A Tool Selection Framework for Cross Platform Mobile App Development

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ABSTRACT
Cross platform Mobile application development is currently enjoying some good riddance in the Mobile App Development Community. Nonetheless, developers are somehow confronted with a tool selection dilemma since development for multiple platforms are still at the inceptive stage. In this paper we propose a framework for choosing the appropriate Cross Platform Development Tool for a given project. The framework defines the set of criteria to be considered for evaluation and makes pair-wise comparison to compute the priority for the criteria as well as priority of the alternative tools compared. The implementation of the framework on the Tools: PhoneGap, Titanium and Xamarin recommend PhoneGap as the preferred tool for Cross Platform Development. The result from the implementation also considers the capability criteria as the most important in Mobile Cross Platform Development.

General Terms
Cross Platform Mobile Application Development.

Keywords
Tool Selection Framework, Mobile App development, Cross Platform Tools

1. INTRODUCTION
The popularity of mobile devices has motivated majority of vendors to get on board and contribute to the provision of mobile operating systems as well as software that run on mobile devices [1]. Different vendors have developed their own proprietary method of developing applications for their devices using a variety of programming languages and Development Kits. This means that an application developed for Google's Android operating system will not run on the RIMS blackberry platform. This had led to a challenge in the mobile computing industry known as platform fragmentation. The issue of fragmentation becomes more challenging for developers when applications built for a targeted platform are not able to run on different versions of hardware devices [2].

This makes cross platform development very relevant and inevitable. A survey by Appcelerator and IDC in August 2012 showed that companies continue to be very interested in cross platforms regardless of the challenges and difficulties [3]. In 2011, developers had shown interest in running on twice as many platforms as a similar survey in the previous year had indicated a multi-platform patronage by developers averaging an incredible four operating systems [4]. This trend continued to increase in 2012 [3].

Despite the popularity and potential for developing for multiple platforms, there is no detailed metric to measure the capability and performance of Cross Platform Development Tools (herein after referred to as CPDTs). Through the development an evaluation framework based on acceptable metrics for CPDTs, developers will gain the knowledge needed to determine which tool to use for their application.

2. RELATED WORKS
[15] provided a comparison for four Cross Platform Tools. All these tools were viewed in respect to their ability to deliver animation applications. Titanium according to [15] emerged as the best tool for developing animation applications. The work of [15] lacked the needed depth to allow for its consideration in business applications due to the fact that, only one criterion was considered. The tools compared included: PhoneGap, JQuery, Titanium and MoSnyc.

[5][6] in their works also compared features of CPDTs although their comparison lacked greater depth. Comparison of tool features was done with a 13-item chart [5]. Storage and camera access among other important features were covered in the survey. However, the reports did not include performance evaluation and discussion of development practices.

Many CPDTs are discussed in [7] but just partial comparison was provided. They compared native and web-based user interface elements as well as the importance of well performing applications. However, the authors emphasized that they were not concerned with the internal workings of the tools but rather the approval of the application for mobile stores. [7] further discusses the lack of debugging tools in many CPDTs in the system currently and provided an 8-point scale to compare features. The authors developed a simple application that provides a screen with a text label and measured the start time and the RAM usage for nine CPDTs.

Currently, the PCMark suite is the most prominent desktop PC benchmarking software and uses several open source and commercial applications [8]. Using the contained test suites allow CPU, memory, graphics and hard disk performance analysis. There had not been any equivalent gold standard among these test suites in the mobile community [10], although work is in progress on native benchmarks for different platforms. Some currently available benchmarks are Quadrant proposed in Aurora [11] and [9]. Published work on mobile benchmarking is very limited. Performing a simple test on Android has been the basis for some time now in terms comparing CPDTs [15].

3. PROPOSED FRAMEWORK

The proposed framework can be divided into four stages: Problem Definition, Ranking Criteria, Ranking of Alternatives and Evaluation Report as shown in Figure 3.

3.1 Problem Definition (Level 1)

A decision is a result of a comparison of one or more alternatives with respect to one or more criteria that is considered relevant for the decision [14]. Among these relevant criteria, some are considered more and some as less important, a process that involves assigning weights to the criteria according to their relative importance. For the majority of our everyday decisions which usually have an impact only on us and our immediate future, weights are assigned intuitively based on relevant decision criteria.

3.2 Ranking of Criteria (Level 2)

In arriving at the criterion to be included in the framework, relevant data had to be collected from varied sources including primary and secondary sources. The sources including documentation from tool vendors as well as experts in the field of software development helped to gather relevant facts to arrive at the appropriate criteria to include in the framework. Procedures embarked upon to obtain the primary data included focus group discussions and interviews with 6(Six) software developers with more than 10 years of experience in the industry. The criteria considered for the evaluation includes: Capabilities, Performance, Development Speed, Native UI, Learning Curve and Device Access. The relative preference among the various criteria is measured by comparing individual factors against each other in a pairwise comparison matrix. Numerical values expressing a judgement of the relative importance (or preference) of one factor against another has to be assigned to each factor. A comparison scale suggested by [14] is used to make comparison between factors (criteria). The scale for comparison consists of values ranging from 1 to 9 which describe the intensity of importance, whereby a value of 1 expresses ‘‘equal importance’’ and a value of 9 is given to those factors having an ‘‘extreme importance’’ over another factor as shown in table 1. The scale shown in Table 1 indicates how many times an alternative is more relevant than another one, with respect to a specific criterion. The relevance is established according to either subjective or objective statements. A matrix at this stage will collect the pairwise comparison of the criteria by the decision maker as illustrated in Table 2.

A relative verbal appraisal between pairs, similar to what happens in daily conversations is adequate on the part of decision makers during comparison. To check for consistency of the pair-wise comparison, a consistency ratio $\text{cr} = \frac{\text{ci}}{\text{ri}}$ where ci = consistency index and ri = random index has to be computed. The Consistency Index should be less than 0.1. Consistency ratio less than 1.0 means responds are not consistent. The consistency index (ci) is calculated using the formula $\text{ci} = \frac{\text{lamdamax}-\text{n}}{\text{n}-1}$ where n is equal to the number of criteria compared and lamdamax is the highest product of sum of each criteria column and the priority of the criteria.

3.3 Ranking of Alternatives (Level 3)

The priority which indicates the ranking of the alternatives with respect to a given criteria is evaluated. The priority is computed by finding the 6th root of the product of each row in the matrix and dividing the resultant of each by the total. Finally the weighted average rating of each decision alternative is achieved by multiplying the criteria weights from level 2 by the rating of the decision alternatives of each criteria and finally summing up the respective products

3.4 Evaluation Report

The results of the individual matrices are interpreted and rankings of the compared platforms made based on the criteria selected. The platform with the highest standardized weight gets the nod as the ideal platform for cross platform development. .

4. IMPLEMENTATION

In order to implement the framework proposed, three (3) Mobile Cross platform tools are used namely: PhoneGap, Titanium and Xamarin. These tools are compared and ranked based on the criteria outlined in section 3.

4.1. Problem Definition: (Level 1)

Although the framework can compare any number of tools, three (3) tools namely PhoneGap, Titanium and Xamarin are selected to provide data for the implementation of the framework. These tools are selected based on their popularity and advice from software developers partnered to do the comparison and evaluation.

4.2. Ranking of Criteria (Level 2)

A pair-wise comparison is done by capturing the selected criteria in a 6× 6 matrix as illustrated in Table 3.

4.2.1. Priority and Lamdamax

Lamdamax and priority for the 6 criteria are calculated as illustrated by Table 4. The criteria with the highest priority attracts the highest ranking in it follows in that order.

4.2.2. Calculation of Consistency Index

The consistency index (ci) is computed using the formula $\text{ci} = \frac{\text{lamdamax}-\text{n}}{\text{n}-1}$ where n = number of criteria to be compared. With respect to this problem, the number of criterion is equal to 6, therefore n is equal to 6. $\text{Consistency index} = {}^{6.325962 - 6}/_{5} = 0.0651924$.

4.2.3. Calculation of Consistency Ratio (cr)

The consistency ratio was arrived at using the formula $\text{cr} = \frac{\text{ci}}{\text{ri}}$ where cr = consistency ratio, ci = consistency index and ri = random index. The rational index is obtained using the rational index table as illustrated in Table 5.From the figures in Table 5, the random index for 6 is 1.24 considering the number of criteria compared which is 6. Consistency ratio is therefore computed as $cr = \frac{0.0651924}{1.24} = 0.052575$. The consistency ratio of 0.052575 is less than 0.1 and indicates that the pairwise comparison made is consistent

4.3. Ranking of Alternatives (Level 3)

A pair-wise comparison was done on the three (3) compared alternatives: PhoneGap, Titanium and Xamarin. The priority, lamdamax, ci, ri and cr are computed as shown in Table 6 to Table 11. Table 12 provides the weighted average rating of each of the alternatives.

4.4. Evaluation Report (Level 4)

PhoneGap is preferred to Titanium and Xamarin considering the Six (6) criteria which provides the basis for evaluation. In the absence of PhoneGap, Titanium can serve as the alternative since it lies second in the ranking. Detailed report after the implantation is presented in the next section.

5. DISCUSSIONS

By implementing the individual stages in the tool selection framework, each phase of evaluation provides significant information regarding the tools' strengths and weaknesses. These results are presented in this section. The results show the relative importance of each of the criterion and their subsequent ranking derived using the framework.

5.1 Ranking of Criteria and Tools

The results in Table 5 illustrate the ranking of criteria. According to the results, the most important criteria with the highest priority is the capability criteria. This means that, during Cross Platform development, developers place much emphasis on the capabilities of the application. Different CPDTs also exhibit strength and weaknesses based a given criteria. The results in Table 6 to Table 11 show the strength and weaknesses of Xamarin, Titanium and PhoneGap. PhoneGap is preferred among the three in terms of its ability to deliver applications with high capabilities. Developing applications with PhoneGap is found to be relatively faster and is the best among the three tools in terms of ease of learning to work with it. These findings are supported by Tables 6, 8 and 11. Titanium on the other hand is good for applications which emphasizes on UI appeal and faster access to devices such as camera and accelerometer. These findings are in agreement with that of [2]. Xamarin is considered ideal for UI appeal but falls short in all other criteria.

5.2 Weighted Average of Tools

The weighted average for all the tools is computed to determine the best with respect to all the criteria. PhoneGap is considered the best with the highest priority. Titanium comes second with Xamarin assuming the least preferred with the lowest priority. This result is not in agreement with [2] which do not produce an eventual winner after comparison of tools.

6. CONCLUSION

The result indicates that, tool selection can have a great impact both negatively and positively on development of a mobile application. Some CPDTs are shown to have performance issues while others provided too little capability. The most attractive part of this framework is that it can be extended to include the addition of new criterion brought by future releases of CPDTs with the core concepts remaining. Future works will focus on extending the framework to include other criteria such as security and user experience.

Table 1: Scale of Comparison (Saaty, 2001)

Intensity	Definition	Explanation
1	Equally preferred	Two elements contribute equally to the o the objective
2	Between equal and moderate	
3	Moderately preferred	One element is slightly more relevant than another
4	Between moderate and strong	
5	Strong	One element is strongly more relevant than another
6	Between Strong and very strong	
7	Very Strong	One element is very strongly more relevant than another
8	Between very strong and extremely strong	
9	Extreme	One element is extremely more relevant than another

Table 2: Pairwise Comparison Matrix for the Criteria

	Capability	Performance	D.Speed	Native UI	L.Curve	D.Access
Capability						
Performance						
D.Speed						
Native UI						
L.Curve						
D.Access						

Table 3: Pairwise Comparison of Selected Criteria

	Capability	Performance	D.Speed	Native UI	Learning Curve	Device Access
Capability	1.00	5	3	7	5	5
Performance	0.200	1	0.5	3	2	2
Development Speed	0.333	2	1	4	3	2
Native UI	0.143	0.333	0.25	1	0.5	0.5
Learning. Curve	0.2	0.5	0.333	4	1	2
Device Access	0.2	0.5	0.5	2	0.5	1

Table 4: Calculation of Lamdamax for selected criteria

	Capabiliti	Performance	Dev Speed	Native UI	L.curve	D.Access	product	6th root	priority	lamdamax
Capabilities	1.00	5	3	7	5	5	2625	3.714111	0.457376	6.325962
Performance	0.200	1	0.5	3	2	2	1.2	1.030853	0.126945	
Dev.Speed	0.333	2	1	4	3	2	15.984	1.587136	0.195449	
Native UI	0.143	0.333	0.25	1	0.5	0.5	0.002976	0.379266	0.046705	
L.curve	0.2	0.5	0.333	4	1	2	0.2664	0.80215	0.098781	
D.Access	0.2	0.5	0.5	2	0.5	1	0.05	0.606962	0.074745	
sum	2.08	9.33	5.58	21.00	12.00	12.50		8.120479	1.00	
sum*priority	0.949512	1.184776707	1.091189655	0.980801	1.185374	0.934308	6.325962			

Table 5: Table of Random Index (ri)

n	1	2	3	4	5	6	7	8
Random Indix (ri)	0.00	0.00	0.58	0.90	0.12	1.24	1.32	1.41

Table 6: Comparison Matrix Based on Capabilities Criteria

Capabilities	PhoneGap	Titanium	Xamarin	priority	Lamdamax	ci	ri	cr
PhoneGap	1.0	5.000	2.00	0.581554	3.00366242	0.001831	0.58	0.003157
Titanium	0.200	1	0.333	0.109449				
Xamarin	0.5	3.000	1.000	0.308997				

Table 7: Comparison Matrix Based on Performance Criteria

Performance	PhoneGap	Titanium	Xamarin	priority	Lamdamax	ci	ri	cr
PhoneGap	1.0	0.20	0.33	0.109126	3.001498763	0.000749	0.58	0.001292
Titanium	5.000	1.00	2.0000	0.58177				
Xamarin	3.000	0.50	1.000	0.309109				

Table 8: Comparison Matrix Based on Development Speed Criteria

Development Speed	PhoneGap	Titanium	Xamarin	priority	Lamdamax	ci	ri	cr
PhoneGap	1.0	3.00	5.00	0.648329	3.003694598	0.001847	0.58000	0.003185
Titanium	0.333	1.0	2.00	0.22965				
Xamarin	0.200	0.50	1.00	0.122020				

Table 9: Comparison Matrix based on Native UI Criteria

Native UI	PhoneGap	Titanium	Xamarin	priority	Lamdamax	ci	ri	cr
PhoneGap	1.000	0.17	0.25	0.88983	3.009202713	0.004601	0.5800	0.007933
Titanium	6.00	1.00	2.000	0.58763				
Xamarin	4.00	0.50	1.000	0.323386				

Table 10: Comparison Matrix Based on Device Access Criteria

Device Access	PhoneGap	Titanium	Xamarin	priority	Lamdamax	ci	ri	cr
PhoneGap	1.00	0.17	0.33	0.095338	3.018294707	0.009147	0.5800	0.015771
Titanium	6.00	1.00	3.000	0.65481				
Xamarin	3.00	0.33	1.00	0.249856				

Table 11: Comparison Matrix Based on Learning Curve Criteria

Learning Curve	PhoneGap	Titanium	Xamarin	priority	Lamdamax	ci	ri	cr
PhoneGap	1.00	5.00	7.00	0.739594	3.014151882	0.007076	0.5800	0.0122
Titanium	0.200	1.00	2.00	0.16659				
Xamarin	0.1429	0.50	1.00	0.093813				

Table 12: Weighted Average rating of each alternative

criteria / Options	Capabilities	Performance	Development Speed	Native UI	L. Curve	D.Access	Score	Ranking
	0.457376	0.126945	0.195449	0.046705	0.098781	0.074745	1.000	
PhoneGap	0.885246	0.109126	0.648329	0.088983	0.739594	0.095338	0.629798	**Winner**
Titanium	0.004098	0.58177	0.22965	0.58763	0.16659	0.65481	0.213457	2nd
Xamarin	0.110656	0.309109	0.12202	0.323386	0.093813	0.249856	0.156746	3rd
Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	

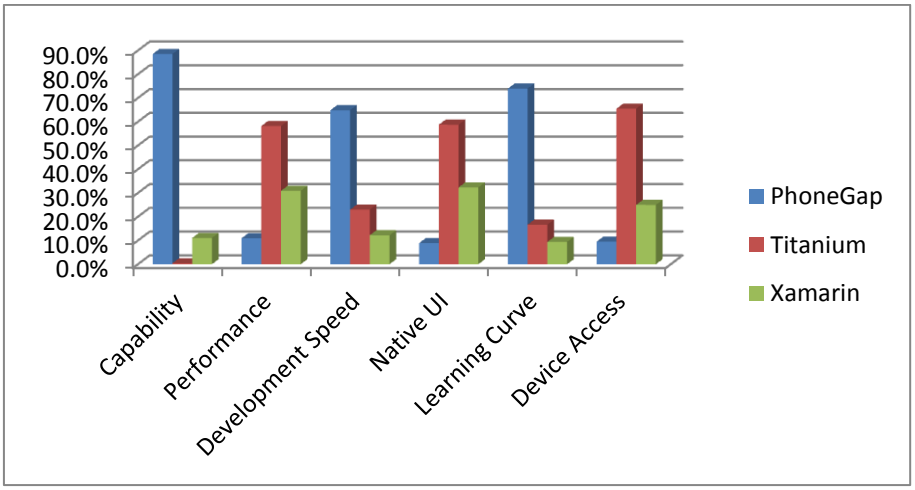

Figure 1: Comparison of CPDTs based on Selected Criteria

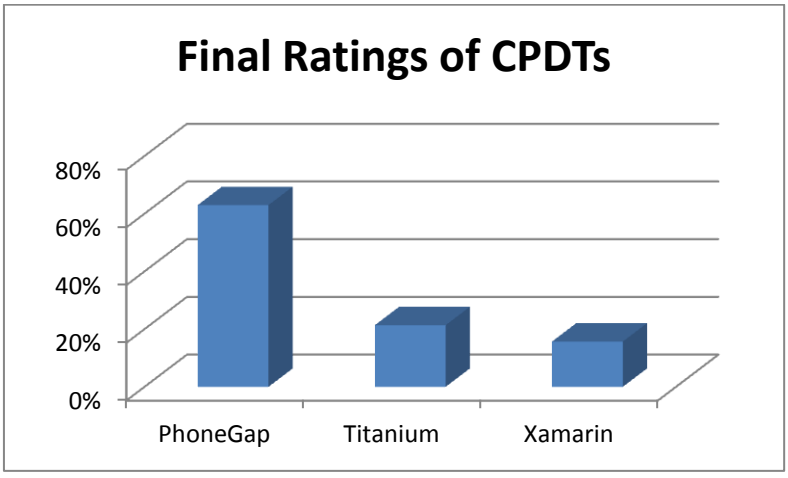

Figure 2: Final Rating of Cross Platform Development Tools

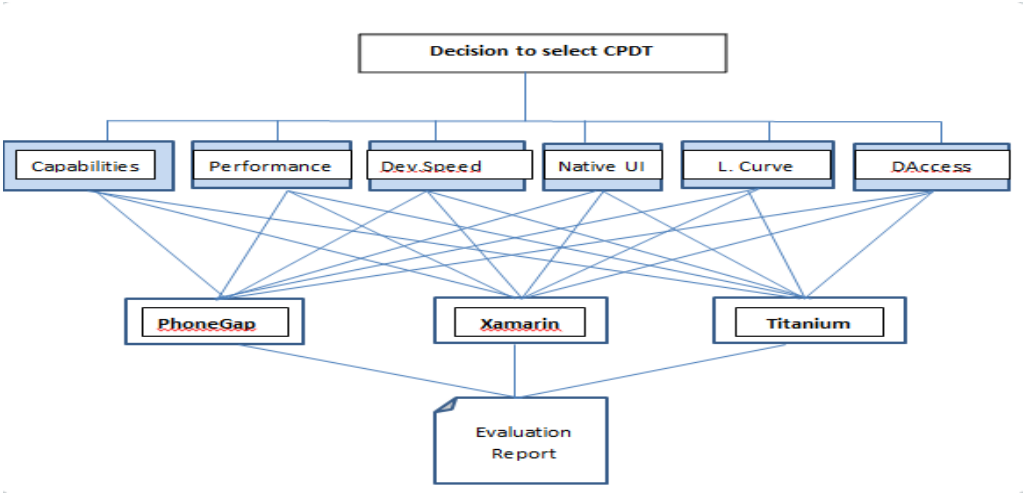

Figure 3: Proposed Framework

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