An Empirical Evaluation of Software Quality Assurance Practices and Challenges in a Developing Country

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Abstract—Globally, it has been ascertained that the implementation of software quality assurance practices throughout the software development cycle yields quality software products that satisfies the user and meets specified requirements. The awareness and adoption of these techniques has recorded increase in the quality and patronage of software products. However, in developing countries like Nigeria indigenous software produced is not patronized by large corporations such as banks for their financial portfolio, and even the government. This research investigated the software quality assurance practices of practitioners in Nigeria, and the challenges being faced in implementing software quality in a bid to improve the quality and patronage of software. It was observed that while most practitioners claim to adhere to software quality practices, they barely have an understanding of software quality standards and a vast majority do not have a distinct software quality assurance team to enforce this quality. The core challenges inhibiting the practice of these software quality standards have also been identified. The research has helped to reveal some issues within the industry, of which possible solutions have been proffered.

Keywords—software, software quality, software quality challenges, software quality assurance

I. INTRODUCTION

Software engineering is the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software, and the study of these approaches; that is, the application of engineering to software [1]. According to Sommerville, [2] it is an engineering discipline that is concerned with all aspects of software production from the early stages of system specification to maintaining the system after it has gone into use.

Globally, this field of engineering is growing rapidly, and becoming more structured than ever. At the moment, it is more relevant than it has ever been in history. Software products are ubiquitous and changing the face of businesses globally. They are being used to monitor and deploy government infrastructures, to manage financial portfolios, carry out medical procedures, build and control real-time and mission critical systems that can't afford to fail. Although standards in the field are not yet as pronounced and enforced as in other engineering disciplines; there are best practices and already proven quality techniques that should be taken with austerity, if quality software is to be developed.

However, this universal growth in the field is not so evident in developing countries; a negative trend is observed instead. It is indeed saddening to know that only 10% of the software products used in Nigeria is built by indigenous companies; the larger percentage comes from outside the country, specifically India. It is on record that Nigeria loses an average of $1 billion dollars to software importation annually; between 1995 and 2008, N23 billion was spent on the purchase of foreign software, and in 2012 alone, over N59bn was transferred out in purchase and maintenance of software; even the government invests so much in foreign software. Nigeria has been noted to be one of the major importers of software products in sub-Saharan Africa [3,4,5]. An explanation to all these might be that the local companies are not producing quality software products.

The quality of a software product is determined by how much the product meets the customer's requirements, how much the product performs to specifications and the number of defects in it. It is well known, that high quality products are always patronized to the detriment of substandard ones. Therefore, a need for the assessment of the software development practices in indigenous companies in Nigeria, in a bid to unravel the cause of its low patronage and recommend possible solutions to move the industry forward is what motivated this research.

As such, this research evaluated software companies in the country based on their software quality management and assurance practices in the process of developing software products. The research questions this work sought out to evaluate are as follows:

RQ1: Do software companies in Nigeria engage in software quality planning?

RQ2: Do software companies in Nigeria follow certified standardized processes and procedures

RQ3: What are the challenges inhibiting the adoption of quality practices?

The instrument used to collect data was the questionnaire and the data collected was used to answer the research questions.

The next section presents a literature survey of previous works carried out in the area of software quality management and assurance, followed closely by the detailed methodology that this research work employed. The results of the findings are then be presented, followed by the discussion of results, recommendations, and conclusions.

II. LITERATURE

A. Quality

Quality in the language of software engineering as discussed by Lewis [6] means 'meeting requirements' and 'fitness for use'. This implies that the software meets the requirements of the users as stated in the requirements specification, and it does exactly what the user needs. Quality is considered a vital requirement of software products, a business essential, a competitive necessity, and a survival issue for the software industry [7].

B. Quality Management

Quality management entails all planned systematic activities and processes for creating, controlling and assuring quality. It is not just a task, but it is a habit that needs to be ingrained into a company's culture [8].

C. Software Quality Assurance

Software Quality Assurance (SQA), is a well-defined, repeatable process that is integrated with project management and the software development lifecycles to review internal control mechanisms and assure adherence to software standards and procedures. The objective of the process is to assure conformance to requirements, reduce risk, assess internal controls and improve quality while conforming to the stated schedule and budget constraints [9].

SQA is the planned and systematic approach to the evaluation of the quality of and adherence to software product standards, processes and procedures [10]; it is a continuous process and assessment [11].

D. Quality Planning

This is the process where a specific quality plan is developed for particular project. It involves a selection of organizational standards that are specific to the software project in question and the development process to be used. It also specifies how the quality assessment process will be carried out.

E. Challenges Inhibiting Iplementation of Software quality Assurance

Software companies frequently face many difficult challenges in their attempt to deliver high-quality software and strife to achieve customer satisfaction [15]. From different literatures, possible factors that can impair software quality management include: impatient management, strict deadlines, developer ego, extra cost required (e.g. for the purchase of tools), bureaucracy, inadequate tools that can help to automate the process, low level of acquaintance and knowledge of the process, lack of organizational training on quality standards, inexistent framework for quality management in the organization, disapproval by top management, contrary beliefs and opinion, and previous futility of the process.

F. Related Works

Generally, quality management processes are not strictly adhered to by software companies, and this reduces the overall quality of the software produced. Different researches have been carried out to confirm this.

An empirical study was carried out in [16] to evaluate the proper implementation of measurement and metric programs in software companies in an area in Turkey. From their research, they observed a common reluctance and lack of interest in utilizing measurements/metrics despite the fact that they are well known in the industry. They also discovered that internationally recognized standards such as ISO and CMMI are only followed if they are explicitly specified as a project's requirements.

An assessment [17] of the implementations of quality standards in the software industry of Turkey was done. They found out that even organizations that have the ISO and CMMI certificates do not follow the prescribed directives of this organization after obtaining the certificates. They found out the companies do not see quality issues as primary, some don't even know the names of common quality standards; they believe acquiring the standards are just for 'show-off' and that they do not necessarily influence the quality of the products, neither do they make the customers happy which is their priority.

A group of researchers investigated [18] the state of software engineering ethics in Nigeria. They observed nonchalance, dispassion and mass negligence on the issue. They also showed with the aid of a case study, that the ACM/IEEE software engineering code of ethics when applied to software development project help to resolve ethical dilemmas. A research [19] to feel the pulse of software professionals in Nigeria on their perceptions of the software inspection as a software quality assurance activity was carried out. The authors used a structured questionnaire research instrument for their work. They found out that software inspection is highly neglected in their software development process, as they consider it a waste of time.

All these works individually assessed only a part of the entire software quality management process This research on the other hand goes beyond that to identify the challenges and discover why it is so in Nigeria so that peculiarities in the environment can be unraveled and suitable solutions proffered.

III. RESEARCH METHODOLOGY

The qualitative research methodology was used for this work. After a survey of different articles and software textbooks, the research questions for this work were clearly

determined. From the review of literature, activities involved in software quality assurance management were garnered; possible factors that inhibit these practices (i.e. challenges) were identified likewise, and were used to form a closed-ended questionnaire which was used as the research instrument for this survey in a bid to answer the posed questions.

The first section of the instrument is on the background information of the individual and his/her organization. The subsequent sections are: quality standards, quality planning, and challenges faced. The questionnaire was reviewed and validated. The structure of the questions and its suitability for the research at hand was also verified by a statistician. The instrument was then revised to effect the changes and comments. A pilot survey was then conducted to ensure that respondents have the correct understanding of the questions.

The questionnaires were then distributed to stakeholders in software development in Lagos being the hub of software activities in Nigeria, and the home to nearly 50% of all software firms in Nigeria [20], and the data collected was collated and analyzed. The results were discussed, and based on the findings, conclusions made. Fig. 1 illustrates this.

IV. RESULTS

A total of 65 (sixty-five) questionnaires were distributed. 63 (sixty-three) were valid, and 2 (two) invalid. The analysis of the data gathered is as follows:

On quality standards as seen in Table 1 and Fig. 2, 71.6% of the respondents reported that their organizations observed quality standards while only 7.6% said they have no idea of what quality standards are.
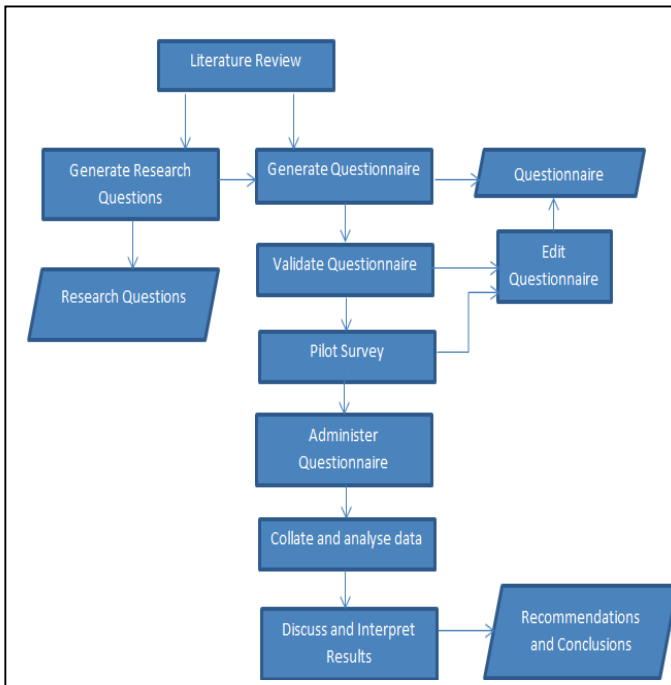
TABLE I. QUALITY STANDARDS

Questions	Yes	No Idea	No
Do you have defined organizational processes for software development in your company? (A)	54	1	8
Do you have defined standards that govern processes for software development in your company? (B)	53	3	7
Are members of staff usually trained on the quality standards of your organization? (C)	48	6	9
Does your organization have a software quality assurance team? (D)	41	5	17
Is your organization's quality assurance team different from the project development team? (E)	28	9	26

However, it was noticed that about 35% either do not have a SQA team or have no idea about it, while only 44% have a SQA team that is separate from the development team.

On quality planning, as seen in Table 2 and Fig. 3, only 39.7% always carry out these activities. Only 17 of the respondents reported that they carry out risk management activities.

The respondents accented the fact that there are challenges that inhibit adherence to software quality practices. The major ones being strict deadlines (43 respondents), inadequate manpower (34 respondents), lack of adequate planning (33 respondents), bureaucracy of the process (31 respondents), and extra cost involved (30 respondents). Fig. 6 shows the details.

V. DISCUSSION

86% of the respondents were male while only 14% were female. Most of the respondents had 0-5 years of experience, while the sizes of the organization (based on the staff strength) were varied.
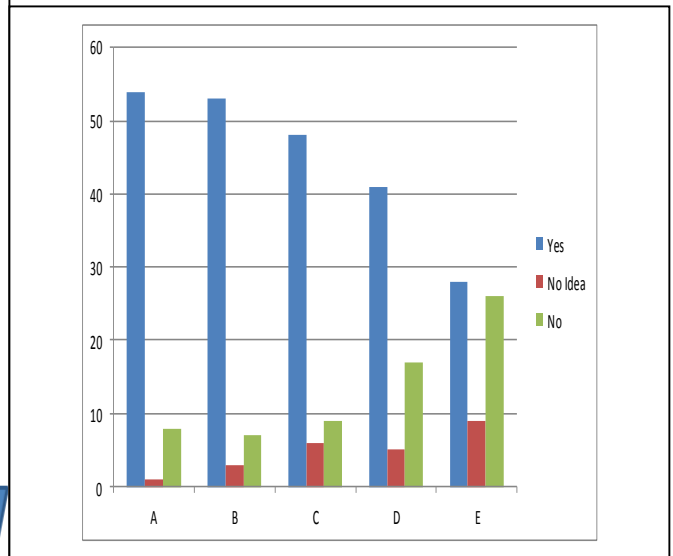

Fig. 1. Research Methodology Framework

Fig. 2. Quality standards

TABLE II.   QUALITY PLANNING

Questions	Always	Often	No Idea	Rarely	Not at all
Do you develop a quality plan for new software projects before their commencement? (A)	29	17	4	12	1
How often do you use a project schedule plan for each software project? (B)	25	29	1	6	2
Do you use a project management plan for each software project? (C)	32	19	3	7	2
Do you carry out risk management activities for your software projects? (D)	17	16	7	16	7
Do you use a budget plan for every software project? (E)	22	16	6	13	6

TABLE III.   CHALLENGES

Fig. 3. Quality Planning

From the results, software Nigeria do engage in software quality planning, improve their quality processes over time, and carryout quality control measures. However, there is no evidence that they follow certified standardized processes and procedures, and those certified by international organizations are less than a quorum.

Software practitioners in Nigeria attested to the fact that there are challenges that prevent adherence to these quality practices. Particularly, the results showed that strict deadlines are a major factor which means that when the time to market is very close, a lot of steps to ensure standards are bypassed. Lack of adequate planning to incorporate these quality processes into the software development process, inadequate manpower, bureaucracy involved in the process and the extra cost involved are other major inhibiting factors.

A majority of the software developers that work in this organizations partake in a minimum of 3 phases of the software lifecycle, this shows that the same set of people are involved in different aspects of a project simultaneously which is not a very good practice because, a likely error

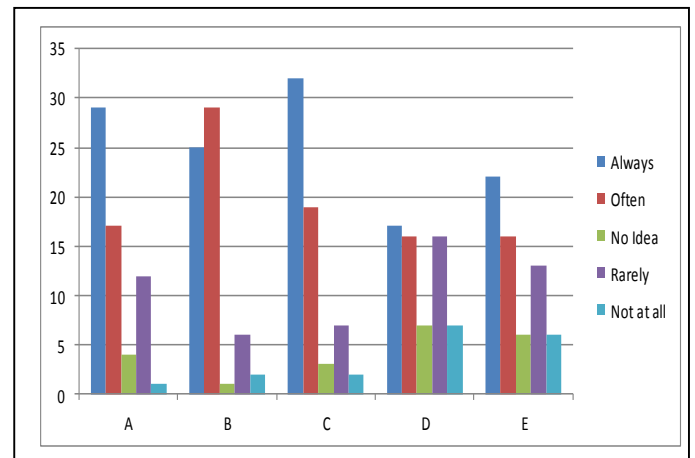committed might not be discovered, it sometimes takes another eye to see a defect.

VI. RECOMMENDATION

From the findings of this research, the following are recommended.

The Institute of Software Practitioners of Nigeria (ISPON) should establish a set of quality standards. These standards should be based on existing internationally acclaimed standards but adopted to fit into the peculiarities of the Nigeria software industry. They should then ensure that the software practitioners adhere strictly to these standards.

Software companies should have a SQA team which should be separate from the development team. They should also ensure members of staff are adequately trained not only on the technical aspects, but also on the quality standards of the organization, the industry and their importance.

| Questions	Strongly Agree	Agree	No Idea	Disagree	Strongly Disagree
Strict deadlines (A)	13	30	4	11	5
Developer ego (B)	5	21	10	16	11
Extra cost required (e.g. for the purchase of tools) (C)	10	20	9	20	4
Bureaucracy involved in the process (D)	10	21	8	20	4
Inadequate automated tools (E)	7	14	10	25	7
Low level of acquaintance and knowledge (F)	6	16	11	20	10
Inexistent framework for quality management in the organization (G)	5	16	12	21	9
Lack of adequate training about the organization's quality framework (H)	6	18	11	23	5
Disapproval by top management (I)	7	14	11	21	10
Contrary beliefs and opinion (J)	2	24	14	16	7
Previous futility of the process (K)	2	19	15	22	5
Inadequate capacity (manpower) (L)	8	26	7	18	4
Lack of adequate planning to incorporate software quality processes (M)	8	25	7	16	7
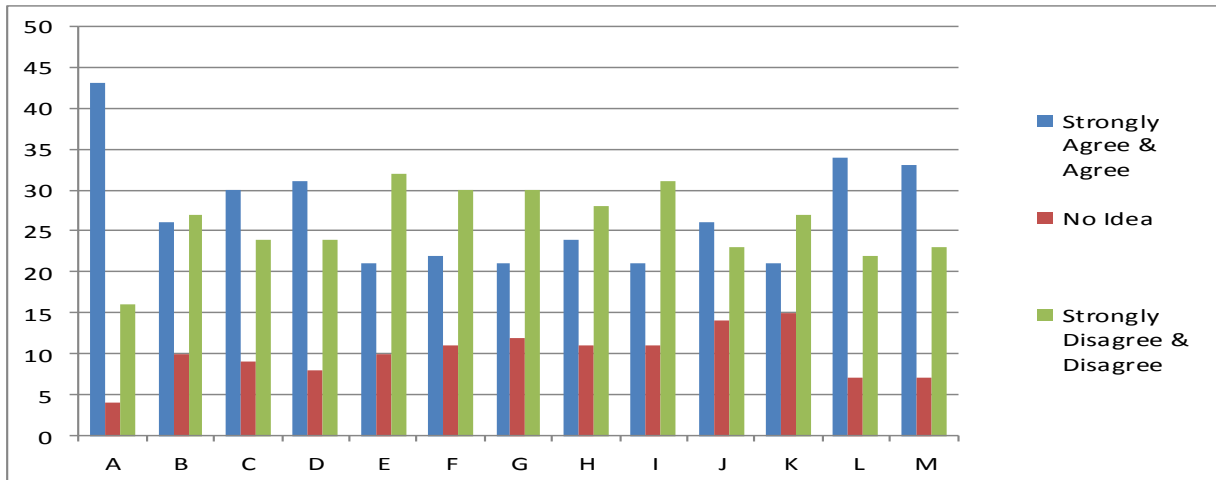
Fig. 4. Challenges

VII. CONCLUSION

The research has been able to assess the quality assurance practices of stakeholders in the software industry. In order to reduce the level of importation of software in Nigeria, some actions points need to be taken. Based on the current state of things, suggestions have been recommended, which if adopted will propel the industry forward. The importance and essence of quality in the aspect of software development cannot be overemphasized. If quality software is produced by a firm, then such firm can be trusted. If firms follow due processes and quality assurance techniques, they'll be able to build more robust systems, and reliable safety critical systems. The software industry in Nigeria has to take steps in this line.

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