The Impact of the Mobile Web in Developing Countries

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ABSTRACT
Mobile phone penetration in the developing world shows remarkable growth patterns, which triggers competition among mobile operators and service providers. As a consequence, this has made mobile communications more affordable for people in developing countries. At the beginning, people use mobile phones only for audio or text communications. Later, people start using their mobiles to access the World Wide Web, which is called mobile Web. Despite rapid mobile Web adoption in the developing world, there has been no comprehensive research methodology to define, identify, and measure the impact of mobile Web use. In the context of Web Science research, the methodology is needed by various mobile Web stakeholders to enable the advancement of mobile Web technology, as well as to anticipate the potential impact on society. In this paper we describe a proposed methodology to measure the impact of mobile Web in developing countries. The methodology will be tried in Kenya and Indonesia this year. Then it will be evaluated, refined, and tested again in 2011.

Keywords
Web Science, Mobile Web, Research Methodology, Developing Countries

1. INTRODUCTION
There were 4 billion mobile cellular subscriptions globally by the end of 2008 [1]. In 2002 international mobile cellular subscriptions were still dominated by developed countries, and only 44% of them were from developing countries (Figure 1).

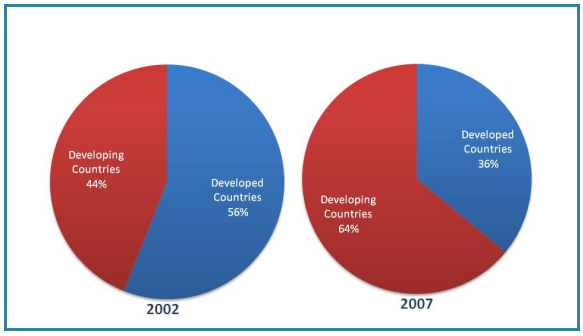

Figure 1. Mobile cellular subscription [1]

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Mobile telecommunication markets in the developed world have become saturated [2]. Therefore mobile operators and service providers put more efforts to compete in the developing world. This has made mobile communications more affordable for 6.7 billion people in developing countries, which represented 80% of the world population, as shown in Figure 2 [3].

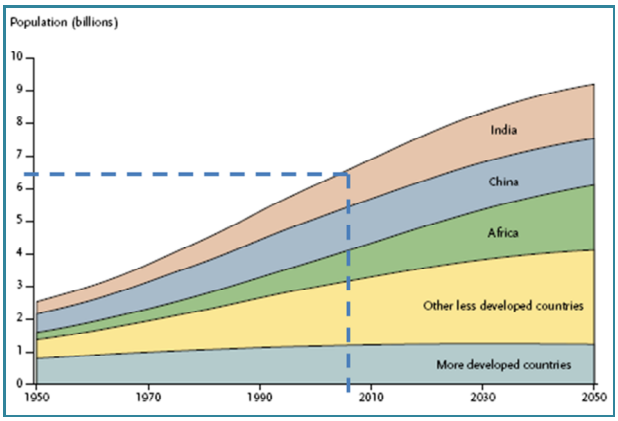

Figure 2. World population prospects: the 2006 revision [3]

Initially people use mobile phones only for voice calls or sending texts. But as the market matures, browser enabled handsets become cheaper. Additionally the mobile operators offer more reasonable tariffs for data communications, which in turn can make Internet browsing 1,000 times cheaper than sending texts [4].

As a result, people start using their mobiles to access the World Wide Web. Mobile Web application, such as Facebook, is modified to meet the need of their potential users in developing countries. Facebook launches Facebook Zero, which is a text-only version of Facebook mobile [5]. It is developed for Facebook users with poor mobile connections.

Besides, there are mobile Web applications that can empower people in the developing world to have a better standard of living. Various case studies have been documented and analyzed by the World Wide Web Consortium (W3C) – Mobile Web for Social Development (MW4D) Interest Group. Examples are m-agriculture, m-commerce, m-banking, m-education, m-health, and m-government in Africa, Asia, and Latin America [6].

Figure 3 illustrates that although mobile Web usage is only less than 1.5% of all Web traffic, there has been tremendous global growth in Web page views from mobile devices since 2008 [7]. Most of them came from developed countries in North America,

Oceania, and Europe. Surprisingly Africa, which is mainly considered as the developing world, is in the fourth place and has shown an impressive increase since mid 2009. It is followed by Asia, which also consists of many developing countries.

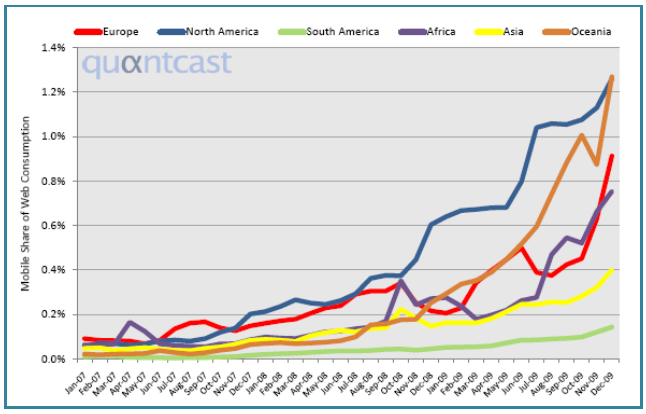

Figure 3. Mobile share of pageviews by continent

There is a concern among Web Scientists, that a comprehensive methodology is needed to anticipate rapid adoption of mobile Web. The methodology should define, identify, and measure the impact of mobile Web. It will then allow various mobile Web stakeholders to improve mobile Web technology, and to anticipate the potential effects on society.

The rest of the paper explains some related work, then the methodology that we propose to address the problem. It is followed by future work to test and refine the methodology. Finally the paper is closed by conclusions.

2. RELATED WORK

Basically the World Wide Web is application software, which runs on the top of the Internet. So the first related work is about new challenges to software engineering method to facilitate life cycle of Web applications, interplaying with social interactions and Web infrastructure [8].

Secondly, we explore a methodology which has been used by the International Telecommunication Union (ITU) to measure the Information, Communication and Technologies (ICT) Development Index (IDI) [1]. The methodology is chosen because mobile Web running on mobile networks, which is part of the IDI.

Thirdly, the Global Information and Communication Department (GICT) has conducted a fascinating study on the role of mobile phones and rural poverty reduction [2]. It is related to our research, which focuses on mobile phones in developing countries with significant poverty issues.

Fourthly, social sciences have well established methods to observe how technology influences people, and how people reshape the technology [9] [10] [11] [12] [13]. Therefore we also investigate social research methods in order to develop our proposed method.

2.1 New Challenges to Software Engineering Method

Figure 4 shows that the Web requires infrastructure such as computer networks, Web architecture or protocols, and data, which enable it to be scalable and open applications. Furthermore the use of Web applications triggers tremendous social interactions, which in turn creates new application needs, as well as novel infrastructure requirements. It emphasizes that Web Science must cover the overall levels.

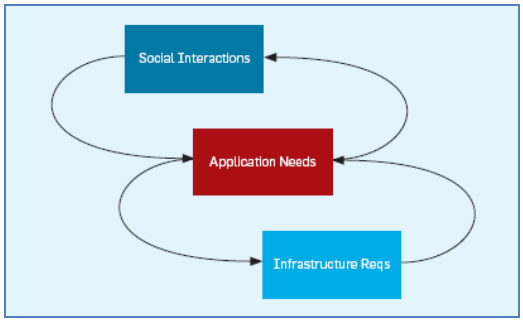

Figure 4. The interplay of social interactions, Web Applications, and Web infrastructure [8]

The Web also drives a new software engineering method to develop Web application, which is designed based on available supporting technologies with a social construct (Figure 5). Definitely Web applications are not developed for just a single machine or a single user. The applications are tested by a small group or deployed on limited users, which test the applications' micro properties. Then some Web applications, such as Mosaic browser, YouTube, Facebook, or Twitter are widely accepted by remarkable global users.

It leads from micro to macro system generating more complex social interactions, which are often unpredictable. The impact or effect of the Web on macro scale is very interesting and important to explore, since it can produce new challenges, opportunities, or threats on the Web and society.

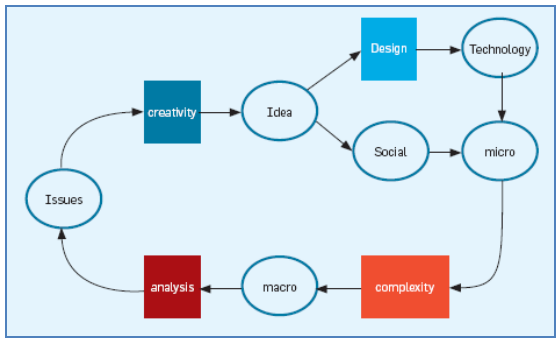

Figure 5. New challenges to software engineering and application development presented by the Web [8]

The processes create a life cycle, which also applies to mobile Web supply and demand. Mobile Web has several stakeholders, such as mobile service developers, mobile industry, capacity builders, government/regulatory bodies, and donors [4].

At the beginning mobile Web stakeholders supply mobile Web solution to the users on micro scale. Later mobile Web usage can cause feedback and new demand towards its use on macro scale, which should be analyzed to produce more suitable new mobile Web supply.

2.2 ICT Development Index (IDI)

As a process to calculate the IDI, ITU followed several steps [1]:

1. Defining main objectives or what should be measured.
2. Working on a conceptual framework.
3. Indentifying main indicators.
4. Formulating the methodology.

The process is based on a conceptual framework called the three-stage framework (Figure 6). It models the evolution of any country towards information society, with an assumption that ICT can be a development enabler if they are applied and used appropriately.

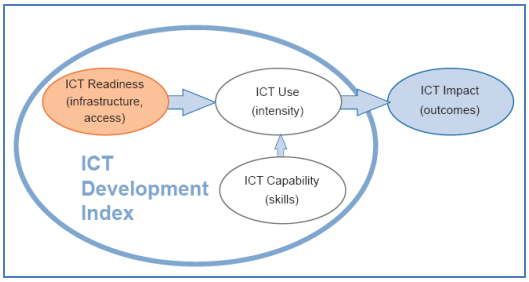

Figure 6. Three stages in the evolution towards an information society [1]

The framework consists of:

1. ICT Readiness which shows the coverage level of ICT infrastructure and access.
2. ICT Use which shows the intensity level of ICT use in the society.
3. ICT Impact which shows the outcomes of effective and efficient ICT use.

Having access to ICT Readiness (stage 1) is a prerequisite for ICT Use (stage 2). In other words without ICT infrastructure and access, there will be no ICT use. Moreover, the evolution towards an information society and achieving ICT Impact (stage 3) are influenced by ICT Capability. It is required to enable any country taking advantage of new technologies, realizing their potential benefits, and reaching value-added from ICT Use. Therefore ICT Impact highly relies on the availability of skills, knowledge, as well as capability to use ICTs effectively and efficiently.

2.3 GICT Report

The GICT publishes an interesting report on the impact of affordable mobile phones. It aims to support policy recommendations regarding mobile phone roles in sustainable poverty reduction [2]. The report reveals that low GDP in the developing countries does not always hamper mobile penetration. In 8 of 18 African countries, mobile penetrations have achieved over 70% population coverage, although per capita income is less than $1,000. It can be caused by small geographical areas with good market conditions, favorable policy, and high population density. Similar situations also occur in other continents, where many low income Asian countries have 90% population coverage, as well as in 8 of 18 Latin American countries.

Other barriers for mobile technologies uptake in the emerging world are lack of education and electricity. Surprisingly less privileged people often find their own ways to cope with the problems. Literate youths often help illiterate older people to use voice or text communications from mobile phones. Besides, they found ways to charge their mobiles using car batteries, or collecting the devices and charging them in another village.

The GICT report indicates that positive impact or benefits of mobile telecommunications can overcome the obstacles. The benefits are classified into three categories: direct, indirect, and intangible.

Direct benefits considered as the economic or macro level, which includes GDP growth, job generation in mobile industry and wider economy, productivity increase, taxation revenue, and value-add from mobile operator [14]. Indirect benefits are the social or micro-level advantages, such as entrepreneurship and job search enablers, information symmetry reduction, decrease of market inefficiencies, and transport substitution [2]. Lastly, intangible benefits consist of disaster relief, education and health, social capital and cohesion.

2.4 Social Research Methods

Case study is selected to be used in our research, because it is suitable for research questions emphasizing on why and how social settings happen, with no control of behavioral events [9]. In order to develop methodology to measure the impact of mobile Web, we need to study why people use mobile Web, how people interact with mobile Web technology, and how they affect each other. And as researchers we have no control on people's behavior in using mobile Web.

The way we do our research is also closely related to ethnography and qualitative research. We plan to do document analysis, questionnaire, interview, observation, and focus group about mobile Web use [10] [11] [12] [13].

Document analysis is very useful as reference sources. It can provide background information about topics being researched. So it is continuously conducted throughout our research.

Questionnaire, especially online questionnaire, is relatively inexpensive way to get data from large number of respondents. It is even very possible to recruit participants from distant places. It is very helpful, because location of case study is far from researchers' residence. In addition, we try to get initial qualitative information from questionnaire. Interview will be conducted to dig more information from questionnaire participants.

In questionnaire and interview, researchers give questions to stimulate participants and interviewees expressing their experience or ideas. A complementary method to study social setting with less interference from researchers is observation. People being observed are expected to act naturally, when researchers participate or watch the social setting. Observation can resolve discrepancy between what people say in questionnaire and interview with reality.

Focus group is needed when researchers need to reveal ideas, feelings, opinions, or motivation from a group of people about certain issue. Here the interaction among group members can construct group meanings and norms, which hardly can be achieved by individual or even group interview.

Since our study adopts several social research methods, it crucial for us, a group of computer scientists, to collaborate with a social scientist from University of Southampton. Besides, we got fantastic help from the University of Cambridge social anthropologists. Because the Web is inherently interdisciplinary, then collaboration among researchers from different domains becomes crucial.

3. PROPOSED METHODOGY

Our proposed methodology is based on the ITU three-stage framework (Figure 6).

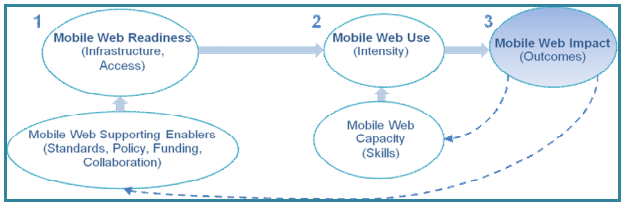

Figure 7. Proposed three-stage framework for mobile Web research [1]

Mobile Web Readiness covers mobile Web infrastructure, as well as access to mobile Web content and applications. A component influencing the Mobile Web Readiness is also added, called Mobile Web Supporting Enablers. It comprises of standards, policy, funding, and collaboration, since they are key mobile Web challenges. The impact becomes the major issue in this research, instead of an aggregation index like the IDI. Therefore the thick circle is removed from Figure 6, and the Mobile Web Impact is highlighted. Figure 4 and Figure 5 suggest a loop back arrow showing a life cycle of the Web. It demonstrates that Web usage create some effects, which can influence future Web development. As a result, in Figure 7 there are dashed lines with arrows from Mobile Web Impact pointing to Mobile Web Capacity and Supporting Enablers.

Proposed indicators reflecting mobile Web challenges for each mobile Web components/sub components are listed in. There are also mappings between each indicator and possible mobile Web stakeholders involved in it. The stakeholders will be the objects of research

Table 1. Proposed mobile Web indicators for Mobile Web Readiness, Supporting enablers, Use, and Capacity [1] [4] [15]

Mobile Web Readiness		
Sub Components	**Proposed Indicators**	**Mobile Web Stakeholders**
Infrastructure (mobile networks, such as GSM, CDMA, GPRS)	Penetration	Mobile Industry
	Coverage	
	Reliability	
	Airtime tariff and payment methods	
Access to Content and Applications	Affordable Internet-ready handsets	Mobile Industry
	Free supporting browsers	
	Locally relevant information	Mobile Service Developers, Capacity Builders, Government/Regulatory Bodies, Donors
	Local languages	
	Local character sets	
	Support for illiteracy	
	Service monetization	
Mobile Web Supporting Enablers		
Sub Components	**Proposed Indicators**	**Mobile Web Stakeholders**
Standards	Availability, publicity, implementation of the standards	Mobile Service Developers, Capacity Builders
Policy	Sustainability and scalability support	Government/Regulatory Bodies
Funding	Sustainability and scalability support	Donors, Government/Regulatory Bodies
Collaboration	Networking coverage	Donors, Capacity Builders, Government/Regulatory Bodies

Mobile Web Use (Intensity)		
Sub Components	**Proposed Indicators**	**Mobile Web Stakeholders**
	Mobile Web applications being used	Users
	Amount of money spent per month for airtime and mobile handsets, in proportion of their income and other expenses	
	Amount of time spent per month to access mobile web	
	Number of downloaded bytes, from which sites	
	Number of uploaded bytes, to which sites	

Mobile Web Capacity (Skills)		
Sub Components	**Proposed Indicators**	**Mobile Web Stakeholders**
	Literacy rate	Users, Government/Regulatory Bodies, Donors, Capacity Builders
	Mobile phone literacy rate	
	Capability to develop mobile applications	

The study of mobile Web Impact as a consequence of Mobile Use Figure 7 is derived from [2].

Table 2. Proposed indicators of Mobile Web Impact [1] [4] [14][15]

Mobile Web Impact		
Sub Components	**Proposed Indicators**	**Mobile Web Stakeholders**
Indirect (social of micro level case) and intangible benefits	Job offer or customer increase	Users, Capacity Builders, Donors, Government/Regulatory Bodies
	Productivity rise	
	Income growth	
	Time saving (waiting time to get jobs, do transactions, gain information, get diagnostic of diseases, rescue disaster casualties)	
	Better price of commodity	
	Reduction of travelling (frequency, distance)	
	Changes in business process (no more middlemen, creation of new roles)	
Web technologies	Protocol improvement	Capacity Builders, Mobile Service Developers
	Browser advancement	
	Standard development	
Mobile technologies	Wider, better, cheaper mobile networks	Mobile Industry, Capacity Builders
Mobile Web Impact		
Sub Components	**Proposed Indicators**	**Mobile Web Stakeholders**
	Handset advancement	Mobile Industry, Capacity Builders

The indicators will be measured by doing research on related mobile Web stakeholders. Methods to do the research are depicted in Figure 8.

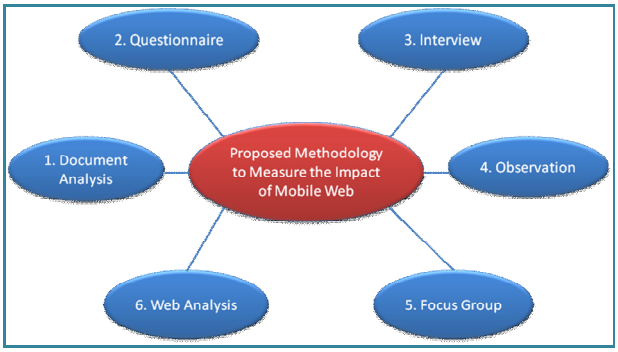

Figure 8. Proposed research method [9] [10] [11] [12] [13]

Methods number 1 up to 5 have been discussed in § 2.4 Social Research Methods. There is an additional method, which is called Web Analysis. It includes Web application development that can record users' activities. It is used to triangulate the data produced by other methods.

4. FUTURE WORK

Case studies in Kenya and Indonesia are planned to test the proposed methods. Those countries are chosen because research team has networks to local researchers. Besides Kenya and Indonesia represent Africa and Asia, which show significant growth of mobile Web use in developing countries (Figure 3).

The first series of case study is planned in 2010. The results will be evaluated to refine the method, which will be tested in 2011 case studies.

Up to now the detail plan of case study is only available for the one in Kenya, focusing on users as mobile Web stakeholders. Questionnaire and interview will be conducted to Kenyan university students studying computer science/engineering/natural science, and another group of students studying social science/humanities/arts. Similar interview will be conducted to informal entrepreneurs from slum area in Nairobi. There will be also observation in Nairobi on how people use mobile Web. The methods will try to study the indicators of users in Table 1and Table 2.

5. CONCLUSIONS

One research challenge in Web Science is developing a method that can define, identify, and measure the impacts of mobile Web in developing countries. The method is essential for various mobile Web stakeholders to improve mobile Web technology and anticipate its effect on society.

Because the Web is inherently multidiscipline, the research group comprises of experts from various domains, such as computer science, social science, especially social anthropology.

The processes of mobile Web up take follow three-stage framework from the ITU and Web development life cycle. Indicators are defined for each stage. Then they are studied or measured using several steps adopted from social research methods. Proposed indicators and method are going to be tested in case studies conducted in Kenya and Indonesia.

6. REFERENCES

[1] ITU, *Measuring the Information Society, the ICT Development Index 2009*, 2009.

[2] A. Bhavnani, R.W. Chiu, S. Janakiram, a33nd P. Silarszky, *The Role of Mobile Phones in Sustainable Rural Poverty Reduction*, ICT Policy Division, Global Information and Communications Department, 2008.

[3] Population Reference Bureau, *2008 World Population Data Sheet*, 2008.

[4] S. Boyera, "Mobile Web for Social Development Roadmap," Nov. 2009.

[5] BBC, "BBC News - Facebook launch 'Zero' site for mobile phones," Feb. 2010.

[6] MW4D, "Stories - Mobile Web For Social Development (MW4D)," Mar. 2010.

[7] Quantcast, "2009 Report, Quantcast Mobile Web Trends," Jan. 2010.

[8] J. Hendler, N. Shadbolt, W. Hall, T. Berners-Lee, and D. Weitzner, "Web Science: An Interdisciplinary Approach to Understanding the Web," *Communications of the ACM*, vol. 51, Jul. 2008, pp. 60-69.

[9] R.K. Yin, *Case Study Research Design and Methods*, SAGE, 2009.

[10] M. Hammersley and P. Atkinson, *Ethnography: Principles in Practice*, London: Routledge, 2007.

[11] C. Mann and F. Stewart, *Internet Communication and Qualitative Research: A Handbook for Researching Online*, London: SAGE, 2000.

[12] A. Bryman, *Social Research Methods 3ed*, Oxford University Press, 2008.

[13] J. Woollard, "Questionnaires," 2010.

[14] Deloitte & Touche LLP, *Economic Impact of Mobile Communications in Serbia, Ukraine, Malaysia, Thailand, Bangladesh and Pakistan*, 2008.

[15] S. Boyera, *W3C Workshop Report: The Role of Mobile Technologies in Fostering Social and Economic Development*, Maputo, Mozambique: W3C MW4D, 2009.