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ISSUES AFFECTING TESTING ACTIVITIES IN PORTING MOBILE APPLICATIONS

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Abstract: Competitions in the mobile market has driven mobile software application organizations to meet market demand by developing applications within a short period of time which should run on different mobile platforms. As such, porting these mobile applications to other platforms once they have been developed on one platform, has been considered a desirable attribute. However, the methods used in porting these mobile applications to other platforms have been adhoc which has also affected the testing activities of the ported mobile applications. Literatures revealed that 85% of testers do not use specific models for testing mobile applications. The lack of use of specific models has also made testing of the ported mobile applications to be adhoc based. In this research, issues responsible for affecting the testing activities in porting mobile applications were identified and highlighted. Data were gathered through questionnaires and interviews and analyzed. The results showed that testing requirement phase is usually overlooked by the testing teams. The results also revealed the problem of communication between the developers and the testing teams due to lack of a well-defined testing strategy peculiar to porting mobile application.

Keywords: Mobile Application, Ported Software Applications, Testing Activities, Testing Standards

INTRODUCTION

The mobile applications development is one of the fastest growing businesses. In 2009 alone [1], out of the about 6.4 billion native and third party mobile applications that were downloaded yielded an income of almost $4.5 billion estimating global business application to be worth $25 billion by the year 2015.
Moreover, different mobile companies (such as iPhone, Blackberry, Nokia etc.) provide different mobile operating system and as such, most of the mobile companies own their mobile application market. For instance the Ovi market by Nokia, iPhone application market, BlackBerry application market, Andriod application market and so on [2]. The App Store (a platform where mobile applications are published and sold) for example launched by apple one year after the Apple introduced the iPhone, opened a new world for mobile applications development to gain momentum; where software companies such as Adobe started porting their desktop application to mobile device and other

companies such as Google, Microsoft, Nokia and others began their own App Store and joined the competition creating a significant impact of mobile applications in the software industry [3]. The high demand of applications in the mobile market – due to competition – has required mobile organizations to develop an application within a short period of time to meet the competitive market's demand [4]. Consequent to that, porting these mobile applications to other platforms has been considered as a desirable attribute by mobile organizations; however the methods used in porting these mobile applications are often ad hoc based [5]. A research conducted by Dantas et. al [6] showed that 70% of mobile developers used the incremental model approach for developing the mobile application while some combined the incremental with prototyping approach to effectively validate the requirements with clients. On the contrary, 85% of testers do not use specific models for testing mobile applications even though, they often considered testing on emulators as the real devices but the testers were not using testing process peculiar to the mobile application which implies that the testing of the applications are ad hoc based. More so, as more enterprises "go mobile", they are discovering that traditional software testing methods (which they have been using) are no longer suitable to ensure the quality and performance of their new mobile apps and websites[7]. This research therefore intends to identify and present the issues that are affecting testing activities in the mobile application with focus on porting of the mobile applications. Data will be gathered (through questionnaires and interviews) and properly analyzed to reveal the problems.

SOME EXISTING PROBLEMS WITH TESTING ACTIVITIES IN MOBILE ORGANIZATIONS

Mobile organizations are aware that "testing of software" in the pc-based environment has been one the activities that is most expensive when developing software. As such, these organizations have (as well) refused to pay adequate attention to the process of testing mobile applications [8]. Lack of paying attention to the testing process during mobile application development [6], has resulted to most organizations not to have a testing process which is peculiar for the mobile applications environment. Testing performed in the mobile application environment are not executed systematically rather they are carried out by developers and testers based on their intuition or previous experience from the pc-based environment. Due to this misunderstanding and improper application of a testing strategy based on proper software engineering techniques, quite a number mobile applications for instance (13% for windows phone market, 24% for apple store and 37% for android market) were being removed from the app store every month in 2011 [9, 10].

EFFORTS MADE ON IMPROVING SOFTWARE TESTING PROCESS

There had been quite efforts made by individuals and organizations to improve the testing process (using existing testing standards/models) during software application development. The standard/model have few limitations which has made it difficult to be applied to porting mobile applications. For instance, the V-Model uses what is known as the parallel testing strategy[11-13]. Parallel testing strategy addresses software applications which are built from scratch. However, in porting software applications, part of the testing requirements are already in existence and the porting specifications are clear. IEEE 829 testing strategy is another example of an organization that has also made effort on improving the software testing process by emphasizing on documenting each testing phase, but the mobile application environment is agile-based which emphasizes on less documentation[14]. Besides, the rate at which mobile applications are needed by users nowadays will not be feasible to follow the documentation recommendation by IEEE 829.Other literatures on improving software testing process as stated inJerome et. al [15], Ralph and Gerard [16], RapidSoft_Systems [17].

DATA GATHERING

There are four ways of properly collecting data according to Sapsford and Jupp [18] namely: through observational research, research and information on the internet, asking questions and using documents. This research used all the techniques mentioned by Sapsford and Jupp with the exception of observational research technique.

QUESTIONNAIRES

According to Krysik and Finn [19], questionnaires are economical and feasible when gathering data from so many respondents. The questionnaire is a feasible way of gathering different opinions, perspective for proper statistical analysis and valid result. More so, a questionnaire that is well-designed can effectively gather information required and needed for the research conducted. Based on that, the questionnaire constructed focused on two basic practitioners – mobile application programmers and testers concerned with porting mobile applications. The mobile application programmers were selected because they perform some testing activities in the porting process. Testers were also selected because they performed testing on the finish product. The questionnaire being a quantitative approach was carried out by sending it online to mobile application porting experts and professional mobile testers. The online questionnaire was prepared using survey monkey (*www.surveymonkey.com*) – a website for creating and sending surveys online. The questionnaires were distributed to three different targets using the link (https://www.surveymonkey.com/s/7V2XWJ9) supplied to the researcher by survey monkey site. The first target was a professional social website known as www.linkedin.com.

The link (https://www.surveymonkey.com/s/7V2XWJ9) was sent to eleven (11) groups which the researcher joined. The first target which the researcher sent the online questionnaire to were in one way or the other related to the area of research such as Android porting group, Android porting and testing group, mobile handset and application testing and lots more. The total members in the entire first target group were over forty thousand (40,000). The second targets which the link was sent to as an attachment to a request mail were two mobile application porting companies. The link was sent to six (6) groups in goggle forum concerned with porting and testing mobile applications. Besides this, about ten (10) private mails were sent to expert practitioners in the field of research whom the researcher read their profile. It should be noted that the link sent to the groups, individuals and companies were formally structured in the sense that a piece of writing or letter was written containing salutation, purpose of the link sent and thank you message in advance.

INTERVIEWS

For the interviews, a semi-structured approach was used to have a clearer understanding of testing problems which occurred in the porting process knowing well that organizations might not be willing to say that any problem existed. However, using the semi-structured approach, the researcher was able to gather vital information and identify testing issues within the porting process. More so, the researcher used the seven (7) stages of an interview research approach highlighted by [20] which are:

Thematizing – Establishing the reasons for asking questions and categorizing this reasons under themes so that the interview would be easily analyzed to answer the research questions

Designing – Establishing how the intended knowledge would be obtained by designing the interview questions and preparing what would be used to record the interview sessions.

Interviewing – Conducting the actual interview with the interviewees carefully while recording it verbatim.

Transcribing – Converting the interview conducted into written text.

Analyzing – Analyzing the interview using appropriate analysis techniques.

Verifying – Establishing the generalizability, validity and reliability of the interview findings. Generalizability refers to how the answers agree to with broader

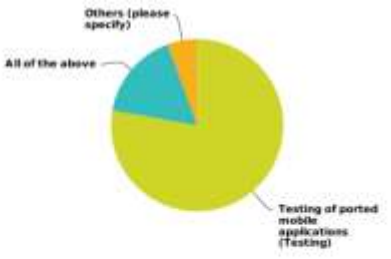
research. Validity refers to whether the interview achieved what it was intended for. Reliability here refers to whether the results are consistent.

Reporting – Communicating finding in an ethical manner.

DATA ANALYSIS

The quantitative analysis – which is the responses of the questionnaires received – are going to be presented using charts for ease of understanding. Every question asked in the questionnaire had a reason. The reason was to assist in affirming the existence of problems identified from secondary literatures and also to ensure that the researcher was on the right direction of finding solution to the problems identified. As such, every question would be described, analyzed and pictorially presented to explain the problems regarding testing strategy in the organization. As mentioned earlier, the survey was sent online to professional social network comprising a group of experienced professionals in the field of mobile application development/porting and mobile application testers and quality assurance. The qualitative data analysis would begin by tabulating the overview of the organization, the kind of business done in the organization, the number of experts interviewed, each interviewed expert's role, the expert's responsibility and the categories in which questions in the interview were asked. Although, the interviews carried out were semi-structured, the researcher transcribed each recorded session and properly made them presentable in a tabular form for understanding. The answers given by the interviewees are going to be analyzed afterwards in-line with goal of the research. From the questionnaires sent, twenty-three (23) responses were received. Out of this 23 questionnaire responses, four (4) were not filled completely but submitted; as such, it was not included in the analysis. The questions completed by the nineteen (19) respondents were the ones analyzed and discussed below.

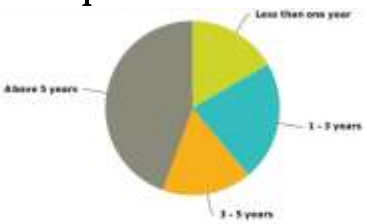
1. Which of the Category do you Fall into?



Answer Choices	Responses	
Development and porting mobile applications (Development)	0%	0
Testing of ported mobile applications (Testing)	77.78%	14
All of the above	16.67%	3
Others (please specify)	5.56%	1
Total		18

Figure 1: Classification of Respondents

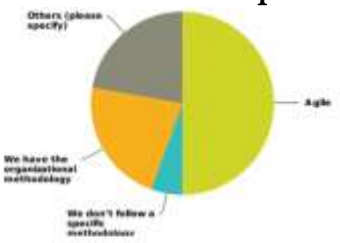
2. Years of Experience in the Category Selected in (1) above?



Less than one year	16.67% 3
1 - 3 years	22.22% 4
3 - 5 years	16.67% 3
Above 5 years	44.44% 8
Total	18

Figure 2: Years of Experience of Respondents

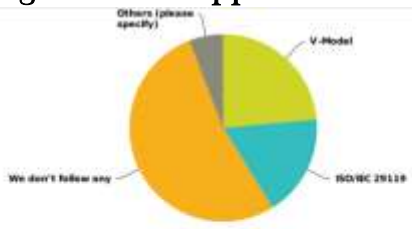
3. Which Methodology do you usually follow/use when Porting your Mobile Applications? For example Native Applications to another Platform?



Waterfall	0% 0
Agile	50% 9
We don't follow a specific methodology	5.56% 1
We have the organizational methodology	22.22% 4
Others (please specify)	22.22% 4
Total	18

Figure 3: Responses to Methodology Used when Porting Mobile Applications

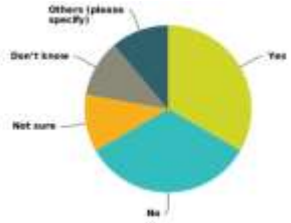
4. Which of the following Testing Standards or process Model do you follow when Porting a Mobile Application from one Platform to another?



V-Model	22.22% 4
IEEE 829	0% 0
ISO/IEC 29119	17.65% 3
We don't follow any	52.94% 9
Others (please specify)	5.88% 1
Total	17

Figure 4: Responses to Testing Standard or Model Used when Porting Mobile Applications

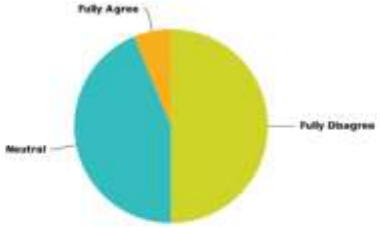
5. Do you know or use the Concept of Extreme Programming in your Organization?



Yes	
No	
Not sure	
Don't know	
Others (please specify)	
Total	

Figure 5: Responses to the Knowledge of Extreme Programming Concept

6. We don't have a Particular Methodology we use in Testing.



Fully Disagree	
Neutral	
Fully Agree	
Total	

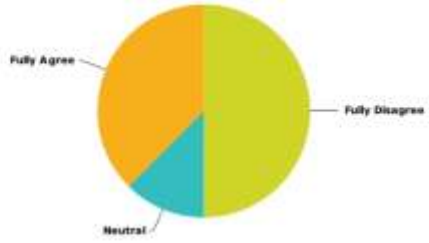
Figure 6: Responses to no Particular Methodology used in Testing

7. The Management gives the test Cases or the Strategy for Testing the Ported Mobile Applications.

Fully Disagree	
Neutral	
Fully Agree	
Total	

Figure 7: Responses to Test Cases given by the Management

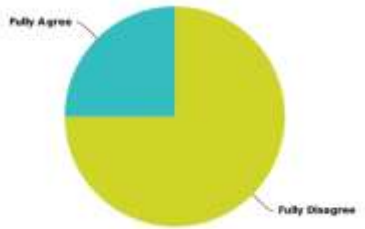
8. The Mobile Developers Port Applications and Write Test Cases for the Testing Team to Follow.



Fully Disagree	50%
Neutral	12.50%
Fully Agree	37.50%
Total	

Figure 8: Responses to Developers Port Applications and Write Test Cases

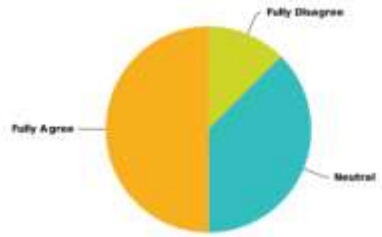
9. The Testing Team Test the Ported Applications using Test Cases Prepared by Developers



Fully Disagree	75%
Neutral	0%
Fully Agree	25%
Total	

Figure 9: Responses to Testing Team Test Ported Application Using Test Cases Prepared by Developers

10. The Test Lead/Manager is the same as the Quality Assurance Manager.



Fully Disagree	12.50%
Neutral	37.50%
Fully Agree	50%
Total	

Figure 10: Responses to Test Lead/Manager is the same as Quality Assurance Manager

11. The Test Lead/Manager is Effective or Necessary during the Gathering and Establishing of Porting Requirements and Specifications.

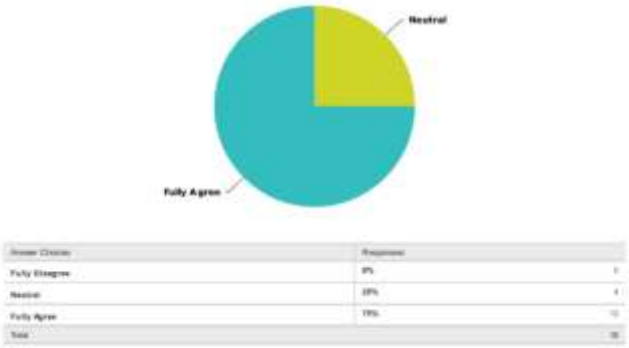


Figure 11: Responses to Effectiveness or Necessity of Test Lead/Manager during Establishing Porting Requirements

12. The Test Lead/Manager and the Testing Team Develop Test Cases for the Target Mobile Application to be Ported.

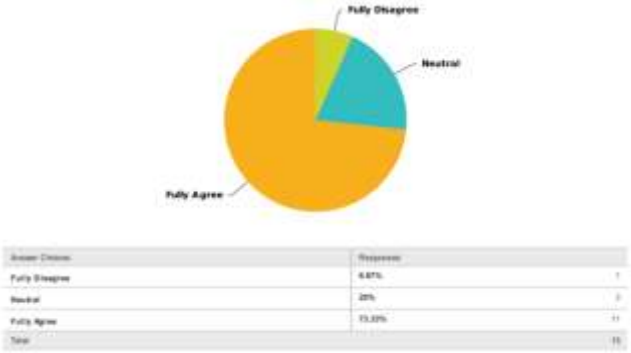


Figure 12: Responses to Test Lead/Manager and Testing Team Develop Test Cases for Target Mobile Application

13. The Test Lead/Manager need not Develop Test Cases because it would be Prepared by the Developer.

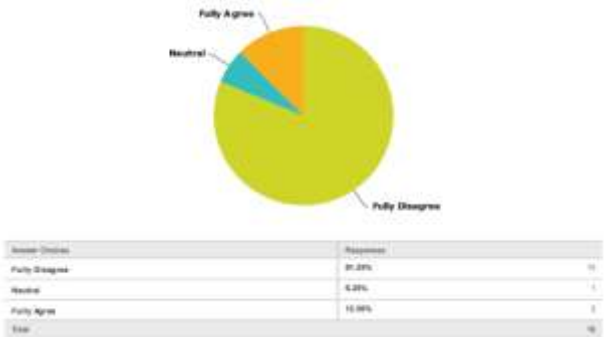


Figure 13: Responses to Test Lead/Manager does not need to Develop Test Cases because it would be prepared by the Developer

14. The Test Lead/Manager Need not Develop Test Cases because it would be Prepared by the QA Manager.

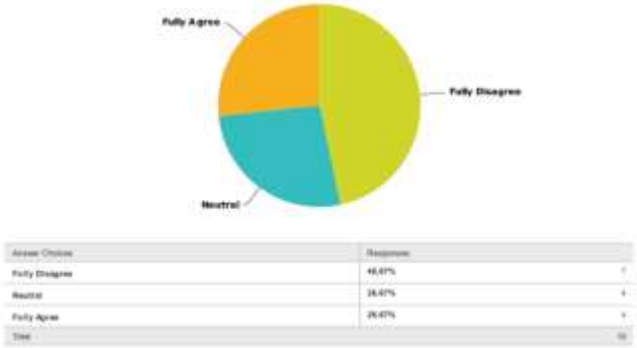


Figure 14: Responses to Test Lead/Manager does not need to Develop Test Cases because it would be prepared by the QA Manager

15. The Test Team seems to take time in Understanding Test Cases Handed Over to them by either the Management or QA or Developers.

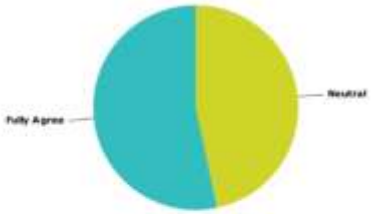


Figure 15: Responses to Testing Team take time to understand Test Cases Handed to them by Programmers or QA

16. We need a Testing Strategy that would Improve our Testing Activities in Porting Mobile Application Projects.

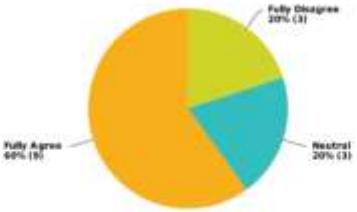


Figure 16: Responses to the need for Strategy to Improve Testing Activities during Porting Mobile Applications Projects

DEDUCTIONS FROM QUESTIONNAIRE ANALYSIS

Deductions according to [21] is an approach to data analysis where logical conclusions are drawn through the process of reasoning from a set general premises. As such, it could be deduced from the questionnaire analysis that the porting organizations do not generally have a defined process or strategy for testing in porting mobile applications which is similar to [6] conclusion on the testing process in mobile organizations. As it could be seen from question four (4) that 50% claimed to use the agile methodology for porting their mobile applications but 52.94%% claimed not to follow any testing standard during the porting process. In contrast, 50% in statement six (6) claimed to have a particular methodology they use in testing in the organization but only 5.88% specified other standard besides the mentioned standards in the questions' options (IEEE 829, ISO/IEC 29119 and V-model). Moreover, 43.75% couldn't ascertain in statement six (6) whether they have a particular methodology or not. This result deduces that that the testing methodologies used in these organizations were ad hoc. Furthermore, in statement eight (8), 50% of the respondent agreed that developers port mobile applications and write test cases but statement nine (9) showed that the testing team do not use the test cases prepared by the developers since 75% of the respondent claimed that the testing team do not use the test cases prepared by the developers. The contradictions can be deduced that the process of testing the ported applications within these porting organizations is performed in an ad hoc manner.

In statement ten (10), 50% of the respondent claimed that the test lead/manager was the same as quality assurance (QA) which contradicted the result of statement fourteen (14). If the respondent were sure of the claims in statement ten (10), the "*fully agree*" option would have had more votes but reverse was the case. 46.67% of the respondent disagreed while the "fully agree" and the "neutral" options has same count (26.67%) which deduces role definition problem. There wouldn't have been any form of ambiguity in the fourteenth (14th) statement considering the fact that over 80% of the respondents were experts with over one (1) year experience. It just shows that the testing process performed was ad hoc without proper definition of roles. Moreover, statement fifteen (15) clearly pointed out that 53.3% of the respondent claimed that the testing teams take time to understand test cases given to them by the QA or developers. It could be deduced from this statement that understanding among the whole team is an issue. Statement sixteen (16) crowned it all by getting the opinion of the respondents on whether it was necessary to have a testing strategy which will improve the testing activities in porting mobile application and 60% of the respondent agreed with the statement.

QUALITATIVE DATA ANALYSIS

As mentioned earlier, the qualitative data was gathered and analyzed to ensure the existence of testing problems within the porting process (especially the issues gathered from the questionnaire analysis) and to concretize the solution to be proffered in this research. Besides that, analyzing and presenting findings from the qualitative research will complement the quantitative research performed and allow for a more complete analysis [22]. The objective of qualitative data analysis according to [23] " is to identify, examine, and interpret patterns and themes". The qualitative data gathered in this research used the approach mentioned by Hair et al. Figure 17 shows the qualitative analysis process used. The qualitative data was gathered by recording the interview sessions via a phone recorder after which each interview session was transcribed. The researcher read through the transcribed interviews while comparing each of the interviewee's perspective as well as identifying and examining the patterns and themes within the interview data. What was important and learned from the data was extracted, described and grouped into different sections for proper understanding. Table 1 gives an overview of each organization, showing its *business, the number of experts interviewed, experts role and responsibility and the subject area (categories) of interview conducted.*

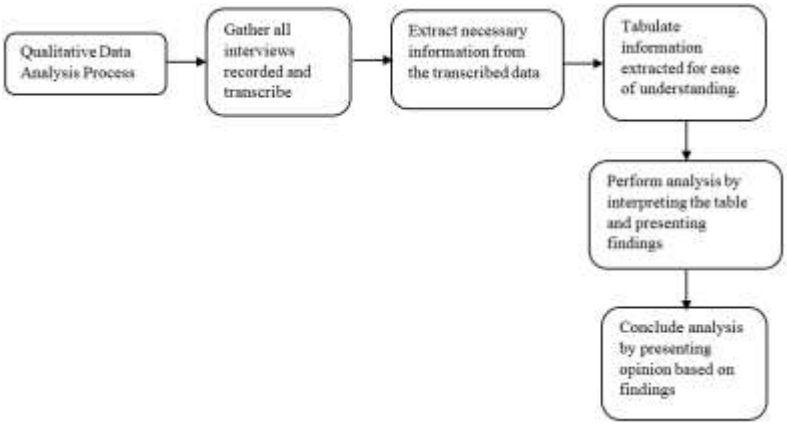


Figure 17: Qualitative Data Analysis Process

TABLE 1: OVERVIEW OF ORGANIZATION INTERVIEWED

S/N	Organization Type	Business Description	Number of Interviewee	Interviewee role	Responsibility of Interviewee	Categories
1	Software and Mobile applications Development	- Development of software and Mobile applications - Port desktop applications to mobile devices - Testing	1	Senior Software Engineer	- Responsible for and in-charge of mobile application development for different platforms. - Responsible for porting desktop	Design and developme nt, Testing strategy and techniques , test outsourcin g, porting, requireme

					applications to mobile applications. - Responsible for test case design - Responsible for establishing porting requirements specifications	nt gathering, test cases, testers, testing tools, testers participation, challenges
2	Software and Mobile applications Development	- Web applications development and client support - Mobile development outsourcing	1	Developer	- In-charge of the software development team.	Testing standards and models, Test cases, Test planning, testers participation, challenges
3	Software Development/Porting and Mobile applications Porting	- Software Enterprise application development - Porting between pc-based applications - Porting mobile applications - Performing quality assurance and testing	2	Senior Software Engineer (SSE) and Quality Assurance (QA)	- The SSE is in-charge of the software and mobile development team - The SSE is responsible for test case design. - The SSE is part of the software and mobile porting development. - The QA is in-charge of QA and testing activities.	Porting process, test strategy and techniques, porting requirement, test cases design, test outsourcing, quality perception, quality assurance, extreme programming, development and testing methodologies, documentation, challenges
4	Software Development and	- Development of Software and	1	Senior Mobile	- Responsible for mobile	Porting process,

	Mobile applications Porting	mobile applications - Porting mobile applications using phone-gap technology		Developer and Project Manager	applications porting projects	testing strategy, phone gap technology, agile, quality assurance, porting projects, porting requirement, test cases, perceived quality.

INTERVIEW ANALYSIS DISCUSSION

From table 1 above, the interview sessions were carried out with two (2) senior software engineers, one (1) developer, one (1) quality assurance personnel, and one (1) senior mobile developer who was also the project manager of the company. The interviews were conducted in four (4) companies with two (2) interviewees from the same company. The duration for each interview session was between fifteen (15) to twenty (20) minutes. The questions asked covered the categories or subject area stated under the column - *Categories*. The coding approach was used in the analysis of the data and the process is further discussed below (section 5.2.2)

CODING

According to [24], "a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data" is often called a code. The data to be coded could be an interview transcript, journals, observations, artifacts and so on. More so, when relevant words, phrases, sentences or sections are labeled on the data – were the label could be about actions, activities, processes, concepts, opinions, differences or whatever is relevant; the process is known as coding.

With respect to the information obtained, the researcher used the coding approach by performing the following steps:

1. Read through the transcripts and made notes of impressions from the interviewees
2. Labeling of relevant pieces was performed on the transcript to fish out the codes. Table 2shows an example of how the codes were created from an excerpt of the transcript.
3. Some codes were either combined with other codes or not used because they were either not necessary or already covered.

4. Final codes created were grouped together under different categories and themes – the categories and themes were created based on the code characteristics.
5. Deductions were made based on the results obtained from the categories/themes created.
6. The result were presented and interpreted

TABLE 2: CODING APPROACH EXAMPLE USED IN ANALYZING INTERVIEW TRANSCRIPT

Excerpts from transcript (**Q** = questions by interviewer, **A** = Answers by interviewee)	Codes generated	Category	Theme
Q: How do you go about the documents you receive from the management and the programmers, do you produce your own document or use just the documents given to you? *A:* *1. We get both documents and compare it (that is the design documents from the programmers and the original documents from the management). We will check for what is missing and add something to it such as comments, design and so on;* *2. Though I have to go through everything on the original document from the beginning for proper understanding to ensure that the design part from the programmers matches the original documents which is the porting requirement specification (PRS).* *3. Our communication channel is from the programmers to the testers and from testers to the project managers*	1. How testing process is conducted 2. Testers/QA depends heavily on the document passed to them. 3. Communication of test process is linear.	1. Testing Strategy 2. Documentation 3. Communication	1. Information 2. Problem 3. Problem

Table 2 shows a general example of how the codes were generated and categorized from the transcript of the interview. The captivating points in the answers (**A**) provided by the interviewee were labeled with numbers such as 1, 2, and 3 shown on the first (1st) column. The corresponding labels were summarized and translated into codes shown in the second (2nd) column. Categories were created by assigning a word or phrase to the code generated based on the code attribute(s) as shown in column three (3). This implies that similar attributes would be assigned same categories. Further assignment and classification was done on the codes to separate knowledge acquired (themed as "*information*")

from problem identified (themed as "*problem*") and opinion of the interviewee (themed as "*opinion*"). Based on the steps (1 – 6) mentioned earlier and the example of the coding approach discussed, the next section shows a neat analysis performed on the transcript omitting the unnecessary details of the work done during the coding process

RESULTS FROM ANALYSIS OF INTERVIEW TRANSCRIPT

Tables 3, 4, 5 and 6 shows the codes extracted from the interview transcript. The extracted codes from the transcript (as earlier mentioned) were grouped into categories and further classified into themes. Each table contains the heading: *codes*, *category* and *theme*. The *codes* are the relevant information extracted from the interview transcript; the *category* are the family to which the researcher has grouped each code; the *theme* is a further classification performed on the code to enable the researcher to generate tangible result and to come up a concrete deduction.

TABLE 3: CODES GENERATED FROM ORGANIZATION ONE (1) INTERVIEW

Codes from Organization One (1) Interview			
S/N	Codes	Category	Theme
1.	No specific standard or process used when testing ported mobile applications	Standard/Model	Problem
2.	Programmers and testers have different view of the ported applications	Perception	Opinion
3.	End users still complain of the application even after testing	Test coverage	Problem
4.	Standards of the target platform is followed when porting	Standard/Model	Information
5.	Testers are not fully aware of the requirements	Requirement	Problem
6.	Testing is outsourced sometimes due to lack of testers and ensuring quality of ported application	Quality issues	Problem
7.	Testing tools are mostly used for non-functional requirements	Tools	Information
8.	Testing tools is not guaranteed because it sometimes gives different result. Testing on real devices is preferred.	Tools	Problem

TABLE 4: CODES GENERATED FROM ORGANIZATION TWO (2) INTERVIEW

Codes from Organization Two (2) Interview			
S/N	Codes	Category	Theme
1.	Nobody practically follows the models	Standard/Model	Opinion
2.	The waterfall or V-model approach is used for mobile	Standard/Model	Information
3.	Disagreement is usually experienced during test case design between the testers and programmers	Communication	Problem
4.	Test cases are given to testers	Test Case	Information

TABLE 5: CODES GENERATED FROM ORGANIZATION THREE (3) INTERVIEW

Codes from Organization Three (3) Interview (2 interviewees)			
S/N	Codes	Category	Theme
1.	Porting process is ad hoc (get strategy online)	Standard/Model	Information
2.	No specific model or standard followed	Standard/Model	Information
3.	Porting requirement comes from the management	Requirement	Information
4.	Strategy created every time an application is to be ported	Standard/Model	Problem
5.	Testers receive test cases from senior programmer	Test Case	Information
6.	Testers don't know the application details	Requirement	Problem
7.	Testing follows general process	Standard/Model	Information
8.	The quality assurance (QA) do not understand the porting requirements	Requirement	Problem
9.	Establishing porting requirements by programmers is time consuming	Requirement	Problem
10.	Outsourcing testing is normal sometimes due of lack of resources	Resources	Information
11.	Several kinds of methodology is used in the testing implement	Standard/Model	Information
12.	Port requirement specification (PRS) comes from the management	Requirement	Information
13.	PRS is documented by the management for the QA	Requirement	Information
14.	Tester think like end-users and QA at the same time while ensuring that quality is met	Perception	Problem
15.	Testers struggle between ensuring that porting requirements are met through testing and overlooking errors made by programmers	Quality issues	Problem
16.	Project managers, programmers and testers have different perception of the application	Perception	Information
17.	Testers/QA are not aware of what to do at times as they depend on just documents handed to them	Standard/Model	Problem
18.	Perception of a quality ported application by QA is: ported application should first meet the porting requirements which are originally documented and user should be satisfied with the application	Perception	Opinion
19.	Perception of quality ported application by programmer is: ported application should behave the same way as previous platform	Perception	Opinion

TABLE 6: CODES GENERATED FROM ORGANIZATION FOUR (4) INTERVIEW

Codes from Organization Four (4) Interview			
S/N	Codes	Category	Theme
1.	Use tools to enhance porting process (phone gap)	Tools	Information
2.	Follows the phone gap guidelines during porting	Standard/Model	Information
3.	Testers are involved from the development process	Standard/Model	Information
4.	Porting requirements are passed to testers from QA manager.	Requirement	Information
5.	Time is required for establishing requirements	Requirement	Information
6.	Establishing requirement is the most important in porting process	Requirement	Information
7.	Testers don't understand programmers language in performing testing activities	Communication	Problem
8.	Miscommunication between testers and programmers delay porting application	Communication	Problem
9.	Test cases is designed by developers	Test case	Information
10.	Perception of quality ported application is well written codes, application should perform as it should and no bugs	Perception	Opinion

A total of forty-one (41) codes were generated from the interview transcript as shown in tables 3, 4, 5 and 6. The forty-one (41) codes were grouped into nine (9) categories (Table 7 shows the categories and their frequencies while figure 18 shows the percentage of the issues). From figure 18, it can be seen that 29% of issues from the codes were related to *standards/models*, 24% of the issues related to *requirements*, 15% of the issues related to *perception*, 7% of the issues each were related to *testing tools*, *communication* and *test case* respectively, 5% of the issues related to *quality issues* and 3% of the issues each were related to *test coverage* and *resources* categories respectively. To figure out the problems from the issues generated, further classification of these codes were performed to obtain themes from the analysis (table 8). Three (3) themes were generated based on the situation or context of the code. The themes generated were *Information*, *Problem* and *Opinion*. A code was themed *information* if it provided a general statement of fact or if it added new knowledge to the researcher. Meanwhile a code was themed *problem* if the statement from the code portrayed a form of complain, lament or concern. Lastly, a code was themed *opinion* if the statement portrayed in the code was the interviewee's thought or opinion. To obtain the percentage of the problems from the issues (codes) generated, the row "*Total*" was plotted against the theme (from table 8) and results showed that 37% of the codes generated were problems (figure 19). Furthermore, The *problem* column from table 8 was plotted against the *category* column to obtain the percentage of the problems for each category and the results (figure 20) showed that; 27% of the problems were requirements related issues, 20% were standard/model related issues, 13% were 'quality issues' related issues, 7% were test coverage related issues, 7% were tools related issues and 6% were perception related issues.

TABLE 7: TESTING RELATED ISSUES IN PORTING MOBILE APPLICATIONS

S/N	Category	Frequency
1.	Standard/Model	12
2.	Requirement	10
3.	Perception	6
4.	Tools	3
5.	Communication	3
6.	Test Case	3
7.	Quality Issues	2
8.	Test Coverage	1
9.	Resources	1
TOTAL CODES		**41**

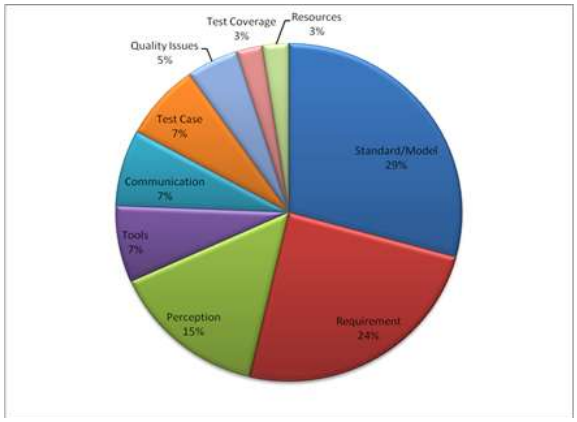


Figure 18: Percentage of Testing Related Issues in Porting Mobile Applications Projects

TABLE 8: TESTING RELATED ISSUES IN PORTING MOBILE APPLICATIONS SHOWING THE THEMES CREATED

Category	Theme			Total = Frequency
	Information	Problem	Opinion	
Standard/Model	8	3	1	**12**
Requirement	6	4	0	**10**
Perception	1	1	4	**6**
Tools	2	1	0	**3**
Communication	0	3	0	**3**
Test Case	3	0	0	**3**
Quality Issues	0	2	0	**2**
Test Coverage	0	1	0	**1**
Resources	1	0	0	**1**
Total	**21**	**15**	**5**	**41**

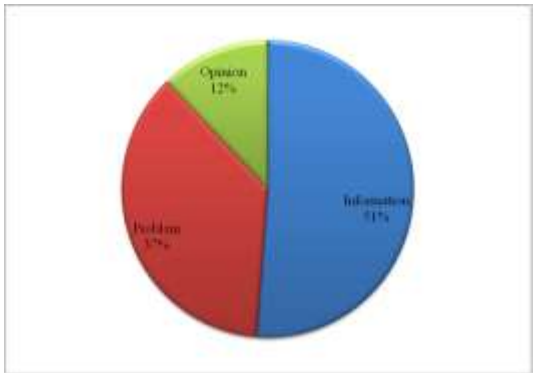


Figure 19: Further analysis on identified testing related issues to obtain the problems

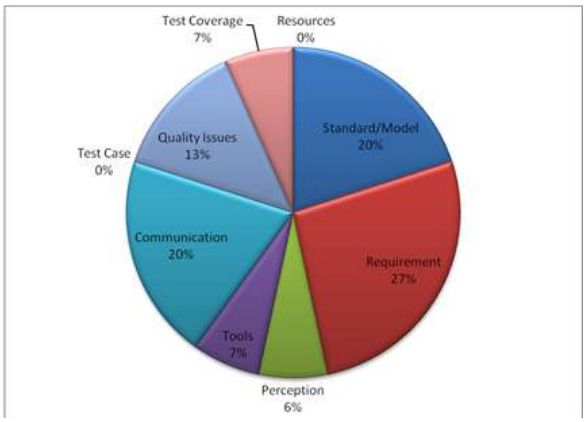


Figure 20: Problems Areas Identified in Testing Ported Mobile Applications

DEDUCTIONS FROM QUALITATIVE ANALYSIS

From the analysis and result discussed above, it could be deduced that the testing process in porting mobile applications needs some standard form of guidelines to be followed by porting organizations as it could be seen from figure 20 above that 20% of the problems faced in testing comes from the lack of recognized standard/model or guidelines. Moreover, since the available standards used by these porting organizations such as the V-model, ISO 29119 and so on does not properly fit into the mobile application porting environment, it could be stated that an ad hoc strategy is used in testing these ported application which will end up been expensive as stated by [25] and eventually affect the quality of the ported application. It could also be deduced from figure 20 that requirement establishment process is essential to have a good testing strategy as it is shown that 27% of testing activities problems experienced in porting mobile applications are related to requirements. The available testing standards or models mentioned in this research addresses requirements gathering process only when developing a new system or application but did not address the handling of requirement process when porting applications. However, [26] mentioned that keeping track of testing requirements in porting mobile applications "have become complex spin-off business of their own". This implies that the complexity of the mobile

phones has made handling testing requirements crucial. According to [27], communication amongst the development team is very crucial in agile development which implies that a porting team need to possess interpersonal and social skills to successfully port a quality mobile application. However, communication as seen in figure 20 constitutes 20% of the problems experienced in the testing activities while porting mobile applications. In the analysis of the interview conducted, it was observed that the communication problem –which was usually experienced between testers and developers - delayed porting mobile applications. The quality issues which constitute 13% of the problems identified stems from the lack of sufficient testers in the organization. The lack of sufficient testers makes the porting organization to outsource the testing activities but still face challenges of the ported application not behaving the way it is expected to be. Another problem that is considered a quality issue is the struggle experienced by the testers between overlooking some errors made by programmers and abiding strictly by the requirements. It can also be deduced from the perception related issues (which constitutes 7% of the problems experienced) that different perceptions of the mobile applications by each individual in the porting team would affect the usage of tools used in testing, test coverage and eventually affect the quality of the ported mobile application. When perceptions are synchronized among the development team through proper communication process, there would be more test coverage which will enhance the quality of the ported application.

SUMMARY AND CONCLUSION

In this paper, problems with testing activities in mobile organizations were highlighted. Efforts have made by individuals and organizations to improve the testing process especially in view of porting mobile applications but still there are problems. In an effort to know and highlight the issues affecting the testing activities in porting mobile application, data collected (both quantitative and qualitative) were analyzed and presented. The quantitative data analysis showed that the test process in porting mobile application was not systematically executed. The qualitative data analysis concretized the researcher's claims (in quantitative analysis) by presenting the results of the analyzed interviews conducted with experts in porting and testing mobile applications. The results from the qualitative data analysis showed that establishing testing requirement phase needed attention by the testing team. Communication also needed attention which was due to lack of a well-defined testing strategy peculiar to porting mobile application.

FUTURE WORK

Hence, in the future work, an unambiguous well-defined testing strategy will be designed which will serve a testing guidelines to address the problems identified

from the data analysis (quantitative and qualitative) and improve testing activities required in the porting of mobile applications

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