes joy or frustration, and physiological response of users as well as the project stakeholder's needs (Baxter and Sommerville, 2011; Bourimi *et al*., 2010; Ogunyemi *et al.*, 2018) among others.

iii. **Human-centered design (HCD):** the HCD has its roots in semi-scientific fields such as ergonomics, computer science and artificial intelligence. The HCD was identified as an alternative method to design sociotechnical systems (Bannon, 2011; Giacomin, 2014; Ogunyemi *et al.*, 2018). Although, it is an act of designing and developing systems using standard principles or practices to make the software products interactive focusing on the users of the systems and applying human factors or ergonomics and usability knowledge and techniques (Giacomin, 2012; Ogunyemi *et al.* 2018). Societies, people and technologies are constantly evolving with new trends in software development, hence there is a great need for the practices that guide software development to evolve as well using the HCD practices in software development process. Software firs engagement in HCD practices are capable of developing quality software products (Ogunyemi *et al.,* 2015).

Empirical Review

This section reviews the studies from other scholars and their findings on the innovation capability of software innovation activities, dynamic and absorptive capabilities of software firms, the factors influencing the innovation capabilities of the firms as well as users' perception to accept and use software products.

The study of Ogunyemi, *et al.,* (2016), considered HCI practices as innovations activities since they are new techniques to software firms especially in sub-Saharan Africa. Although HCI and software development has been in existence since early 2000, the dearth of HCI practitioners in the software industry are few and majority of the software firms have little or no background knowledge in HCI techniques. Hence, their study described the HCI practice in Nigeria and found out that HCI practice in the country is at its infancy stage in most software companies, as a result of the lack of the required knowledge transfer within higher institutes of learning and poor government policies to recognize the need for end-users and customers' participation in software product development.

According to the study of Ogunyemi *et al.* (2018), interactive interfaces are developed for human use and should be approached from the perspective of sociotechnical systems approach to develop software products using the HCI practice. They added that, the perceptions of software firms are unclear concerning sociotechnical systems development and HCI practices. Their study revealed the maturity state of HCI practice in Nigeria, using exploratory questions, to interview

ten companies and the result revealed that humans are at the central focus for the development of software products thus the user interface design, usability and human centered design practices are considered for adoption by software firms that are familiar with the HCI principles. Therefore, adopting HCI practices by indigenous software firms in the Nigeria would create avenues for more collaborations and in-house research.

RESEARCH METHODOLOGY

The study employed a quantitative analysis that assesses the innovation activities of selected software firms in Nigeria. This involves the identification of software innovation activities in software firms as described in the sociotechnical theory. Therefore, to determine the extent of engagement in software innovation activities the innovation capability maturity model (ICMM) framework was employed to determine the maturity level of software firms in Nigeria (Knoke, 2013). The model depicts the innovation capability maturity levels from level 1 through to level 5 where level 1 is the Ad hoc innovation level, level 2 is defined innovation level; level 3 is the supported innovation level; level 4 is the aligned innovation level; and level 5 is the synergized innovation level (Knoke 2013). Where maturity level 1 indicates to a 'small extent', level 2: to 'some extent'; level 3: to a 'moderate extent'; level 4: to a 'great extent' and level 5: to a 'very great extent'. Generally, the conceptual framework is used to examine the relationships that exist within the context of this study. In Figure 1, the innovation activities are the measures for assessing the innovation capability of the software firms. The innovation activities are the activities in the Human-Computer-interaction (HCI) principles that software firms undertake while designing and developing new software products or improving an already existing software product. The CMMI framework is built accordingly and represented in figure 1. This model is a reflection of the extent of ICMM of the firms, the firms with highest modal response of their extent of engagement are used to compute the ICMM level of the firms for each variable of measurement. Afterwards, a cumulative mean value is calculated and ranked, to obtain the overall ICMM level of the selected software firms in Nigeria.

Therefore, as shown in Figure 1, the conceptual and methodological framework for this study were developed using the sociotechnical theory and categorized based on the CMMI framework, to assess the IC of indigenous software firms.

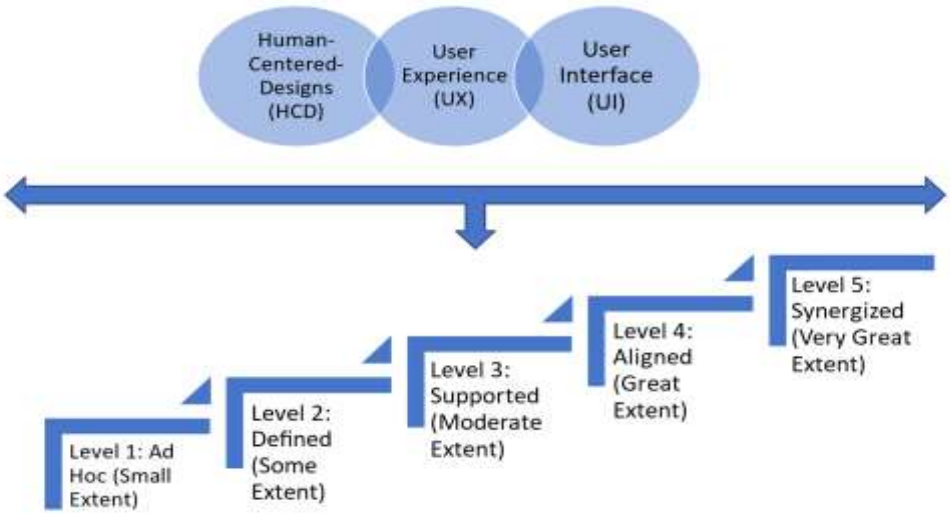

Figure 1*:* Conceptual and Methodological framework to determine the ICM Levels of Nigerian Software firms (adapted from Knoke, 2013 and Ogunyemi *et al*., 2018)

Area of Study

The study focuses on three specific areas where the clusters of software firms are densely populated. From the six geopolitical regions of the country, three regions were selected namely: North-central (Abuja-Federal Capital Territory), the South-West (Lagos State) and the South-South (Rivers State). This is also based on the perspective of most software firms that establishing their businesses in these locations (Soyinka, 2019) is more advantageous.

Study Population, Sample and Sampling Technique

The respondents for the study entail top managers from selected number of software development firms within the study area. The respondents were selected using a multi-stage sampling technique. The first stage was geopolitical zonal selection using a three-cardinal division of the Country, having North-central, South-West and South-South. Next is the selection of States within the selected geopolitical zones with the highest cluster of software development firms. Thus, from the business directory of Nigeria, it was identified that the North-Central, Abuja (FCT) has the highest cluster of software firms, while in the South-West; Lagos state is clearly outstanding as the State in the zone with the highest cluster of software firms. Subsequently, from the South-South geopolitical zone, Rivers State has the highest cluster of software firms and thus selected for the study as well. The selection process was followed by the selection of software firms that have been registered and have been in operation for at least one years.

Sample Size Determination

To determine the true representation of a particular population, whether finite or infinite, it is important to choose the right sample size for the study (Charan *et al*., 2021). Hence, for the quantitative aspect of this study, the sample sizes are determined for software firms within the study area. The population of the software firms according to the Nigerian Business Directory (2023), are 20, 73 and 17 software firms in Abuja (FCT), Lagos State and Rivers State respectively, totaling to 110 software firms in the selected study area. Thus, the sample size for software firms is determined as finite. Hence, the Yamane's formula according to Israel (1992), for finite population is used to determine the sample size for software firms. The formula is given as:

$$n=N/(1+Ne^2) \quad (1)$$

where, n is corrected sample size, N is the population and e; is the error margin (taken as 0.05 or 5%)

Hence, n = N/(1+Ne^2)
= 110/ (1+110(0.05) ^2)
= 110/(1 + 110)
= (0.0025)
= 110/ (1 + 0.275)
= 110/ 1.275
= 86

Therefore, the sample size for software firms is eighty-six (86). However, to determine the respondent sample size for each study area, Slovin's formula was used, where the Slovin's formula is given as

$$[RPS/N] \times n \quad (2)$$

Where, RPS is the respondent population size; N is the total population size and n is the total sample size. Hence, the sample size for

Abuja (FCT) = [20/110] x 86
= 15.6 = 16
Rivers State = [17/110] x 86
= 13, and
Lagos State = [73/110] x 86
= 57

Total Sample size from the three locations
= 16 + 13 + 57 = 86

Research Instrument

The study employs the use of structured questionnaire to obtain primary data from the software firms. Table 1 shows respondents' response to the extent to which they engaged in software innovation activities that was measured to determine the extent to which the software firms engaged in HCI practices using a 5-point Likert rating scale of 'To a small extent', 'To some extent', 'To a moderate extent', To a great extent' and 'To a very great extent'. To measure the software innovation activities in the firms, the mean values of each variable describe the extent to which the

Table 1: Determination of the Innovation Capability Maturity Levels

Element	Definition	Level 1: Ad hoc innovations *Small extent (μ= 0.1-1.4)*	Level 2: Defined innovations *Some extent (μ= 1.5-2.4)*	Level 3: Supported innovations *Moderate extent (μ=2.5-3.4)*	Level 4: Aligned innovations *Great extent (μ= 3.5-4.4)*	Level 5: Synergized innovations *Very great extent (μ= 4.5-5.0)*
Software Innovation Activities (SIA)	The extent to which the firms engage in innovation activities to develop innovative software products	The extent to which the firms engage in innovation activities are to a small extent, inconsistent in their development of innovative software products	The extent to which the firms engage in innovation activities are to some extent, inconsistent but with traceable development of innovative software products	The extent to which the firms engage in innovation activities are to a moderate extent, with consistent development of innovative software products	The extent to which the firms engage in innovation activities are to a great extent, aligning activities and resources for consistent differentiation software products	The extent to which the firms engage in innovation activities are to a very great extent to synergize activities and resources to develop software product that creates competitive advantage

Source: Adapted from Arends and Advisory (2018).

firms had engaged in the activity. The overall mean value of all the innovation activities indicates the extent to which the software firms had engaged in software innovation activities and determines the firms' innovation capability maturity level (ICML) to develop innovative software products. The software innovation activities are measured in three broad categories: Human-Centered-Designs (HCD), Useability/User Experience (UX), and User Interface (UI). To operationalize the firms' overall HCD, UX, and UI software innovation activities several questions that give a sense of self evaluation on likely innovation activities were asked. The dimensions that were covered in identifying the innovation activities engaged by software firms in developing customized-software products were eighteen (18) variables. The eighteen variables were sub-divided into the categories HCD, UX, and UI.

HCD variables are measured using the following statements: conduct interview with users to understand their goals, tasks, and needs; users were involved all through the design phases, designs are based on users' level of experience; use iterative and incremental development process; designs are easily understood by users and all other stakeholders, team members comprised of multidisciplinary skilled personnels.

UX was measured using the following variables: An in-person or remote usability test was set-up at the end of the development process; the user-centered system design process is specified, adopted, and implemented locally; After project delivery, users were given opportunities to rate the firm's performance and quality of project; prototypes were developed early and continuously to visualize and evaluate ideas and design solutions with end-users in mind; All users' requirements were documented, contracts signed and filed appropriately; all necessary requirements were obtained from stakeholders; organized content for easy discovery and navigation; software developed with full compliance with global standards; and future use situation features were developed in parallel to accommodate a robust system.

User Interface (UI) was measured using the following variables: A style guide was created for each User Interface component; consistent and familiar designs were created across different applications; we ensured all our designs were universal.

This was addressed using frequencies and percentage counts to describe the profile of the software firms: location of the firms, year of establishment, applications developed by sectors, nature of developed applications, types of applications, and types of innovations. The extent to which software firms engage in innovation activities was identified using the mean value to determine the extent to which software firms engage in innovation activities and the overall mean of the innovation activities was determined using descriptive analysis, the mean value was used

to indicate the extent to which the software firms in Nigeria engages in innovation activities during software development process. Given that the software innovation activities are the HCI practices broadly divided into three categories such as the UI, UX and HCD approaches (Ogunyemi *et al.,* 2016). A one-way ANOVA was used to rank the mean values of the UI, UX and HCD innovation activities and used to estimate of the ICML of the extent to which Nigerian software firms engaged actively in the practice of software innovation activities

RESULTS AND DISCUSSION

The collection of the quantitative data for software firms was done through the use of structure questionnaire.

Response Rate Analysis

Table 2 shows the response rate of software firms' respondents from the study areas North-Central (Abuja), South-West (Lagos State) and South-South (Rivers State). A total of 95 copies of the questionnaire were administered to software firms in the selected areas. The extra copies were made handy to make up for wastage and poor-response incidents. Afterwards, the researcher copies of questionnaire were retrieved from the software firms. Seventy-eight copies of the questionnaire were retrieved from the entire study area (Abuja, Lagos and Rivers States), indicating a 91% response rate. However, from the questionnaires retrieved, 73 copies from the software firms were found to be suitable for analysis.

Table 2: Study area questionnaire response rate (Software firms)

Study Area	Number administered	Number returned	Number duly filled
Abuja	20	15	13
Lagos	60	50	49
Rivers	15	13	11
Total	95	78	73

Profile of software firms and the respondents

The profiles and socioeconomic characteristics of the software firms and the respondents respectively are represented in Table 3. The analysis indicates that Nigerian software firms predominantly (72.6%) develop customized software products (CSPs) used for financial transactions, health-related applications (49.3%),

Table 3: Profile of Software firms

Variables	Items	Frequency	Percentage
Developed customized software products for	Financial transactions	53	72.6
	Health-related applications	36	49.3
	Enterprise resource planning application	42	57.5
	Educational-related application	34	46.6
	Other business-related applications	61	83.6
Applications were developed based on	Users-specific Demands	35	47.9
	Societal-needs Demands	17	23.3
	Both user and societal demands	21	28.8
Software products developed based on	Smart Mobile devices	55	75.3
	Desktop/Laptops computers	61	83.6
	Web-based platforms	58	79.5
	Off-line based platforms	55	75.3
Number of Staff	1-5	14	19.2
	6-10	23	31.5
	11-15	17	23.3
	16-20	11	15.1
	21 and above	8	11.0
Year of Establishment	1991-2000	9	10.5
	2001-2010	21	28.8
	2011-2020	37	50.7
	2021-2023	6	8.2

enterprise resource planning (57.5%), educational applications (46.6%), and other business-related applications (83.6%). These applications cater for both mobile devices (75.3%) and desktop/laptop computers (83.6%), operating as web-based applications (79.5%) and offline on a Client-Server Platforms (75.3%). This diversity highlights the range of software products developed by software firms in Nigeria.

Furthermore, the study reveals that some (47.9%), software products were developed CSPs only based on the request from software users (organizations) others (23.3%) developed only to address certain social needs identified from market research, whereas some (28.8%) of the firms develop both on request and to meet social needs. However, only a few of them combine both business models. This can be corroborated with the response from some of the participants of the interview who reported that marketing software product is a challenge for software firms.

They advised firms to stick to developing customized software and have marketing team to commercialize the software products.

Regarding the size of software firms, the analysis shows that a significant proportion of the firms are small scale, with 19.2% having 1-5 staff members, 31.5% having 6-10 staff members, and 23.3% having 11-15 staff members. On the year of establishment, the majority (50.7%) were founded between 2011-2020, indicating a period of high entrance of firms into the industry when the prospects of the industry became clearer, and the session of neglect was over (Ki-moon, 2012).

Demographic profile of respondents

The results of the analysis in Table 4 shows the demographic profile of respondents. Analysis results on the position of respondents revealed that 13.7% were Chief Executive Officers of the organization, 37.0% were Project Managers and 49.3% were Senior Software Engineering managers. This implies that a larger proportion (49.3%) of the respondents were top senior engineers who are considered knowledgeable of the software application development project/activities of the firms.

Table 4: The Demographic Profile of Respondents

	Variables	Frequency	Percentage
Position of Respondents	Chief Executive Officer	10	13.7
	Project Manager	27	37.0
	Senior Software Engineering	36	49.3
Gender	Male	62	84.9
	Female	11	15.1
Years of Experience	2-5	31	36.0
	6-9	33	38.4
	10-12	12	14.0
	13-15	7	8.1
	16 and above	3	3.5
Age	Under 25	19	26.0
	26-30	23	31.5
	31-35	12	16.4
	36-40	9	12.3
	40 and above	10	13.7
Field of study	Computer Science	28	38.4
	Computer Engineering	17	27.4
	Engineering	12	12.8
	Others	16	21.9

Analysis for gender of top managers staff in the software firms showed that 84.9% were male and (15.1%) were females. This result implies that the majority (84.9%) of the respondents were male in top management levels of the firms as compared to their female counter-parts, revealing a gender imbalance of top management staff in software firms. Analysis on the age of the respondents shows that 26.0% are under 25 years of age, 31.5% are between 26-30 years old, 12.3% are in the 36-40 years of age group, while 13.7% are 40 years and above. This denotes that the largest proportion (31.5%) of the respondents is young and vibrant in the field.

On the years of experience, 35.6% of the respondents of the surveyed firms had gained experience in software development business activities for 2-5years, 39.7% for 6-9 years, 12.3% for 10-12 years, 8.2% for 13-15 years, and 4.1% for 16 years and above. This result denotes that the emergence of software development activities and the entry rate into the sector is increasing over time.

Furthermore, from Table 4, analysis of the results revealed that the fields of study of the top managers of the software firms were computer science (38.4%), computer engineering (23.3%), other engineering fields (16.4%), and others fields of study (21.9%). The result indicated that majority of top managers in software firms had computer science (38.4%) background.

Types of software innovation

According to the OECD (2018) definition, innovation could be entirely new or a slight improvement of an already existing goods or services. Table 5 revealed that 67 (91.8%), of the selected software firms engaged in the development of entirely new applications, 48 (65.8%) improved on existing applications, 15 (20.5%) applied entirely new software methodology, 56 (76.7%) improved on existing software methodology, 42 (57.5%) introduced entirely new software services, 57 (78.1%) slightly improved on existing software services, 64 (87.7%) initiated entirely new software designs, while 44 (11,2%) slightly improved on existing design interface. However, the most prominent type of innovations the software firms surveyed embarked on, were the development of entirely new applications (91.8%), followed closely by the initiation of entirely new software design (87.7%) and slightly improving on existing software service (78.1%). This implies that software firms engage mostly in radical software innovations and developing new applications, designs and services, indicating the innovativeness of the software firms.

Table 5: Types of software innovations

Types of software innovations	Frequency	Percentage
Develop entirely new applications	67	91.8
Improved on existing applications	48	65.8
Apply entirely new software methodology	15	20.5
Improved on existing software methodology	56	76.7
Introduced entirely new software services	42	57.5
Slightly improved on existing software services	57	78.1
Initiated entirely new software design	64	87.7
Slightly improved on existing design interface	44	11.2

**Multiple Responses: Dichotomy group tabulated at value 2-Yes*

Software firms' innovation activities

In the process of software development, innovation activities play a crucial role in determining the interactive-nature of the software product. The result denotes the details of the selected software firms' innovation activities, categorized into three groups as Human-Centered Design (HCD), Usability/User Experience (UX), and User Interface (UI). The findings are based on the assessment of the extent to which the firm's engaged in the different categories of software innovation activities (SIAs).

The analysis of software innovation activities among the selected software firms, is shown in Table 6, where it was revealed that the software firms engaged to a great extent in the HCD SIAs (μ=3.6247) such as 'organizing teams with multidisciplinary skills' (μ=4.27), 'using iterative and incremental development process' (μ=3.81),

'conducting research to understand users tasks and environment' (μ=3.73), 'designing based on users' experience' (μ=3.34) and 'involving users at all developmental stages' (μ=2.97). This is in conformity with the study of Ogunyemi *et al.*, (2018) where the companies surveyed showed some level of HCD practice. Also, Table 6 indicates that the UX SIAs (μ=3.4505) of the firms is to a moderate extent where the firms engaged in 'developing process in full compliance with global standards' (μ=3.96), 'organizing remote or in-person usability test' (μ=3.88), 'organizing contents for easy discovery and navigation' (μ=3.77), 'incorporating stakeholders' requirements' (μ=3.66), 'experts reviewing software documents and products to ensure due adherence' (μ=3.58) as well as 'early and continuously developing prototypes' (μ=3.58), 'quality and performance rating of software products' (μ=3.37), 'achieving users' requirements documentations' (μ=2.68) and 'developing parallel features for a robust system' (μ=2.59).

Table 6: Software firms' innovation activities

Software firms' innovation activities		**Mean**
Human- Centered Design (HCD) (μ= 3.6247)	Conducting Research to understand users, tasks and environment	3.73
	Involving users at all developmental stages	2.97
	Designing based on users' experience	3.34
	Using iterative and incremental development process	3.81
	Organizing teams with multidisciplinary skills	4.27
Usability/User Experience (UX) (μ=3.4505)	Developing process in full compliance with global standards	3.96
	Organizing remote or in-person usability test	3.88
	Organizing contents for easy discovery and navigation	3.77
	Incorporating stakeholders' requirements	3.66
	Experts reviewing software documents and products to ensure due adherence	3.58
	Early and continuously developing prototypes	3.58
	Quality and performance rating of software products	3.37
	Achieving Users' requirements documentations	2.68
	Developing parallel features for a robust system	2.59
User Interface (UI) (μ=2.8527)	Developing universal designs	3.08
	Developing easy and understandable designs	3.63
	Creating style guides for each UI component	2.37
	Developing consistent and familiar designs for different applications	2.33

This also corroborated with the study of Ogunyemi *et al.* (2018) that software companies excluded usability requirements in many cases from requirement and the companies are silent about it to avoid additional cost. Moreso, Table 5, reveals that the software firms engaged to a moderate extent in UI SIAs (μ=2.8527) such as 'developing easy and understandable designs' (μ=3.63) and 'developing universal designs (μ=3.08), 'creating style guides for each UI component' (μ=2.37) and 'developing consistent and familiar designs for different applications' (μ=2.33). In Ogunyemi *et al.,* (2018) study, participants of the survey revealed that their UI was barely functional, the usability awareness among the software firms was very low, the user experience values were prioritized base on the 'ease of use' and the major challenge of the software firms was not having adequate number of professionals in the team. Hence, from this study, there is a significant improvement of the SIAs among software firms in Nigeria as compared to their innovation activities some few years back.

Comparative analysis of innovation activities variables in software firms

A comparative analysis of the mean scores for the three SIA categories (HCD, UX and UI) was conducted using an analysis of variance (ANOVA) test (Table 7). This is to indicate the overall extent to which the software firms engage in SIA, by comparing the means of the three SIA categories. The descriptive analysis reveals the ground mean of the firms SIA as (μ=3.3093) indicating that the software firms to a moderate extent engage in SIAs and are assessed to be at the ICML 3, the supported innovation level. This implies the consistent development of innovative software products where software innovations that are consistently

implemented by software firms to absorb new knowledge that would improves their IC to manage the firm (Octasylva, *et al.,* 2022). Also, Table 8 shows the results of the Analysis of Variance (ANOVA) test for the software firms' SIA, which reveals that the significant F-statistic (31.064) with a p-value of .000 indicate that there is a significant difference between and within the groups of the variable.

Table 7: Comparative Analysis of Software Innovation Activities

Innovation Activities	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini	Max
					Lower Bound	Upper Bound		
HCD	73	3.6247	0.7179	0.0840	3.4571	3.7922	1.60	4.80
UX	73	3.4505	0.5383	0.0630	3.3249	3.5761	1.89	4.33
UI	73	2.8527	0.5919	0.0693	2.7146	2.9909	1.50	4.00
Total	219	3.3093	0.7011	0.0474	3.2159	3.4027	1.50	4.80

Table 8: Software Innovation Activities Analysis of variance (ANOVA) Test

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	23.933	2	11.966	31.064	0.000
Within Groups	83.207	216	0.385		
Total	107.139	218			

SUMMARY/CONCLUSION

Software firms in Nigeria were in the business of buying and selling software products about two decades ago but now are developing customized software products that are solving specific business problems for organizations in diverse sectors such as finance, healthcare, education, and other commercial enterprises. Hence, the study sought to examine the extent to which selected software firms in Nigeria have built their innovation capability to engage in software innovations activities. According to the findings from this study, it was revealed that the majority of the selected software firms within the study area were established between 2011 and 2020, exhibiting a significant rate of entry into the global software market, engaging in the development of entirely new software products and improving existing products. Moreso, the firms engaged in software innovation activities to a great extent in HCD and UX, whereas the firms engaged to a moderate extent in UI activities. Overall, it was revealed that the firms had moderately engaged in software innovation activities and where classified to be on level 3 of the ICMM framework which indicated that the firms are consistently developing novel products thus enabling them to maintain their position on the global software market.

RECOMMENDATIONS

The study therefore recommends that Nigerian software firms should not only maintain their position in the global software market rather they should engage more to a great extent in software innovation activities in order to become global industry leaders. Thus, it is recommended that they should

- focus on user-centric designs where users ability will be taken into cognizant while developing software products
- ensure adequate engagement in user research and usability testing to gather appropriate feedback from users on the ease of use, learning and navigation through the user interfaces in order to continuously improve the user experience.
- encourage the acquisition of new HCI knowledge for the effective incorporation of newer interactive features, intuitive interfaces, and customized options for user satisfaction.

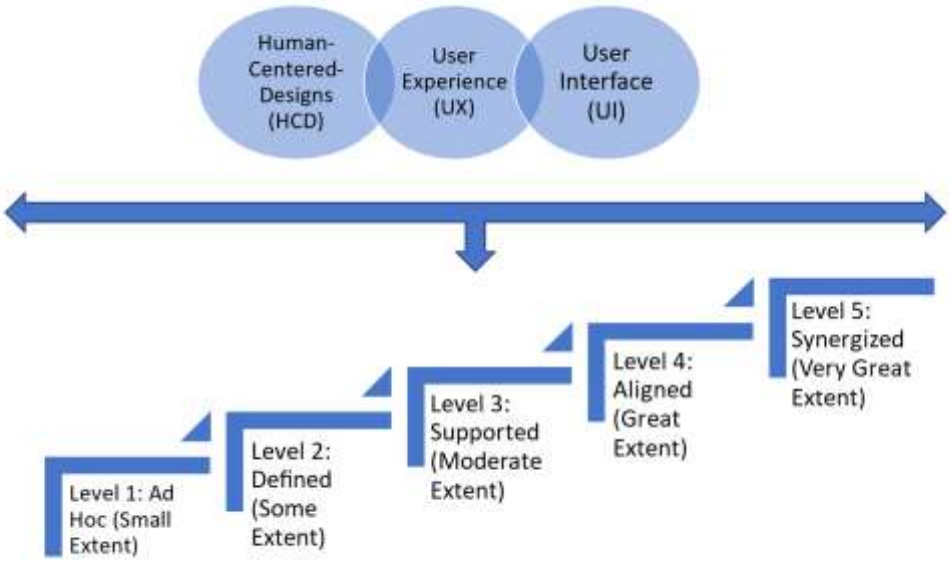

Figure 2: The Innovation Capability Maturity Level of the Selected Software Firms in Nigeria

References

Arends, S. C., and Advisory, B. G. K. I. (2018). Development of a firm-level innovation capability maturity model and identification of innovation archetypes. Eindhoven University of Technology, Netherlands.

Bannon, L. (2011). Reimagining HCI: toward a more human-centered perspective. *interactions*, *18*(4), 50-57.

Baxter, G., & Sommerville, I. (2011). Socio-technical systems: From design methods to systems engineering. *Interacting with computers*, *23*(1), 4-17.

Bennett, S., Bishop, A., Dalgarno, B., Waycott, J., & Kennedy, G. (2012). Implementing Web 2.0 technologies in higher education: A collective case study. *Computers & education*, *59*(2), 524-534.

Berni, A., and Borgianni, Y. (2021). From the definition of user experience to a framework to classify its applications in design. Proceedings of the Design Society, 1, 627-1636.

Bourimi, M., Barth, T., Haake, J. M., Ueberschär, B., & Kesdogan, D. (2010). AFFINE for enforcing earlier consideration of NFRs and human factors when building socio-technical systems following agile methodologies. In *Human-Centred Software Engineering: Third International Conference, HCSE 2010, Reykjavik, Iceland, October 14-15, 2010. Proceedings 3* (pp. 182-189). Springer Berlin Heidelberg.

Bullinger, H. J., Kühner, M., & Van Hoof, A. (2002). Analysing supply chain performance using a balanced measurement method. *International Journal of Production Research*, *40*(15), 3533-3543.

Carayon, P. (2006). Human factors of complex sociotechnical systems. *Applied ergonomics*, *37*(4), 525-535.

Charan, J., Kaur, R., Bhardwaj, P., Singh, K., Ambwani, S. R., & Misra, S. (2021). Sample size calculation in medical research: a primer. *Annals of the National Academy of Medical Sciences (India)*, *57*(02), 074-080.

Chinhanga, S. S. (2018). Investigating the principal barriers to innovation in telecommunication enterprises operating in a dynamic and unstable macroeconomic environment.

Dillon, A. (2000). Group dynamics meet cognition: applying socio-technical concepts in the design of information systems. In Coakes, E., Willis, D. and Lloyd-Jones, R. (eds). The New SocioTech: Graffiti on the Long Wall Springer Verlag Series on CSCW, London: Springer, 119-125

Divisekera, S., and Nguyen, V. K. (2018). Determinants of innovation in tourism evidence from Australia. Tourism Management, 67, 157-167.

Giacomin, J. (2014). What is human centred design? *The design journal*, *17*(4), 606-623.

Israel, G. D. (1992). Determining sample size.

Kiveu, M. N., Namusonge, M., and Muathe, S. (2019). Effect of innovation on firm competitiveness: the case of manufacturing SMEs in Nairobi County,

Kenya.*International Journal of Business Innovation and Research*, 18(3), 307-327.

Knoke, B. (2013). A Short Paper on Innovation Capability Maturity within Collaborations. In NGEBIS Short Papers. 7-11.

Michael, K., Abbas, R., & Roussos, G. (2023). AI in cybersecurity: The paradox. *IEEE Transactions on Technology and Society*, *4*(2), 104-109.

Mohammed U. F, and Ephraim, C. O. (2018). Consumption of foreign software and its effects on the development of indigenous software in Nigeria. *International Journal of Science and Research (IJSR),* 7(296), 921-930

Octasylva, A. R. P., Yuliati, L. N., Hartoyo, H., and Soehadi, A. W. (2022). Innovativeness as the Key to MSMEs' Performances. Sustainability, 14(11), 6429, pp. 1-14.

OECD/Eurostat (2018), Measuring External Factors Influencing Innovation in Firms (Chapter 7 from the Oslo Manual 2018 'Guidelines for Collecting, Reporting andUsing Data on Innovation, 4th Edition')

Ogunyemi, A. A., Lamas, D., Adagunodo, E. R., Loizides, F., and Da Rosa, I. B. (2016).Theory, practice and policy: An inquiry into the uptake of HCI practices in the software industry of a developing country. *International Journal of Human–Computer Interaction*, 32(9), 665-681.

Ogunyemi, A., Lamas, D., Adagunodo, E. R., and da Rosa, I. B. (2015). HCI practices in the Nigerian software industry. In Human-Computer Interaction–INTERACT 2015: 15th IFIP TC 13 International Conference, Bamberg, Germany, September 14-18, 2015, Proceedings, Part II 15 (pp. 479-488). Springer International Publishing.

Ogunyemi, A., Lamas, D., and Eze, E. (2018). Exploring the state of human-centered design practice in software development companies: A cross-case analysis of three Nigerian software companies. Interacting with Computers, 30(5), 444-467.

Punchoojit, L., and Hongwarittorrn, N. (2017). Usability studies on mobile user interface design patterns: a systematic literature review. Advances in Human-Computer Interaction.

Qian, C., Cong, X., Yang, C., Chen, W., Su, Y., Xu, J., Liu, Z., and Sun, M. (2023). Communicative agents for software development. arXiv preprint arXiv:2307.07924

Rose, J., and Furneaux, B. (2016). Innovation drivers and outputs for software firms: Literature review and concept development. Advances in Software Engineering, 2016, (3), 1-25

Rusu, C., Rusu, V., Roncagliolo, S., and González, C. (2015). Usability and user experience: What should we care about? *International Journal of Information Technologies and Systems Approach (IJITSA),* 8(2), 1-12.

Sa'ad, M., and Jakwa, G. (2022). Quality Software Design, Development and Implementation in Nigeria: A Panacea to National Crisis. International *Journal of Innovative Scientific and Engineering Technologies Research* 10(3), 9-19.

Sharda H. D. V. (2016). Factors affecting innovation capability of Indian software firms (with special reference to Indore city). International Research Journal of Engineering and Technology (IRJET). 3(12). 1213-1219

Sharma, V., and Tiwari, A. K. (2021). A study on user interface and user experience designs and its tools. *World Journal of Research and Review (WJRR),* 12(6), 41-45.

Soyinka, T.F. (2019). Reasons Why You Should Start a Business in Nigeria Today retrieved on the 13th of September, 2023 from https://www.linkedin.com/

Sözbilir, F. (2018). Innovation capacity and innovation performance in terms of educational level of managers. İşletme Araştırmaları Dergisi, 10(2), 1-12.

Spruyt, E. (2021). "African Software Developers: Best Countries for Sourcing in 2021". Retrieved from https://tunga.io/ on 12th November 2021.

Sridevi, S. (2014). User Interface Design. *International Journal of Computer Science and Information Technology Research* 2(2), 415-426

Science and Technology, Second Edition (pp. 394-400). IGI Global.

West, M. A. and Farr, J. L. (Eds) (1990). *Innovation and Creativity at Work: Psychological and Organizational Strategies*, Wiley, Chichester

Zubairu, H. A., Oyefolahan, I. O., Babakano, F. J., Etuk, S. O., and Mohammed, I. K. (2020). Assessing the E-readiness of Nigeria for Digital Economy. *American Journal of Computer Science and Information Technology*, 8(2), 1-6