



<input checked="" type="checkbox"/>	Master's thesis
<input type="checkbox"/>	Licentiate's thesis
<input type="checkbox"/>	Doctor's thesis

Subject	Information Systems Science	Date	4.6.2014
Author(s)	Tuomas Tanskanen	Student number	73988
		Number of pages	76 p. + appendices
Title	Bridging the digital divide in developing countries: The role of mobile technology in bridging the digital divide		
Supervisor(s)	Ph.D. Kai Kimppa, M.Sc. Sami Hyrynsalmi		

Abstract

This thesis investigates how mobile technology usage could help to bring Information and communication technologies (ICT) to the people in developing countries. Some people in developing countries have access to use ICT while other people do not have such opportunity. This digital divide among people is present in many developing countries where computers and the Internet are difficult to access. The Internet provides information that can increase productivity and enable markets to function more efficiently. The Internet reduces information travel time and provides more efficient ways for firms and workers to operate. ICT and the Internet can provide opportunities for economic growth and productivity in developing countries. This indicates that it is very important to bridge the digital divide and increase Internet connections in developing countries. The purpose of this thesis is to investigate how can mobile technology and mobile services help to bridge the digital divide in developing countries.

Theoretical background of this thesis consists of a collection of articles and reports. Theoretical material was gathered by going through literature on the digital divide, mobile technology and mobile application development. The empirical research was conducted by sending a questionnaire by email to a selection of application developers located in developing countries. The questionnaire's purpose was to gather qualitative information concerning mobile application development in developing countries. This thesis main result suggests that mobile phones and mobile technology usage can help to bridge the digital divide in developing countries.

This study finds that mobile technology provides one of the best tools that can help to bridge the digital divide in developing countries. Mobile technology can bring affordable ICT to people who do not have access to use computers. Smartphones can provide Internet connection, mobile services and mobile applications to a rapidly growing number of mobile phone users in developing countries. New low-cost smartphones empower people in developing countries to have access to information through the Internet. Mobile technology has the potential to help to bridge the digital divide in developing countries where a vast amount of people own mobile phones.

Key words	Digital divide, Developing countries, Mobile phones, ICT, Application development, Application marketplace
Further information	





<input checked="" type="checkbox"/>	Pro gradu -tutkielma
<input type="checkbox"/>	Lisensiaatintutkielma
<input type="checkbox"/>	Väitöskirja

Oppiaine	Tietojärjestelmätiede	Päivämäärä	4.6.2014
Tekijä(t)	Tuomas Tanskanen	Matrikkelinumero	73988
		Sivumäärä	76 s. + liitteet
Otsikko	Digitaalisen kuilun kaventaminen kehitysmaissa: Mobiiliteknologia digitaalisen kuilun kaventajana		
Ohjaaja(t)	FT Kai Kimppa, DI Sami Hyrynsalmi		

Tiivistelmä

Tämä tutkimus selvittää kuinka mobiiliteknologian käyttöönotto voisi auttaa tuomaan informaatioteknologian kehitysmaiden asukkaiden käyttöön. Informaatioteknologia ei ole kaikkien kehitysmaiden asukkaiden saatavilla. Jotkut kehitysmaan ihmiset hyötyvät informaatioteknologian käytöstä, mutta samalla on suuri joukko ihmisiä, joilla ei ole tilaisuutta käyttää informaatioteknologiaa tai Internetiä. Internet tarjoaa käyttäjilleen tietoa joka lisää tuottavuutta ja lisää markkinoiden tehokkuutta. Internet lisää informaation kulkunopeutta ja parantaa firmojen sekä työntekijöiden toimintojen tehokkuutta. Informaatioteknologia sekä Internet edistävät talouden kasvua sekä tuottavuutta kehitysmaissa. Tästä kaikesta voidaan päätellä, että informaatioteknologian sekä Internetin käyttöönotto on kehitysmailla hyvin tärkeää. Tämän tutkielman tarkoituksena on selvittää kuinka mobiiliteknologia sekä mobiilipalvelut voivat auttaa kehitysmaita lisäämään informaatioteknologian käyttöä kansalaistensa keskuudessa.

Tämän tutkielman teoriaosuus koostuu useista artikkeleista sekä raporteista. Tutkimuksen teoriaosuuden materiaali kerättiin kirjallisuudesta, joka käsitteli digitaalista kuilua, mobiiliteknologiaa sekä sovellusten kehittämistä. Tutkimuksen empiirinen osuus koostuu tutkimuskyselystä joka lähetettiin kehitysmaissa toimiville sovellusten kehittäjille. Tutkimuskysely lähetettiin sovellusten kehittäjien sähköpostiosoitteisiin. Tutkimuskyselyn tavoitteena oli kerätä laadullista tietoa sovellusten kehityksestä kehitysmaissa. Tämän tutkimuksen ensisijainen tulos osoittaa, että mobiiliteknologian sekä mobiilipalvelujen käyttö voi lisätä informaatioteknologian käyttöä kehitysmaissa.

Tämän tutkimuksen mukaan mobiiliteknologian käyttöönotto on yksi parhaimmista tavoista lisätä informaatioteknologia saatavuutta sekä hyödyntämistä kehitysmaissa. Mobiiliteknologia tuo informaatioteknologian ihmisille joilla ei ole mahdollisuutta käyttää tietokoneita. Älypuhelimien avulla suuri joukko kehitysmaiden ihmisiä voi käyttää Internet yhteyttä sekä erilaisia mobiilipalveluja ja mobiilisovelluksia. Uusien edullisten älypuhelimien avulla kehitysmaiden asukkaat voivat käyttää Internetiä esimerkiksi tiedonhakuun. Mobiiliteknologian avulla on mahdollista lisätä informaatioteknologian käyttöä niissä kehitysmaissa joissa on paljon mobiilipuhelimien käyttäjiä.

Asiasanat	Digitaalinen kuilu, Kehitysmaat, Mobiilipuhelimet, Informaatio- ja kommunikaatioteknologia, Sovellusten kehittäminen, Sovelluskaupat
Muita tietoja	





Turun yliopisto
University of Turku

BRIDGING THE DIGITAL DIVIDE IN DEVELOPING COUNTRIES

The role of mobile technology in bridging the digital divide

Master's Thesis
in Information Systems Science

Author:
Tuomas Tanskanen

Supervisors:
Ph.D. Kai Kimppa
M.Sc. Sami Hyrynsalmi

4.6.2014
Turku



Turun kauppakorkeakoulu • Turku School of Economics

TABLE OF CONTENTS

1. INTRODUCTION	7
1.1 Background of the thesis	7
1.2 Purpose of the thesis	7
1.3 Structure of the thesis	9
2. DIGITAL DIVIDE	10
2.1 Defining the digital divide	10
2.2 Digital divide in developing countries	10
2.3 Digital divide in society	15
2.4 Possible ways to bridge the digital divide	17
2.4.1 Improving ICT infrastructure	17
2.4.2 Building information centers in rural areas	18
2.4.3 Increasing the availability of ICT and information for the people	19
2.4.4 Providing affordable computers for developing countries	22
3. MOBILE TELEPHONY	24
3.1 Mobile phones	24
3.1.1 Mobile broadband	24
3.1.2 Telecommunication in rural areas	26
3.2 Smartphones	27
3.3 Mobile phones providing services	29
3.4 Mobile phones in developing countries	30
3.4.1 Leapfrogging the landline telecommunication industry	33
3.4.2 Mobile phones potential as a tool for economic development	33
4. MOBILE APPLICATION MARKET	36
4.1 Application stores	36
4.1.1 Apple App Store	36
4.1.2 Google Play	37
4.2 Mobile application development	39
4.2.1 Mobile application development in developing countries	40
4.2.2 Publishing mobile applications	41
4.2.3 Paid applications and free applications	42
4.2.4 Developing mobile applications in local language	44
4.3 Providing mobile services to the developing world	44
4.3.1 Deploying eServices to mobile phones	44

4.3.2 Mobile applications in a cloud service.....	46
5. RESEARCH METHOD.....	48
5.1 Data collection	48
5.2 Questionnaire	49
6. FINDINGS	50
7. DISCUSSION	60
8. CONCLUSION.....	64
REFERENCES.....	66
APPENDIX 1: THE QUESTIONNAIRE.....	77
APPENDIX 2: QUESTIONNAIRE DATA	80

LIST OF FIGURES

Figure 1: Global Internet usage.....	12
Figure 2: Percentage of households with Internet access.....	17
Figure 3: Global mobile-cellular subscriptions.....	25
Figure 4: Mobile-cellular subscriptions	32
Figure 5: Fixed-telephone subscriptions	32

LIST OF TABLES

Table 1: Application development companies headquarters	50
Table 2: Application development in other countries	51
Table 3: Mobile platforms.....	52
Table 4: Development on mobile platform	53
Table 5: Mobile platform and other platforms	53
Table 6: The advantages of using mobile platform.....	54
Table 7: Problems in mobile development	56
Table 8: Application development for local and global markets	57
Table 9: Application development group sizes	58
Table 10: Applications sorted by categories	58
Table 11: Free applications and paid applications	59

1. INTRODUCTION

1.1 Background of the thesis

The people of the world can be divided into ‘technology haves’ and ‘technology have-nots’, people who have access to Information and Communication Technology (ICT) and people who do not. This division between these two groups of people is commonly referred to as the “digital divide”. Digital divide is usually greater in developing countries compared to developed countries.

ICT has a great potential to increase innovation, enhance economic growth and create high quality jobs. Innovation often occurs when a skillful labor force has the ability to experiment with the latest technologies and new materials. Several developing economies find it difficult to create the right environment for innovation as it is costly and takes a lot of time to produce any minimal results. (Bilbao-Osorio 2013.)

Modern ICT, such as mobile phone and the Internet hold many opportunities for developing countries. ICT can improve poor people access to markets, health care and electronic public services. Knowledge is important for development. Access to information and communication technology is essential to develop knowledge. The digital divide can be dealt by increasing connectivity among people and by projects that handle the constraints facing poor people. Poor people need knowledge so that they can increase their assets and have better living conditions. (Azam 2008.)

According to literature on digital divide, there have been several attempts to bridge the digital divide through different approaches. It is very difficult to find a single way to bridge the digital divide as the problem is very complicated. Many factors create the environment for the digital divide. People need to identify these factors and find the best solutions to solve them.

1.2 Purpose of the thesis

The purpose of this study is to examine how the use of mobile technology and mobile services might help to bridge the digital divide in developing countries. Mobile technology could help to bring ICT services to the people who do not normally have access to use computers. Mobile phone usage could help to bridge the digital divide by providing universal access and connectivity to people regardless of their economic status or location.

The focus of this thesis is on how mobile technology can help to bridge the digital divide in developing countries. The primary research question of this thesis is:

- RQ: How can mobile technology and mobile services help to bridge the digital divide in developing countries?

Mobile technology is present in many developing countries so mobile device usage might help to bridge the digital divide in these countries.

The primary research question has two subsidiary questions, focusing on mobile phones and mobile application development in developing countries. The subsidiary research questions are:

- Sub-RQ1: How can mobile telephone usage benefit developing countries?

The objective is to investigate what kind of positive results mobile telephone usage can bring to developing countries.

- Sub-RQ2: Why have application developers in developing countries decided to develop applications on mobile platform?

The objective is to study the reasons why application developers in developing countries have chosen to develop applications on mobile platform.

This thesis is based on qualitative research methodology. The main research question and the first sub-question will have answers from a selection of articles and reports. The first sub-question will have answers from theoretical literature. The second sub-question will have answers from the empirical part of this thesis. The empirical part of this thesis consists of a qualitative questionnaire on application development in developing countries. The questionnaire investigates the current state of mobile application development in developing countries. Application development industry provides a great opportunity for software developers in developing countries to develop applications on mobile platform. There is a great demand for a variety of mobile applications as the number of mobile device owners have increased rapidly around the world.

1.3 Structure of the thesis

Chapter 2 defines theoretical background to digital divide and its presence in developing countries. Chapter 2 also shows how digital divide affects people's lives in society. It provides some suggested solutions from theory that could help people to tackle the digital divide. Chapter 3 provides a theoretical background to mobile telephony. In it, smartphones and mobile phone services are discussed. It also presents how mobile phones can be used to leapfrog the landline telephony in developing countries and potentially be used for economic development.

Chapter 4 provides theoretical background to mobile application marketplaces and their functions. Chapter 4 discusses mobile application development and publishing. It also shows how to provide mobile services to the developing countries. Chapter 5 presents the research method and data collection procedures used in the empirical part of this study. Chapter 6 presents the empirical part of the study based on qualitative research method. The empirical part consists of a questionnaire that was sent to a chosen group of mobile application developers. The questionnaires results are presented in detail. Chapter 7 focuses to discuss the findings and results of this thesis. Chapter 8 provides the conclusions of this thesis and presents possible directions for future research.

2. DIGITAL DIVIDE

2.1 Defining the digital divide

According to Fuchs and Horak (2008), the digital divide refers to a situation where people have unequal access to use information and communication technologies. The digital divide can be divided into different categories: “1) *Material access* refers to the availability of hardware, software, applications, networks and the usability of ICT devices and applications. 2) *Usage and skills access* refers to the capabilities needed for operating ICT hardware and applications, for producing online content and for engaging in online communication and co-operation. 3) *Benefit access* refers to ICT usage that benefits the individual and advances a good society for all. 4) *Institutional access* refers to the participation of citizens in institutions that govern the Internet and ICTs, and to the empowerment of citizens by ICT to participate in political information, communication and decision processes”. “These categories have resulted in different types of the social divide. On the other hand unequal patterns of material access, usage capabilities, benefits, and participation concerning ICTs are also due to the asymmetric distribution of economic (money, property), political (power, social relationships) and cultural capital (skills).” (Fuchs & Horak 2008.)

The digital divide reveals that an individual may or may not have good access to hardware, software and network connections to use ICT. In tackling the digital divide, it is also important to notice that some individuals with good education might have minimal benefits from ICT. (Selwyn & Facer 2007.) Digital divide exists between and within most developed and developing countries. The digital divide widens in some countries even though many people use the Internet. New Internet users are demographically similar to those who already use the Internet. (Chen & Wellman 2004.)

2.2 Digital divide in developing countries

The lack of network resources in developing countries is one major indicator of the digital divide. There is a big difference between the end-user bandwidth available in developing countries and developed countries. There is also a big difference between Internet connection expenses in developing countries and developed countries. Developing countries connectivity is very expensive because of many reasons, such as

expensive international bandwidth, inefficient government monopolies, lack of proper peering points, low user density and poor provisioning. Internet connection is often provided through Internet kiosks or public libraries. Internet kiosks usually have shared dialup connections that deliver slow bandwidth around 10-15 Kbps. (Reda, Noble & Haile 2010.)

Internet access can empower workers with information in developing countries. Internet access can help to start economic growth, enhance productivity, create jobs and raise hundreds of millions of people out of poverty. The Internet provides information that increases productivity and enables markets to function more efficiently. The Internet reduces information travel time and increases organizational efficiency. Internet access has changed many aspects of the lives of individuals in developed countries. Internet access has created new ways for communication, new business models and industries, and more effective ways for firms and workers to function. Social media, search engines and online marketplaces have penetrated society and effected productivity, economic growth and business formation. These innovations have changed the way in which public services, education and healthcare are served and distributed. (Deloitte 2014).

The amount of individuals using the Internet was 2.3 billion by the end of 2011. The number of Internet users in developing countries doubled between 2007 and 2011 (Figure 1). (International Telecommunication Union 2012.) In 2013, there are over 2.7 billion people using the Internet, which makes 39% of the world's population. According to estimations, in 2013 Europe will have the highest Internet penetration rate in the world (75%), followed by the Americas (61%). Africa has the lowest Internet penetration rate in the world (16%). Development level estimations indicate that 31% of the population in developing world is online, compared to 77% in the developed world. (International Telecommunication Union 2013b.)

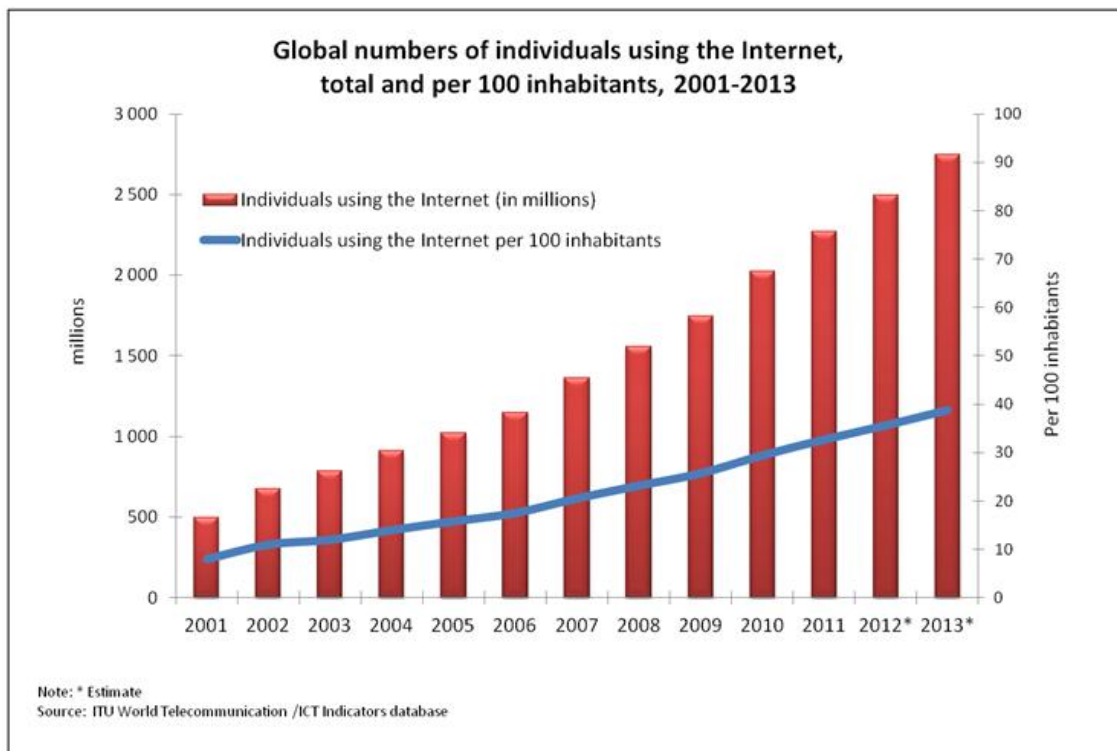


Figure 1: Global Internet usage (International Telecommunication Union 2013)

Most developing countries try to find a solution to deal with digital divide. In developing countries, citizens do not always have access to information they would need and want. In developing countries like India, people often live in distant villages that have unreliable power-supply. It is also common that these village inhabitants have low level of literacy and challenging health problems. Information solution providers should understand the current information access practice of these villages in order to be able to provide digital library and information retrieval technologies that believably help communities to bridge the digital divide. (Lalmas, Bhat & Frank 2007.)

According to Azam (2008), around half of the world's population lives in rural areas, where Internet service is very rare and poverty is widespread. ICT enables fast socioeconomic development in countries that use it. Many people in developing countries think that ICT is too expensive to expand. There are questions about how much money policymakers should use for ICT instead of investing in education, health care and other important sectors. (Azam 2008.)

To bridge the digital divide, information access solutions must be beneficial to the whole community and particularly its most disadvantaged members. A village could have televisions, radio sets and some computers with limited access to Internet. For example, Budikote is an Indian village (approximately 3,000 people) that has low level

of literacy among its villagers. Budikote has its own radio station that provides relevant information to the people in the village through audio. These programs are made at the village's ICT resource center, where they also produce programs with audio synchronized PowerPoint style slides and full audio-video presentations. Their programs range from public service announcements, interviews, plays, reports, panel discussions and songs. Programs topics include health, women and children, legal issues (e.g. property rights) and awareness related programs (e.g. self-help groups). Because of villages low level of textual literacy these programs are distributed in different ways: via cable to televisions and specially adapted radios and on tape to be played in self-help groups. The members of the lower castes receive programs via loudspeakers placed in trees. In the village Budikote people wanted to have information about environmental issues, educational options for children, career options, spoken English, social sciences and mathematics, agriculture, hygiene and cleanliness etc. People wanted to have access to relevant and timely information. (Lalmas et al. 2007.)

According to Agarwal, Kumar, Nanavati and Rajput (2008), some developing countries have tried to bridge the digital divide by providing information kiosks in rural parts of the country. Information kiosks provide services like email, chat, browsing, distant education programs, agricultural services and eGovernment services. Typically, a local entrepreneur owns an information kiosk that is equipped with a computer with printer, web camera, multimedia system and Internet connectivity. Information kiosks have provided rural population a way to have access to information and services but there are some problems. Firstly, most of information kiosk users are not computer literate, and they have to use kiosk operators as mediators. Kiosk operator is a person who uses information kiosk services on behalf of the user. This means that these users do not have direct access to the kiosk. Secondly, a lot of the information that local kiosk user searches for is not available on the Internet. Locally relevant information such as the local bus schedule may not be available on the Internet. Thirdly, people might have to travel a few kilometers to the neighboring village where they have access to the kiosk facilities. Lastly, information kiosks might face power cuts and hardware failures that will make their use difficult at times. (Agarwal et al. 2008.)

In Ghana, 40% of the households are living with less than a 1 U.S. dollar per day. Poor families cannot pay for school uniforms and supplies. Children are often at homes doing tasks such as carrying firewood and water. When children are traveling to schools, they have to walk long distances. Ghana's education quality is affected by

teaching quality and methodology, and the lack of ICT recourses in schools. In 2004, up to 30% of schools did not have enough textbooks for their students. Ghana has a policy to use ICT as the main engine for creating accelerated and sustainable economic and social growth. This policy has some of the following strategies to promote ICT in education:

- *“Mainstream ICT throughout the entire educational system to produce life-long learning.”*
- *“Develop an educational intranet to provide educational materials and tools at all levels of the educational system.”*
- *“Promote Internet access to all education institutions including the schools, universities and colleges.”*
- *“Transform the educational system to ensure that there is uninterrupted quality education for all Ghanaians from pre-school to age 17 to reduce poverty and create the opportunity for human development.”*
- *“Introduce computers into all primary, secondary, vocational and technical schools.”*

Ghana could improve its education quality and increase the use ICT by implementing One Laptop Per Child (OLPC). A laptop enables every student to have educational recourses at school and at home. Children can also teach their parents, aunts, uncles and grandparents how to use laptop computers. This would increase computer literacy throughout Ghana. However, the full implementation of OLPC in Ghana would require huge financial resources as it might cost up to 1 billion U.S. dollars. This amount includes laptop costs of 176 U.S. dollars per unit and support services. There are 3-4 million primary school children in Ghana and many new children require new laptop each year. This money could also be used to improve facilities and equipment and to improve teacher training in schools instead. OLPC would be a big investment for Ghana. (Fox Buchele & Owusu-Aning 2007.)

2.3 Digital divide in society

In the 21st century's information society, the digital divide consists of different issues. The digital divide is social as well as technical issue and its solutions will require cooperation across technical and social research. Cooperation between education and social policy, between industry, community and public sector. (Selwyn & Facer 2007.)

According to Bélanger and Carter (2009), digital divide consists of access divide and skills divide. Access divide means that some people do not have access to the Internet. Skills divide shows that there are people in society that do not have the skills to use information technology. Technical competencies include skills such as typing, using a mouse and giving instructions to the computer. Studies show that less educated, poor, old, and minority individuals in U.S. were more likely to need computer assistance (help to use the mouse and keyboard, email, word processor etc.). (Bélanger & Carter 2009.)

Many parts of society, including employment, education, health, welfare, leisure and politics, have experienced technology-based reconstruction. ICT has very important part in national development, organization growth and individual welfare. (Selwyn & Facer 2007.) ICT can bring qualitative and quantitative difference in to the life of global poor. Still, it should be noted that technologies are only means to an end and not an end in themselves. ICT should be used effectively to produce socio-economic benefits for developing countries. (Ekua Awotwi & Owosu 2009.)

ICT provides technologies that allow people to access and interact with health and welfare services and other areas of government, as ICT has a central role in government and public services. Computer-mediated communication and mobile communications technologies belong to many social interactions in the 21st century life. (Selwyn & Facer 2007.)

In many societies, lack of English skills and computer literacy might be excluding people to get access to the sources of information. English is commonly used language in the Internet although more and more software and websites are developed in national languages. Scholarly publications and international websites are developed mainly in English. It can be argued that English as a dominant communication language in Internet environment could be a threat for national cultures and their identity. Linguistic view of the world connects with cultural identity and that is why the access to

information in national languages is very important for Information and Communication Technologies. (Gorzalanczyk 2008.)

Chen and Wellman (2004) examined data from national representative surveys and examined the digital divide in the terms of access and use of the Internet across eight developed and developing countries (the United States, the United Kingdom, Germany, Italy, Japan, the Republic of Korea, China and Mexico). Socioeconomic status, gender, life stage and geographic locations are factors that significantly affect whether people have access to use the Internet. Next, these four factors are presented in more detail:

1. Socioeconomic status: Internet users are usually wealthy and better educated compared to people who are not using the Internet. Those countries that have lower Internet penetration rate have elite online population. The socioeconomic divide is to some extent decreasing in the U.S. and Japan.
2. Gender: The number of female Internet users is lower compared to male Internet users in each of the surveyed countries, with the exception of the U.S. Men have better access to use the Internet compared to women.
3. Life Stage: The Internet penetration rate is higher among younger people compared to older people, in both developed and developing countries. Most of the Internet users in developing countries are students who get online connection from the schools.
4. Region: Geographical location has an effect to Internet usage. Wealthy regions have higher Internet penetration rates than poor regions.

Socioeconomic status, gender, age, language and geographic location are factors that increase the digital divide. It is difficult for disadvantaged communities to use computers and the Internet because of high costs, English language dominance, the lack of relevant content and the lack of technological support. (Chen & Wellman 2004.)

According to International Telecommunication Union (2013) (Figure 2), people living in disadvantages areas such as Africa, Asia and Pacific or Arab States do not usually have Internet access. According to estimations, in 2013 just 6.7 percent of households in Africa had Internet access while 77.3 percent of households in Europe had access to use the Internet.

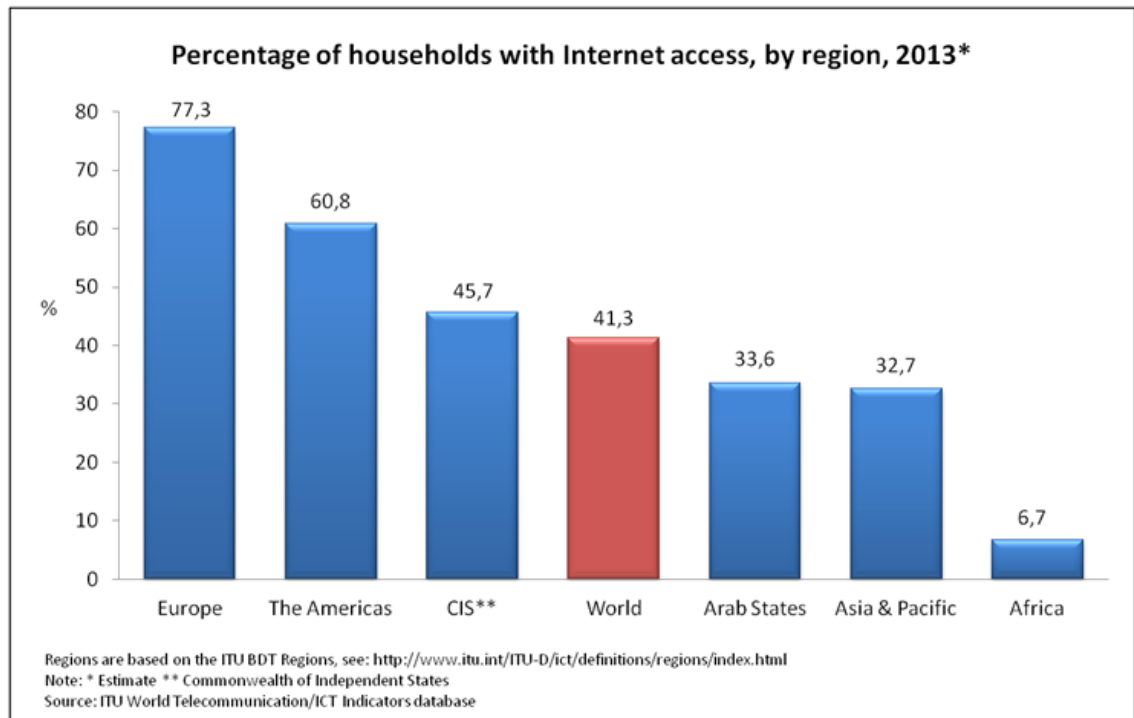


Figure 2: Percentage of households with Internet access (International Telecommunication Union 2013)

2.4 Possible ways to bridge the digital divide

2.4.1 Improving ICT infrastructure

There are some technological, cultural, financial and social challenges that need to be solved in order to bridge the digital divide. In most developing countries, inadequacy of ICT infrastructure is a problem. There is also absence of technical infrastructure planning and sub-optimal utilization of whatever infrastructure is available. Other major challenge is to ensure the sustainability of the ICT infrastructure. In many developing countries, implementation of ICT related projects do not have enough skilled human capital. These countries also miss people's soft skills that are needed for managing implementation of e-Governance systems. Developing countries face financial problems in investigating large sums in ICT from its own coffer. There is also the absence of pro-private sector policies for investments. Social challenges are quite tough in a world where ICT should provide digital services equally to poor and wealthy people. (Azam 2008.) Governments can provide communal Internet access points in schools, libraries, museums and other community settings. This can help individuals and social groups to have better access to computers and Internet. This community technology approach is only one way to tackle digital divide. (Selwyn & Facer 2007.)

Selwyn and Facer (2007) proposed a set of six challenges that should inform future discussions and actions concerning digital divide. These are the challenges:

- *“Challenge one: to start from premise that individuals from all sectors of society can be digitally excluded – not just those who are considered socially disadvantaged in general, or just those who make no use of ICT.”*
- *“Challenge two: to remember that there is a diverse and wide range of technologies, which can be considered ICTs – not just computers and the Internet.”*
- *“Challenge three: to draw upon the diverse and wide range of activities for which ICTs can be used.”*
- *“Challenge four: to strive to extend the range of ICT – mediated activities through the involvement of all social groups in the production of digital content and services.”*
- *“Challenge five: to find the ways to make the full range of ICT – based activities visible and viable to all individuals – regardless of their current engagement with ICT.”*
- *“Challenge six: to seek to match the affordances of ICTs with the everyday needs, interests and desires of individuals.”*

2.4.2 Building information centers in rural areas

According to Agarwal et al. (2008), developing countries have tried to bridge the digital divide by deploying information kiosks or knowledge centers in rural villages. These kiosks offer services such as email, chat and browsing to agricultural services, eGovernance services and distant educational services. An information kiosk typically contains a computer with printer, web camera, and multimedia system connectivity. These PC-based information kiosks could be replaced by using an alternate platform in the telephony network. Telephony network information service is accessible by ordinary phones. End-users can directly interact with the services removing the dependence on the kiosk operator. End-users would not have to travel to neighboring village to access information kiosk as before. (Agarwal et al. 2008.)

VoiKiosks

Mobile phone penetration in rural India is significant and increases constantly. Field studies and literature reviews show that semi-literate and illiterate people are comfortable with speech-based interfaces. Increasing mobile penetration and mobile users comfort with speech-based interfaces gives an opportunity to create and host VoiKiosks (voice interaction over an ordinary phone call). VoiKiosks provide information and service for the village. VoiKiosks provide convenient ways to access services that are relevant to the community using mobile phones. Mobile phones are more pervasive and affordable than PCs so they can fit better in rural areas. VoiKiosks are not relying on Internet connectivity, which is not always available in rural areas. VoiKiosks end-users can directly interact with the services by using its voice-based services. VoiKiosk end-users can either access or post information on the VoiKiosk depending on kiosks services. (Agarwal et al. 2008.)

The VoiKiosk operator configures the kiosk to offer services to the village. VoiKiosk can provide several services for its users. Information dissemination applications have important information to the community, like the local doctors weekly visit schedule. Interactive services are for specific user requirements, like consulting services. Service provider applications are services where end-users can become content/service providers. Users can use VoiKiosk to provide or advertise micro-business to local community. VoiKiosks enable two-way interactions for the end-user so that they can be consumers and provides at the same time. (Agarwal et al. 2008.)

2.4.3 Increasing the availability of ICT and information for the people

There are many challenges to bridging the digital divide. In the Indian state of Kerala, people have limited benefits from access to computers and the Internet. This happens because of infrastructural barriers, economic barriers, literacy and skill barriers, and language and content barriers. The state should reduce the digital divide by developing communication infrastructure and by providing inexpensive access to information. The state government has proposed many projects, which include distant education for adults in rural areas and building information kiosks. The state government has also created programs for e-Governance and citizen service centers. (Kumar K 2011.)

In the Kerala state of India, there exist a divide between rural and urban areas. The urban teledensity exceeds 15 to 18 percent and the rural penetration is about two

percent. The state government of Kerala has tried to bridge the digital divide by involving in several IT-oriented projects. E-Literacy project Akshaya aims to familiarize members of the state to browse the Internet, send emails and use e-Governance services. This project aims to set up around 3,500 broadband enabled community technology centers. These centers services include higher-level computer courses, Internet and email facilities, e-payment of selected utility bills and multimedia aided training programs. There are also e-content in education, career building, health and agriculture. (Kumar K 2011.)

Rural Africa has major challenges relating to basic infrastructure such as electricity and connectivity. Samsung technologies aim to bring modern technological innovations to remote parts of Africa. Samsung presents a new kind on school: Solar Powered Internet School (SPIS) that brings new technology to enhance learning and teaching particularly in rural Africa. The SPIS is a self-contained classroom with solar panels on the roof that provide power to the technology inside the classroom. The classroom includes netbooks, e-boards, multifunction printer etc. Botswana and South Africa have both one SPIS in use. (BiztechAfrica 2013b.)

Building information society for ICT development

In the World Summit on the information Society, governments, civil society and business sector discussed many subjects connected to ICT for development. Governments agreed to set of commitments and actions in order to establish inclusive information society. (International Telecommunication Union, 2010): These are the targets

1. *“To connect villages with ICTs and establish community access points.”*
2. *“To connect universities, colleges, secondary schools and primary schools with ICTs.”*
3. *“To connect scientific and research centers with ICTs.”*
4. *“To connect public libraries, cultural centers, museums, post offices and archives with ICTs.”*
5. *“To connect health centers and hospitals with ICTs.”*

6. *“To connect all local and central government departments and establish websites and e-mail addresses.”*
7. *“To adapt all primary and secondary school curricula to meet the challenges of the information society, taking into account national circumstances.”*
8. *“To ensure that all of the world’s population has access to television and radio services.”*
9. *“To encourage the development of content and put in place technical conditions in order to facilitate the presence and use of all world languages on the Internet.”*
10. *“To ensure that more than half the world’s inhabitants have access to ICTs within their reach.”*

These ten targets were planned to be achieved by 2015. These ten targets are quite broad and therefore it is difficult to monitor and measure them. In order to achieve the WSIS targets, there is a need for national, regional and international stakeholders. Since the WSIS summit people have been successfully connected via mobile technologies. There has been good progress to bring Internet access to central governments, research and scientific institutions and some progress in hospitals, schools, libraries, museums and archives in developing countries major cities. (International Telecommunication Union 2010.)

According to International Telecommunication Union (2010), the WSIS targets should be achieved by 2015; a common policy is needed among national, regional and international stakeholders. Policy actions should focus on the following three main areas in order to achieve the WSIS targets:

1. Expanding broadband Internet access. Broadband Internet access should be expanded, as inexpensive high-speed Internet access is important when governments are developing an information and knowledge-based society. Internet affects the way people communicate, interact with governments, do business, and educate. Governments should be required to pursue on policies that will have significant impacts on Internet usage, including broadband infrastructure (fixed/wired and/or wireless). Developing countries need to have access to wireless broadband Internet.

2. Building an ICT-literate society. People need to have a basic level of ICT literacy in order to use the Internet and its applications (related to health, education or government). Many people around the world are not able to use the Internet and its related applications because they are illiterate. ICTs should be provided in schools and to the population beyond school age.
3. Developing online content and applications. More people would use the Internet if they have access to local content in local languages. Local libraries, museums, archives and cultural institutions could digitalize their books, documents, exhibits and collections so that more content would be available online in local languages. ICT applications should be developed to be user friendly and affordable for citizens and local communities.

According to International Telecommunication Union (2010), the WSIS Mid-term review of the ten targets showed that in developed countries, most indicators show a high level of achievement while developing countries most indicators show low level of achievement. Limited data availability meant that mid-term review did not have comprehensive global assessment of all ten targets. Governments need to collect data that will be used for monitoring progress of achieving the WSIS targets by 2015. (International Telecommunication Union 2010.)

2.4.4 Providing affordable computers for developing countries

The One Laptop Per Child (OLPC) project aims to provide children XO laptops that will give them access to knowledge and learning regardless of their physical location or financial limitations. OLPC aims to narrow the digital divide and provide educational opportunities for under-privileged children. OLPC has many corporate partners including AMD, Brightstar and Google, and the United Nations Development Program as non-profit partners. XO laptops are sold only to governments that will distribute them inside the countries. XO laptops are estimated to cost 176 USD per unit. (Fox Buchele and Owusu-Aning 2007.) In 2007, OLPC started to deploy The XO laptops to governments around the world. Schools gave laptops to the children on a basis of one laptop per child. Over 2 million laptops have been distributed to 42 different countries around the world. (One laptop per child 2013.)

VIA Technologies plans to bridge the digital divide by producing very cheap personal computers powered by Android operating system. The APC costs only \$49

USD, and is able to give a complete PC experience. The computer can access Google Play, which provides hundreds of thousands of downloadable applications. The APC is equipped with full set of I/O ports, which connects the PC to a monitor or TV. The APC is mostly cloud-oriented as its creators state that the Internet is now defining computing. (Racoma 2012.) The APC features a custom build Android operation system that is optimized for keyboard and mouse input. The APC will enable a new group of people to explore the Internet and use HD quality multimedia or play games on a large screen monitor or TV. The APC consumes ten times less power than a standard PC system. Via Technologies unveiled the \$49 USD APC on May 2012. (VIA Technologies, Inc 2012.)

According to Magnier (2011), India plans to distribute \$35 USD tablet computers to its students. These tablet computers are supposed to bring computing to millions of villagers in rural India. The device with touch screen can handle basic computing such as email, social networking, surfing, online banking, instant messaging and multimedia. This tablet uses Google's Android 2.2 operating system and is equipped with headphones, Wi-Fi access, 2 USB slots, 256 megabytes of internal memory and a 7-inch screen. This tablet is not as advanced as Apple's iPad but it can provide basic computing beyond the mobile phone. (Magnier 2011.)

Donating computers to developing countries

World Computer Exchange (WCE) is non-profit organization that dedicates to help bridge the digital divide by donating used computers and technology to developing countries in Africa, Asia, Latin America and the Middle East. Since 2000, over 3.6 million youths in 2,850 computer labs located in schools, universities, youth centers and libraries in 44 developing countries were using WCE refurbished computers. WCE is a volunteer-based organization that has 800 volunteers around the world. WCE aims to connect developing countries youth to the Internet via donated computers. WCE has a global network of partners who help communities to have access to computers and technologies. (World computer exchange 2010).

Some developing countries receive donated computers from wealthy Western countries. Technology's progress is rapid and the lifetime of Western computer is only 2-3 years. Donated computers might not be very useful for developing countries. Developing countries might become dumps for developed countries electronic waste. (Fuchs & Horak 2008.)

3. MOBILE TELEPHONY

3.1 Mobile phones

There has been a great growth in mobile phone usage across the world in the last 20 years (Figure 3). Now the mobile telecommunication industry serves almost half of the world's population. Mobile telecommunication industry is a key driver of economic and social development across the globe. It advances technology, enables new business models, improves existing business models, and creates new jobs. Mobile telecommunication industry connects people to one another and empowers them to have access to information. Smartphones have changed the way people access the Internet, take pictures and navigate. (GSMA 2013a.)

Google's 'Android', Apple's 'iOS', Microsoft's 'Windows Phone 8' and Black Berry's 'BlackBerry 10' are considered to be the top four mobile Operation System (OS) platforms. It is fundamental for mobile operation systems to have a wide range of applications and a healthy developer community. Top OS will provide quality applications and innovations to the customer. (GSMA 2013a.)

3.1.1 Mobile broadband

Governments and institutions have tried to bridge the digital divide by focusing on fixed Internet connections. Mobile broadband provides an alternative way for the people to access the Internet. For many of the people in emerging economies, mobile broadband might be the only way to access the Internet. Mobile broadband empowers the people to have access to highly personalized Internet experiences across the world. Smartphones can provide the first and primary way for people in emerging countries to access the Internet. (Dutta & Bilbao-Osorio 2012.) Mobile phones could provide one way to bridge the digital divide. According to estimations, global mobile cellular subscriptions will reach 6.8 billion in 2013 (Figure 3). Mobile broadband subscriptions have progressed from 268 million in 2007 to 2.1 billion in 2013. Mobile broadband is the most dynamic ICT market as it has an average annual growth rate of 40%. In 2013, developing countries surpassed developed countries in mobile broadband subscriptions. Mobile broadband subscriptions in developing countries have more than doubled from 472 million in 2011 to 1.16 billion in 2013. (International Telecommunication Union 2013b.)

African continent experienced the highest mobile broadband growth rates over the past three years. In Africa, Mobile broadband penetration has increased from 2% to 11% in 2013. Mobile broadband is still much more expensive in developing countries than in developed countries. In 2013, mobile broadband price represents between 11.3-24.7% of monthly GNI (Gross National Income) per capita, in developing countries and 1.2-2.2% in developed countries. Mobile broadband is still more affordable solution for developing countries where fixed-broadband services cost 30.1% of monthly GNI per capita and mobile broadband costs 18.8% of monthly GNI. Mobile broadband services are most affordable in Europe where the average cost is less than 2% of GNI per capita. Mobile broadband services are unaffordable in Africa, where the average cost is almost 47% of GNI per capita. (International Telecommunication Union 2013b.)

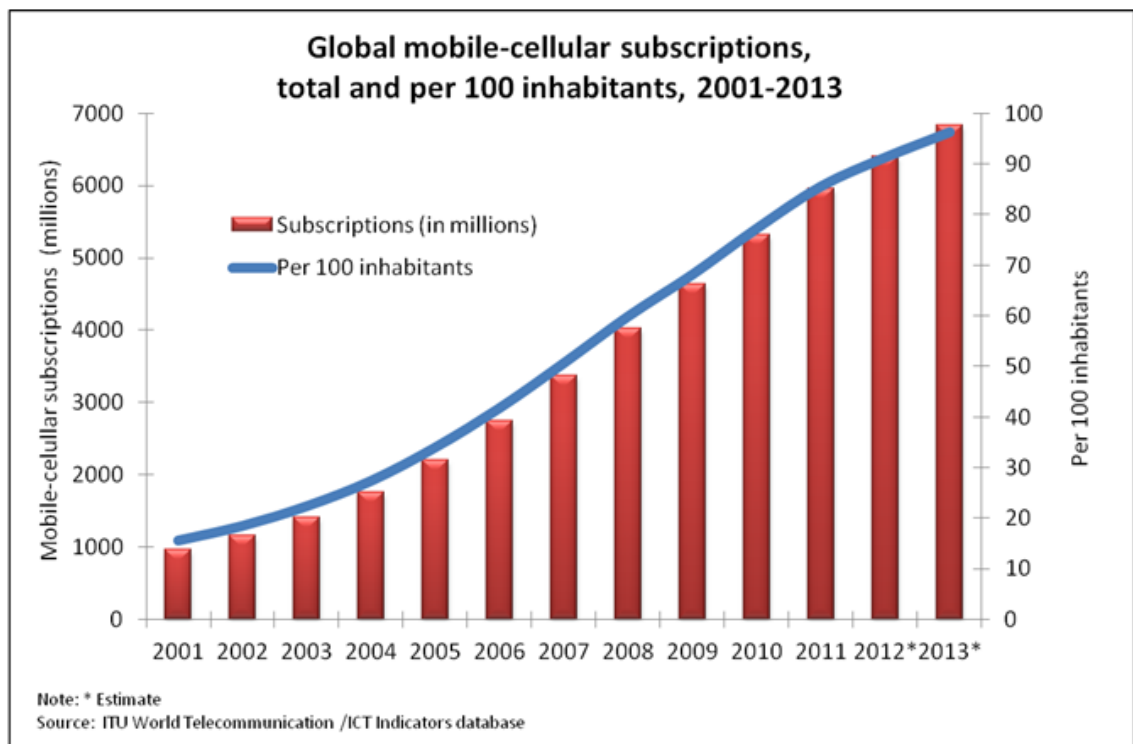


Figure 3: Global mobile-cellular subscriptions (International Telecommunication Union 2013)

According to Dutta and Bilbao-Osorio (2012), the Internet shifts from desktop experience to mobile experience for both developing and developed countries. Mobile connection has lower cost, better reach and better functionalities compared to landline telephony. Mobile broadband changes the way people access the Internet around the world. It has the capacity to change the way people live, learn, work and collaborate.

Mobile broadband services will have an influence on organizations, households and individuals economic activity. Studies in South Africa show that a 10 percent increase in mobile broadband and related industries could generate 28,000 new jobs and 1.8 percent of gross domestic product (GDP) by 2015. According to the World Bank, a 10 percent increase in mobile phone penetration in developing countries correlates to a 0.8 percent increase of per capita GDP. (Dutta & Bilbao-Osorio 2012.) In developing economies, increases in mobile penetration will increase country productivity. Agriculture, healthcare, education and finance are some of the sectors where mobile phones have improved communication, enhanced social institution and expanded economic activity and productivity. (Bilbao-Osorio, Dutta & Lanvin 2013.)

3.1.2 Telecommunication in rural areas

According to Ahuja (2008), Nokia Siemens Networks envisions that by 2015, there are five billion people connected through telecommunications. Nokia Siemens Network works in India to find innovative ways to provide communications to the people in urban and rural areas. India adds around six million new subscribers per month, making it the fastest growing mobile market in the world today. A major part of the future growth in mobile subscriptions in India will come from its rural areas where teledensity is under 2 percent. One solution to increase rural villages' connectivity is based on Global System for Mobile technology that enables calls within and between villages. This will help the operators to get to rural consumers that are able to pay around three USD per month for mobile services. Base transceiver station power consumption could be lowered by using power efficient hardware and software features. It is also possible to use solar and wind powered base transfer stations. Base transfer stations are already being manufactured in India, where people have a clear understanding of India's specific needs and conditions. (Ahuja 2008.)

It is challenging to provide mobility to rural consumers. From economic perspective, there is a need for quick and cost effective networks that decline equipment prices for rural areas. There is also a need to invest in creating products/solutions that provide viable business models that drive down the entire costs of ownership for operators. This will enable operators to provide affordable services for their rural customers. From the technical point of view, rural areas have some challenges. Rural areas have limited electricity supply, equipment, security and network planning, the post deployment maintenance and running of networks. It is challenging to set up a

network in the hills where the population is scattered. Hills create problems to tower lines and mobile networks coverage planning. (Ahuja 2008.)

3.2 Smartphones

Smartphones differ from feature phones. Smartphones allow access to Internet and data rich services, while feature phones allow calls and text messages. Feature phones are often equipped with features such as music and camera capability. The worldwide sales of mobile devices to end-users totaled 1.6 billion units in 2010, a 31.8 percent increase from 2009. Smartphone sales were up 72.1 percent from 2009 and credited for 19 percent of total mobile device sales in 2010. (Gartner 2011.) Worldwide smartphone sales totaled 210 million units in the first quarter of 2013, a 42.9 percent increase from the first quarter of 2012 (Gartner 2013).

According to Ericsson Consumerlab (2013), mobile phones, and more specifically, smartphones have the potential to bridge the digital divide by providing universal access and connectivity to all citizens, regardless of location and economic status. Mobile phones are an extremely influential technology across Sub-Saharan Africa that lacks fixed-line infrastructure. Basic and feature phones still dominate the mobile handset market in Sub-Saharan Africa but an increasing range of smartphones are entering the mobile handset market. People from different social backgrounds will be able to buy low-cost smartphones in the \$50 USD price range. (Ericsson Consumerlab 2013.) According to Canalys (2013b), in 2016, smartphones shipments will double the amount of 695 million units that were shipped in 2012.

Developing countries are adopting less sophisticated mobile devices that do not have as high capacity as smartphones in terms of displaying standard web pages. PC-based Internet access and mobile phone-based Internet access have some differences. Mobile phones may not be as suitable for Internet browsing as PCs. Mobile phones small screen limits the amount of information that can be displayed on the screen. Many of the websites are not designed to operate with mobile phones limited displays. Mobile-tailored Web sites tend to have less information and less functionality than PC-tailored Web sites. Mobile-tailored Websites should be designed to be easily readable and navigable on the small screen. (Napoli & Obar 2013.)

Developing countries need to have smartphones that are cheap, simple to use and have very long battery life. In 2011, Huawei unveiled an \$80 USD Android phone in

Kenya where 40% of the population lives on less than \$2 USD a day. \$50 USD is considered to be the preferred price point for smartphones to become more widely affordable in emerging economies. Smartphones should be strong enough to stand up in daily use. Developing countries will have demand for smartphone applications in the area of banking, market information etc. Unfortunately, they might not be able to afford to run many of the applications, as data is expensive. Applications should take as little bandwidth as possible. (Kochi 2012.)

According to Devine (2014), Mozilla plans to provide affordable \$25 USD Firefox OS smartphones for entry-level smartphone buyers. Customers would have very affordable smartphones and the ability to reach the Web. \$25 USD smartphone chipset is designed with a low memory configuration and high-level integration that reduces the material costs required to build low-end smartphones. These smartphones will have touchscreens, integrated WiFi, Bluetooth, FM, camera functions, browser features and access to web and HTML5 applications. Firefox OS smartphones are targeted to meet the needs of entry-level smartphone buyers in emerging markets such as Asia, Africa and Latin America. (Devine 2014.)

According to Reed (2012), Africa has the highest rate of growth in mobile subscriptions among big regions. Africa will cross the 750 million subscriptions mark during the fourth quarter of 2012 and is going to reach one billion before the end of 2015. According to estimations, the number of mobile subscriptions in Africa will achieve 761 million at the end of 2012 and will rise to 1.13 billion at the end of 2013 (Figure 5). Nigeria is Africa's biggest mobile market with its 100 million mobile subscriptions in the second quarter of 2012. Nigeria is predicted to have 168.99 million subscriptions at the end of 2013. Africa has seen strong growth in mobile data services as the results of 3G networks, affordable data-enabled devices and major improvements in international connectivity. (Reed 2012.)

Mobile Learning

Mobile phones are the most owned and used ICT devices in the world. Mobile phones can provide a learning platform for people in academic studies. This mobile learning (m-learning) could improve the learning and teaching processes. Mobile learning is considered to be cheaper than other ICTs used in teaching and learning. Students can use mobile phones to access web-based content, collaborate with other students, store and retrieve information such as e-books, instructional materials and course materials.

Students can use their mobile phones browsing applications such as Opera Mini and Internet explorer, to surf online. Students can then read their emails, read e-books and download study material. Mobile phones are also equipped with Bluetooth, and Wi-Fi, that are used for sharing information data wirelessly. (Mtega, Bernard, Msungu & Sanare 2012.)

Teachers can also use mobile phones for education in the classroom. In Tanzania, teachers have downloaded educational videos via a local 2.5G or 3G mobile network to a smartphone that they connected to a television in the classroom. Teachers have access to digital catalogue of educational videos, which cover subjects in human biology, geometry and HIV/AIDS. Now teachers can use this mobile platform to screen educational videos, diagrams and images to the entire class. Teachers in South Africa can use mobile phone product that provides daily lesson plans and weekly homework activity schedule for parents to study. This system encourages more parental involvement in learning process as it involves parents, students and teachers. (Unesco 2012.)

Mobile learning has some challenges, as some of the mobile phones are not compatible with programs like pdf, word, excel and Power Point. Mobile phones small screens can also cause limitations to m-learning. (Mtega et al. 2012.) Most of the lessons in mobile learning environment require access to Internet-enabled mobile phones that can download images. The vast majority of learners cannot afford to have a smartphone with Internet connection. This will likely change in the future as smartphones and Internet connectivity becomes more affordable (see e.g. \$25 smartphone earlier). (Unesco 2012.)

3.3 Mobile phones providing services

Mobile phones provide many advantages to the people in developing countries. People can have access to financial, health, agricultural and educational services and have opportunities for employment. Farmers in rural Africa and Asia use Short Message Services (SMS) to find out the daily prices of agricultural commodities. Farmers have better bargaining position as they take their goods to market. (Kochi 2012.)

The mobile phone industry improves the lives of some of the world's poorest people. In African communities, mobile phones have promoted economic development in many ways. The use of mobile phones reduces costs and improves markets, allows

greater effectiveness in business, creates jobs, increases the availability of information and delivers mobile-based services in the areas of finance, agriculture, education and health. Mobile phones allow great interaction through social media platforms. Mobile phone can also provide access to radio stations in such areas where radio frequencies are weak. Africans are getting around high mobile phone costs by sharing mobile phones, making short calls and by relying on text messaging. African countries governments are planning to reduce taxes and provide cheaper mobile phones as mobile phone costs are so high. (Otto 2011.)

According to Jotischky (2010), the ICT industry has the capacity to help Africa's economy to flourish. The public and private sectors on African countries must work together in order to adopt telecommunication services to rural areas. According to surveys, access to electric power is one of the biggest barriers that prevent the adoption of ICT services in rural areas. Rural communities and sub-Saharan Africa tend to have well below 20% electrification rates. This will greatly diminish the availability of ICT services in remote areas. Rural areas will have better access to telecommunication services as electrification rates are improved. (Jotischky 2010.)

Mobile phones can be used as the support for health, business, banking, government services, and education. These e-services are widely SMS-based. SMS is generally available on all phones, it is easy to use and its cost is generally low. On the other hand, SMS-based applications have limited functionality, as they are text-only, have limited size and provide just basic services such as single query/response. (Boyera 2007.)

3.4 Mobile phones in developing countries

Just over 50 percent of Africa's rural population is within reach of mobile cellular network. Developing countries rural households rely mainly on mobile telephony. At least 50 percent of developing countries rural households have mobile telephone. (International Telecommunication Union 2010.) According to statistics, 80% of the 660 million new mobile-cellular subscriptions added in 2011 were from developing countries. India added 142 million new mobile-cellular subscriptions in 2011, which was twice as many as in the whole Africa. (International Telecommunication Union 2012.)

According to Mimbi, Olu Bankole and Kyobe (2011), mobile phone communication has a huge potential in Africa where fixed line phones and broadband Internet connectivity is expensive and underdeveloped (Figure 4). Mobile phones are relatively affordable, portable, and easier to use than computers. People who live in rural areas are able to own and use mobile phones. The demand for mobile phones in African countries is huge. There is a higher level of mobile phone adoption than Internet adoption within the East African countries. Kenya and Tanzania have the highest rates of mobile phone adoption among East African countries. The telecommunication market has opened up innovations such as mobile banking and regional roaming-free services. This has led to a rapid reduction in the cost of the mobile phones. Low income populations can now own mobile phones. Mobile phones are used for communication through voice and text. Mobile phones provide a communication channel that empowers citizens in social and economic activities. People living in rural isolated areas are now connected through their mobile phones. People can use mobile phones for educational and political purposes. For example, in Tanzania, students can make a request for exam results through mobile phones services by sending their examination number to the authority concerned. (Mimbi et al. 2011.)

Mobile phones are widely used in Kenya's rural areas where people charge their mobile phones in phone charging kiosks (Wyche & Murphy 2012). In Africa, over 700 million people live without electricity. Most of these people have to walk many kilometers each week in order to use phone charging services in town centers. These people could use solar powered energy solutions such as the Sunbox. The Sunbox system allows users to charge mobile phones and use LED light. After 5 hours of sunlight, the Sunbox provides 10 hours of mobile charging and LED lighting. (GSMA, 2013b.)

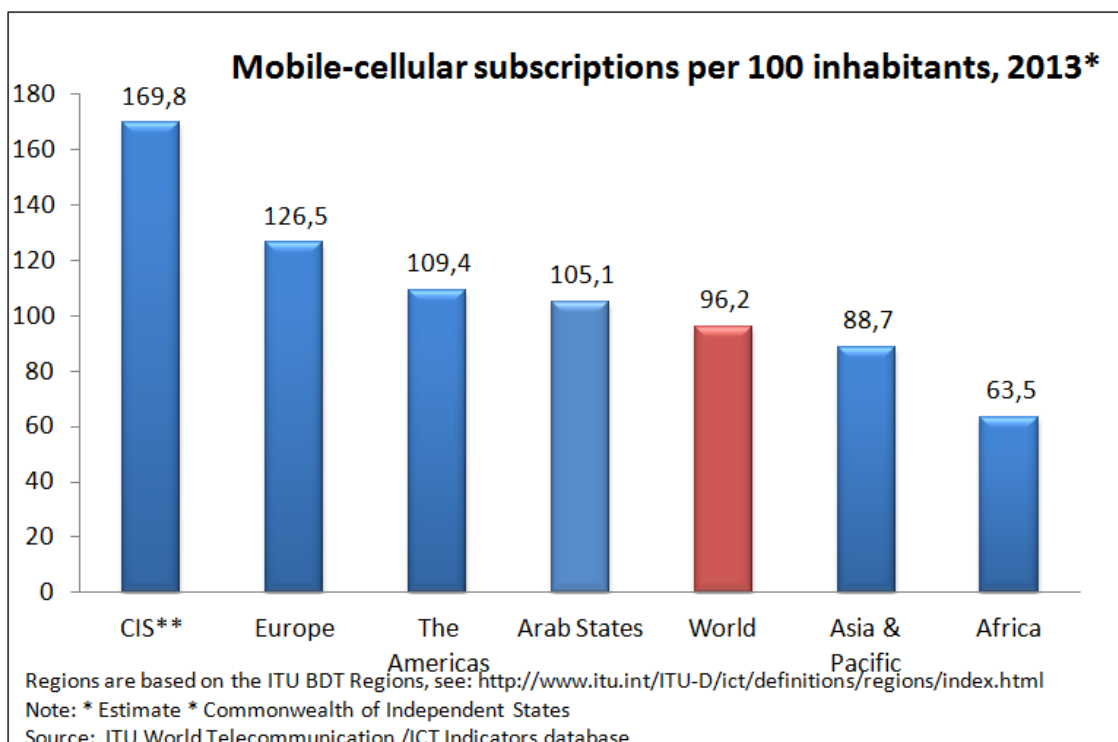


Figure 4: Mobile-cellular subscriptions (International Telecommunication Union 2013)

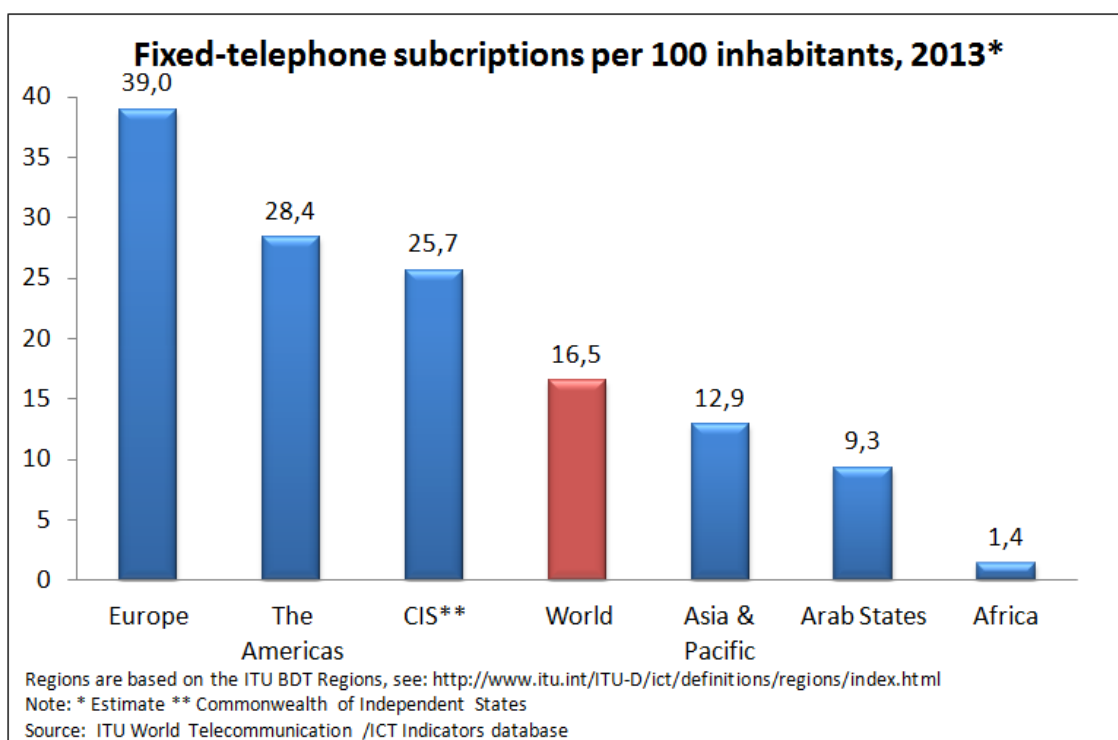


Figure 5: Fixed-telephone subscriptions (International Telecommunication Union 2013)

3.4.1 Leapfrogging the landline telecommunication industry

Populations in developing countries could adopt new technological innovations without ever having to adopt the previous technology. This “technology leapfrogging” could provide one way to bridge the digital divide. Those developing countries that have lacked traditional PC-based Internet access can now begin to use Internet-enabled mobile devices. (Napoli & Obar 2013.) Developing countries might be able to use ICT to leapfrog certain stages of technological or industrial development and become information societies. It is possible for developing countries to use wireless communication instead of old wire-line infrastructure. Digitalized communication systems are better, compared to analog-based systems. (Fuchs & Horak 2008.)

Africa has effectively leapfrogged the landline telecommunication industry and moved straight to the mobile phone networks. Landline telecommunication can be more expensive than network of base stations in countries that have bad roads, great distances and low population densities. In sub-Saharan Africa, mobile phone coverage is mainly provided via a network of specialized base stations, providing service to a 5-10 kilometer radius. People can use mobile phones when they need to send and obtain information quickly and cheaply. Mobile phones enable individuals to connect to individuals and have access to information, markets and services. (Aker & Mbiti 2010.)

According to Napoli and Obar (2013), there is a second level digital divide. Second level digital divide refers to the situation where people have access to technology but they do not have the required skills to use this technology. This second level digital divide might occur when people that have not used the Internet via PC begin to use the Internet via a mobile device. Mobile-based Internet has many of the same elements as PC-based Internet. There is an assumption that mobile device users have access to a PC or have previously used PC-based Internet. There is a possibility that technology leapfrogging replaces previous digital divide with new digital divide. (Napoli & Obar 2013.)

3.4.2 Mobile phones potential as a tool for economic development

Mobile devices and services have seen remarkable growth worldwide. Mobile devices and related services have the capacity to empower users in remote areas as well as trigger development and economic activity. It is important to harness the capabilities of

mobile technology for citizens in the developing world so that they can unleash their full potential as productive human beings. (BiztechAfrica 2013a.)

According to Aker and Mbiti (2010), Consumers as well as producers can have economic benefits from using mobile phones. There are five potential mechanisms for economic benefits:

1. *“Mobile phones can improve access to and use of information, thereby reducing search costs, improving coordination among agents, and increasing market efficiency.”*
2. *“Increased communication should improve firms’ productive efficiency by allowing them to better manage their supply chains.”*
3. *“Mobile phones create new jobs to address demand for mobile-related services, thereby providing income-generating opportunities in rural and urban areas.”*
4. *“Mobile phones can facilitate communication among social networks in response to shocks, thereby reducing households’ exposure to risk.”*
5. *“Mobile phone-based applications and development projects have the potential to facilitate the delivery of financial, agricultural, health, and educational services.”*

African governments, nongovernmental organizations and phone companies have all noticed that mobile phones have the potential to be a tool for economic development. Mobile phone-based services and products are much more than basic voice calls and text messages. (Aker & Mbiti 2010.)

There are several mobile phone-based development projects in Africa in variety of sectors, including agriculture, health, education, emergency response and governance. Mobile phones have been used in variety of mobile health projects in Africa. Mobile phones can be used in the collection, monitoring and measurement of health data. (Aker & Mbiti 2010.)

In sub-Saharan Africa, households and firms search information in variety of areas: potential buyers and sellers, input prices, output prices, natural disasters, new technologies, politics, and the status of friends and family members. Traditional information search mechanisms include personal travel, radio, landlines, letters and television. Mobile phones have presented new search technology in sub-Saharan Africa.

Mobile phones greatly reduce search cost, as people do not have to travel to markets to obtain agricultural price information. (Aker & Mbiti 2010.)

The farmers in developing countries account for 75% of the world's poor. These farmers do not have access to timely market information, financial services or advanced agricultural supplies. Mobile technology enables farmers around the developing world to get access to services and information they need in order to grow their production and improve their standards of living. Mobile technology has the ability to change farming in developing countries to be more sustainable and profitable, and therefore lift millions of people out of poverty. Farmers across the developing world can use their mobile phones to have access to information that gives them regular weather reports and latest market prices. Farmers can save crops from storms and raise their profits by avoiding unnecessary middlemen. Mobile financial services (MFS) such as payment, credit, insurance and savings, are tools that enable farmers to invest in fertilizers, high quality seeds and machinery. This will increase crop yields and benefit farmers and agriculture sector. (World economic forum 2012.)

According to GSMA (2013a), mobile industry is fast growing employment sector in developing countries. Jobs are created in advertising and distribution of online content, such as applications, games and ringtones. Globally, the mobile ecosystem has employed almost 9 million people in 2012. (GSMA 2013a.)

Mobile phones can have positive economic impacts in Africa through job creation. Mobile phone sector provides many jobs. Mobile phones can also create opportunities for entrepreneurship. Most Africans use prepaid mobile phones and use airtime cards. That is why many small shops sell mobile phone credits. Many small firms sell, repair and charge mobile phone handsets. (Aker & Mbiti 2010.)

Mobile-based applications provide possibility for distributing agricultural price information, monitoring health care and transferring money in poor countries. Since 2005, mobile financial applications ("m-money" or "m-banking") have been used in some developing countries. These applications are used for various banking transactions via mobile phone. (Aker & Mbiti 2010.)

4. MOBILE APPLICATION MARKET

4.1 Application stores

Application stores are marketplaces where applications are available for instant download. Application developers can publish their applications in application stores. Application stores allow developers to monetize their software. Users can search for applications and buy them from the developers in the application store. Application store owner will then take a share of the generated revenues. (Jansen & Bloemendal 2013.) The mobile applications market has been growing for the past years. This growth will continue as smartphone penetration increases and mobile application libraries grow bigger. According to estimations, Mobile application downloads are predicted to reach nearly 48 billion in 2015. (International Telecommunication Union 2011.)

Several marketplaces provide applications for mobile devices. Apple App Store, Blackberry App World, Google Play, Nokia Ovi and Windows Phone Marketplace are all in tight competition with each other in the mobile application market environment. Software developers can choose in which of these mobile ecosystems they want to publish their applications. Only a small number of professional developers publish applications in several marketplaces for several operation systems. (Hyrynsalmi, Mäkilä, Järvi, Suominen, Seppänen & Knuutila 2012a.) Multi-platform development is quite expensive. Many successful developers decided to use multi-platform publishing in order to reach much wider audience for their applications. For example, game publisher Rovio launched its Angry Birds Space for Android and iOS (iPhone OS) at the same time. Publishers need to use multi-platform publishing, because one platform is not going to reach the majority of the public. (Spriensma 2012b.)

4.1.1 Apple App Store

Apple launched mobile application store (Apple App Store) in July 2008. At that time, App Store provided 500 applications for the iPhone. The number of applications grew as application developers started to develop more iPhone applications. The value of iPhone increased, as there was an application for many different needs. (Spriensma 2012b).

There are a small number of developers that generate the majority of revenue at Apple's App Store and Google Play. Almost all of these developers are game

companies. According to estimates, 25 developers accounted for 50% application revenue in the US in App Store and Google Play during the first 20 days of November 2012. Game developers are successful in application stores as of the top 25 grossing developers, all but one were game developers. Successful game developers such as Zynga, Electronic Arts, Disney and Rovio have multiple games generating revenue in App Store and Google Play. During the first 20 days of November 2012, on average 145 of App Store's top 300 paid applications and 166 of Google Play's top 300 paid applications were games. At that same time, 94 of Apple's top 300 free applications and 110 of Google Play's free applications were games. (Canalys 2012a.)

4.1.2 Google Play

Google Android market was launched in October 2008. The marketplace provides downloadable software applications that are available either free of charge or for purchase. These applications can be downloaded into devices that use the Android operating system. (Campbell & Ahmed 2011.) Android OS has more than 48 percent of the smartphone market while iOS has 32 percent of the market. According to Google, there are 850,000 Android device activations per day. In March 2012, there were 617 million application downloads on Android and 393 million downloads on iPhone in the United States. (Palli 2012.)

Google Play was launched on March 2012 as Android market, Google Music and Google eBookstore became part of Google Play (Rosenberg 2012a). Google Play provides music, movies, books, Android applications and games on Android phones and tablets. Users need to have a Google account in order to download Android applications into their mobile phones or tablet devices. Google Play has free and paid applications that can be downloaded to devices directly from the Play Store through Internet connection. (Google Play 2013a; Etherington 2013.) According to Costine (2012), in 2012, Google Play provided free applications in 190 countries and paid applications in 132 countries. Google Play had more than 600,000 applications and over 1.5 billion application installations per month.

Android is argued to be the most popular mobile platform in the world at the moment, as it powers hundreds of millions of mobile devices in over 190 countries all around the world. Android users have downloaded more than 1.5 billion applications and games from Google Play each month. In Google Play, Android developers can deploy applications to hundreds of millions of mobile phone users as well as tablet

computer users. (Android 2013.) In September 2012, Google play celebrated as it reached 25 billion downloads. Google Play had then over 675,000 applications and games. (Rosenberg 2012b.)

Google Play celebrated its first birthday on March 6, 2013. Google Play contained more than 700,000 applications and games. Google play is now collaborating with all the major music companies, movie studios and publishers, so that their customers can have access to music, movies, books and applications on their Android mobile phones or tablets. (Rosenberg 2013.) Google play is growing its media ecosystem so that it can compete with Apple and Amazon. Google Play has over 5 million eBook titles and over 18 million music tracks in its catalog. (Etherington 2013.)

Google Play for application developers

Google Play marketplace has many benefits for application developers. The marketplace accepts new developers and there are no acceptance procedures for applications. Application developers can easily enter to the application market, as application development requires very small or zero investment. Application development requires little work and Google Play distributes published applications to huge number of users. (Hyrynsalmi, Suominen, Mäkilä, Järvi & Knuutila 2012c.) Developers can test out what kind of features work best for their applications. Android provides referrer information that anonymously identifies the source of a download. This information will help developers to realize what kind of advertising is or is not working for their applications. Developers can use their best keywords for their application descriptions and title in order to get higher search rankings. In the end, Android offers a bigger overall market and has lower user acquisition costs than Apple's iOS. (Palli 2012.)

Google Play marketplace has also some limitations for applications developers. Developers from only 32 countries (Argentina, Australia, Austria, Belgium, Brazil, Canada, Czech Republic, Denmark, Finland, France, Germany, Hong Kong, India, Ireland, Israel, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Singapore, Spain, South Korea, Sweden, Switzerland, Taiwan, United Kingdom and United States) may register as Google Checkout merchants and sell paid applications. Developers from 148 countries have the possibility to register into Google Play developer console account and distribute free applications. Free applications

cannot be equipped with in-application billing features. (Google Play 2013b; Google Play 2013c.)

Google requires a single one off payment of \$25 USD when developers register to their market terms and conditions. The Android software developing kit provides developers with access to application programming interfaces and development tools. Developers can distribute their applications via the Android market, directly via websites or via third parties. Developers can publish their applications in Android market as free applications or paid applications. Paid applications revenue is divided 70/30 between the developer and Google. Developers do not have to pay any additional fees as Google's 30% revenue includes marketing, hosting and transaction fees. Developers do not have to pay anything to Google when they upload free applications to the Android Market. (Campbell & Ahmed 2011.)

4.2 Mobile application development

Mobile application developers with poor brand might not get their applications noticed in order to monetize them. It can be difficult to get customers to discover other types of applications as games get so much attention. (Canalys 2012a.) Because of the so-called ranking effect, higher ranked applications have more visibility than lower ranked applications. This means that higher ranked applications will generate more downloads and revenue than lower ranking applications. (Agten 2013.) Developers need to promote their applications by using social media, sales promotion and discounts, in-application advertising etc. (Canalys 2012a). Electronic Arts, for example, offers game discounts in the App Store in order to remain visible to customers by featuring in the top application lists (Canalys 2012b). Price drops have positive effect on applications downloads and revenue in Apple App Store and Google Play. These applications will have more visibility and better ranking that will likely lead into even more downloads and higher revenue. Developers use different pricing strategies in order to increase revenue from their applications. Developers might raise the price of their popular applications because consumers are willing to pay a higher price for high ranked applications. (Agten 2013.)

According to Hezemans (2013), only a small number of publishers in Google Play and Apple App Store are new as application market is very crowded. New publishers represent two percent of the top 250 publishers in the Apple App Store in the U.S. and three percent of the top 250 publishers within the last four months in Google Play. Only

12% of the top 300 applications in Google Play in the U.S. were new applications while 17% of App Store's top 300 applications were new. Furthermore, widely known publishers usually publish the most popular new applications. (Hezemans 2013.)

Games are the most downloaded applications that generate the most money in applications stores such as Google Play and Apple's App Store. In 2012, there were nine gaming companies in the list of 10 highest grossing publishers in Google Play and App Store. Other types of applications have also generated a lot of downloads. There has been a decline in applications average price in the past years. This might be the result of increased competition in the application stores. Several publishers are monetizing via in-application purchases instead of one-off fees. Apple's App Stores revenue from in-application purchases increased from 53% (January 2012) to 69% (November 2012). (Spriensma 2012a.) Consumers are willing to pay additional sums of money for extra content, levels or add-ons for low-cost application they like. According to App Interrogator survey, 82 of the top 100 applications in Apple's U.S. store and 22 of the top 100 applications in the Android market's (Google Play) U.S. store cost just \$0.99 USD. (Canalys 2012b.)

4.2.1 Mobile application development in developing countries

According to Boyera (2006), developing countries should have the opportunity to develop mobile applications that are useful for their countries. Still most of the developing countries universities teach students to develop PC-based application to the developed world instead of their countries and communities. (Boyera 2006.) There should be a public forum, where developing countries experts could share their expertise in mobile technologies and in ICT. This would help to gather best guidelines for providing mobile e-services for the developing countries. Mobile application development courses should be taught at the universities in developing countries. This way people in developing countries could develop applications that would fit the needs of their own country. (Boyera 2007.) A study in Kenya indicates that Kenyans do not have good access to locally produced mobile ready content and were therefore using international platforms such as Facebook, Wikipedia and YouTube (Napoli & Obar 2013).

Mobile users in African market want to have access to affordable phones that are equipped with the right local content (Shu 2013). Microsoft 4Africa is Microsoft's program that aims to set up AppFactories in South Africa and Egypt to enable youth

gain application development skills. AppFactory interns will have training on how to develop applications for Windows 8 and Windows phone. Microsoft states that AppFactories could accelerate start up creation and employment opportunities in Africa. (Microsoft 2013a.) Microsoft claims that it wants to ignite African innovation for the continent and for the world. Microsoft claims it wants to work closely with African independent software vendors and developers in order to accelerate the development of relevant Windows 8 and Windows Phone applications. Applications are supposed to be developed by Africans, for Africa. (Microsoft 2013b.)

4.2.2 Publishing mobile applications

The application ecosystems are tools that can improve the main business. App Store increases Apple's mobile device sales. Google Play extends Google's online advertising business into mobile devices. Windows Phone Marketplace might aim to protect Microsoft's software sales. The primary objectives of App Store, Google Play and Windows phone marketplace seems to be to maximize the number of users in their mobile ecosystems. (Hyrnsalmi et al. 2012a.) According to Koekkoek (2012b), several brands use applications in order to get more visibility for their brand. Most of the top 100 best global brands have at least one application in the United States Apple App Store. 88 of these global brands have at least one application available in the Apple App Store. Google and Apple are among the five most valuable global brands and among the top downloaded brands in the App Store. In the U.S. Google's YouTube was the most downloaded application from the Apple App of the top 100 global brands in September 2012. Applications such as Facebook are in the App Store to support the main product of a company. Brands like Apple, Disney, Facebook and Google managed to generate the most downloads in the U.S. Apple App Store. Applications that only promote a brand are not as successful as other types of applications. (Koekkoek 2012b.)

According to Spriensma (2012a), the large number of applications available on both Google Play and Apple App Store makes it more difficult for developers to become successful. Customers will not be able to discover their applications from a vast number of other available applications. Application stores ranking lists for applications tend to drive a lot of downloads to a few number of top developers. For example, in November 2012, 10% of the revenues in the Apple App Store for iPhone were collected from only seven applications. Google Play and Apple App Store have both huge daily download and revenue volumes. On a typical day in November 2012, App Store had \$15M USD

in revenue while Google Play's daily revenues were just below \$3.5M USD. These revenue statistics were collected from 20 countries (Australia, Canada, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Netherlands, Norway, Russia, Spain, Sweden, Switzerland, Taiwan, United Kingdom, and United States) that generated the highest amount of revenue. The United States is the largest market by revenue before Japan, United Kingdom and Australia. (Spriensma 2012a.)

According to Koekkoek (2012a), in-application purchases (IAP) have become the main source of income for several application developers. Free applications with in-application purchases (freemium applications), generated 66% of the revenue from top 200 highest grossing applications in the U.S. compared to 13% revenue generated from paid applications. (Koekkoek 2012a.) In-application purchases generate the majority of the revenue in the application stores. In February 2013 in the U.S., 76% of the revenue in the Apple App Store for iPhone was generated by in-application purchases. Of the top 250 applications in the Apple App Store, 170 applications were free with IAP and 53 applications were paid applications with IAP. The remaining 27 applications belong to the paid only category. Free applications with IAP generate less revenue than paid application in the U.S. Apple App Store for iPhone. Paid applications with in-application purchases generate more revenue than paid applications without in-application purchases. (Koekkoek 2013.) Freemium application purchases are popular in Russia and Turkey where more than 50% of the revenue of the top grossing applications is generated from in-application purchases. In Mexico and Brazil, paid applications generate the majority of application revenue. Brazil, Mexico, Russia, Turkey and number of East Asian countries are the fastest growing markets for applications. (Koekkoek 2012a.)

4.2.3 Paid applications and free applications

Applications in Android Market (currently known as Google Play) are priced from 0.10€ to almost 200€. Google Play has also many free applications for the customers to download. It seems that the applications generate money mainly from advertisements or through products/services that are supported by the applications. (Hyrnsalmi, Suominen, Mäkilä & Knuutila 2012b.) According to the gathered data by Hyrnsalmi et al. (2012b), games present 12.95% and other applications 87.05% of all the applications in Android Market. 69.1% of studied applications were free to download and install and 30.9% required a payment. Google play has 84,644 application developers that have

published an application in the marketplace. 57% of all these developers have published only one application. (Hyrynsalmi et al. 2012b.) In Google Play, developers are free to set any price point for their applications. Apple App Store developers have to choose a price point from \$0.99 to \$999.99 USD. Developers in Google Play and Apple App Store have the access to change their applications prices whenever they like. (Agten 2013.)

Most of the most successful developers in Android Marketplace (Google Play) are big companies such as Electronic Arts (EA) and Gameloft. It seems that applications direct sales create relatively small revenue for the publishers. Free applications can generate considerable income from advertisement. Developers generate higher income when they publish a free and paid version of the application. There are a number of applications that are offered as non-profit service or as free-extension of the application providers' core business, such as online banking. (Hyrynsalmi et al. 2012b.) Free application might contain advertisement, or be time or feature limited. Advertising is one of the common revenue models in Google Play. This freemium-model can generate higher income for the developers compared to directly paid downloads. Some applications generate revenue from in-application Purchase model that allows the customer to buy premium content in the application. (Hyrynsalmi et al. 2012c.)

Application publishers can maximize their revenue by using in-application strategy. Free applications will get high number of users. Publishers can then monetize their users by advertisements and in-application purchases. Paid applications have usually much lower volumes than free applications. Application stores free volume is at least 10 times higher than the paid volume. Google Play store sells applications for mobile phones and tablet computers while Apple App Store has one store for phone applications and second store for tablet applications. (Spriensma 2012b.)

According to Canalys (2013a), application downloads across the four leading stores (Apple's App Store, Google Play, Windows Phone Store and BlackBerry World), had 11% growth in Q1 2013 worldwide over the Q4 2012 total. At the same, time direct revenue from paid applications and in-application purchases grew 9%. The combined downloads of these four stores totaled more than 13.4 billion while revenue reached \$2.2 billion USD. Apple's App Store had the largest proportion of revenue (around 75%) between the four stores. Google Play had the greatest number of downloads (around 51%) of the stores. Apple's App Store and Google's Google Play are the leaders of the application store world. Windows Phone Store and BlackBerry World

should develop more applications and improve their marketing. BlackBerry and Microsoft should also increase their device sales around BlackBerry 10 and Windows Phone 8 in order to get more consumers to buy applications from their application stores. (Canalys 2013a.)

4.2.4 Developing mobile applications in local language

The application industry is a global phenomenon. Application publishers should notice that consumers prefer to use applications that are available in their local language. Applications that are available in local language generate more revenue than applications that are not. In Russia, 70% of the revenue is generated by applications in the main local language. (Koekkoek 2012a.)

All of the major application stores have localized their application stores for several countries. Google Play is localized in more than 120 countries. Apple App Store is available in 135 countries. Windows Phone 8 Marketplace is going to be available in 180 countries. Developers can now publish their applications all over the world. From the top 12 largest countries (United States, Canada, United Kingdom, Germany, France, Russia, Italy, Japan, Korea, China, Brazil and Australia) in terms of application downloads and revenue from Apple App Stores, more than 90% of the top 200 applications support English. App Store consumers in China, Japan and South Korea prefer to buy applications that support their native language. App Store Customers in United States, Canada, United Kingdom, Germany, France, Russia, Italy, Brazil and Australia prefer to buy applications that support English. Applications that support only English have the highest download volumes in countries where English is the main language. (Agten 2012.)

4.3 Providing mobile services to the developing world

4.3.1 Deploying eServices to mobile phones

According to Boyera (2006), there are three major ways of developing and deploying eService applications to mobile phones:

1. *“SMS applications: people are sending request by text-messages to a specific phone number, and get the result with a new text-message they receive.”*

2. *“Voice applications: people are calling a specific phone number on which is connected a voice platform and with either voice or keypad inputs, they can have the information they are looking for.”*
3. *“Web applications: people have a Web browser on their phone and a data-service plan which connect them to the Internet and allow them to browse the Web.”*

The best way to provide eServices (health, education, government etc.) to the developing world is through mobile phones. The developing world has had an incredible penetration rate of mobile phones compared to PC or fixed-line telephony (Figure 3 and Figure 4). SMS applications are most commonly used in the developing world to provide eServices. People send an SMS to the service number and receive the answer by SMS. SMS messaging has many advantages for the user: 1) Users can easily send SMS messages as they have already used text-messages to communication. 2) SMS is available on all mobile phones. 3) SMS does not need high bandwidth network. 4) SMS cost is low and predictable. SMS messaging has also some disadvantages: 1) There are illiterate people in the developing world who are not able to read or write SMS messages. 2) Mobile phones have limited input capabilities, as keypads are very limited. 3) Inputting and rendering non-Latin characters. 4) Interoperability between operators. 5) Lack of standardization for application development. 6) SMS has limited user interaction. (Boyera 2006.)

Mobile phones voice applications have some advantages for the users: Illiterate people can use voice applications easy input mechanism by using their voice or the keypad. Voice application cost is low and predictable. Voice applications have low network requirements. Voice applications have some disadvantages: Voice application hosting is very expensive in the developing countries. Voice applications are available for the most used languages (English, Spanish, French) but not for other languages. Web applications have these advantages: Search engines and portals help to discover existing web applications. It is easy to develop web applications by using standardized markup languages like HTML or CSS and to create content by using programming languages like PHP and ASP. It is easy to host and deploy applications by using inexpensive/free hosting services. It is easy to create good user interface for the interaction between the user and the application. (Boyera 2006.)

Web applications have the following problems: Developing countries do not have high Internet bandwidth that is required for good Internet browsing experience. Handset

manufactures provide developing countries with low-cost mobile phones that have no web capabilities. However, smartphones might replace developing countries existing mobile phones in the future (see e.g. Chapter 3.2 previously). There is a need for limited capabilities web browsers for mobile phones in rural communities. People could use these browsers to access informational text in the documents, although they will not have access to video, sounds and pictures. (Boyera 2006.)

According to Bilodeau, Hoffman and Nikkelen (2011), more than 2.5 billion people in the world do not use formal financial services. A lack of infrastructure, information and inadequate customer service are some of the reasons why individuals have no, or limited access to financial services. Customers that do not have any prior experience with formal financial services might not trust such services. Traditional banks find it difficult to offer products and services that meet the needs of the poor. Mobile financial services offer an alternative solution to traditional banks. People and businesses can use mobile financial services to deposit and withdraw funds and make electronic payments. (Bilodeau et al. 2011.)

Majority of the people without a bank account live in developing economies that lack basic infrastructure and have expensive banking services. Mobile technology's rapid growth in emerging markets can provide one way to solve this situation. Mobile phones can provide financial services to the people without a bank account so that they can save, borrow and transact money. (GSMA 2013a.)

4.3.2 Mobile applications in a cloud service

Mobile cloud applications run on servers and require the use of a browser on the mobile device to display. Cloud applications are used through Internet connection. There is no need to download and install cloud applications on mobile devices. Users can view the mobile cloud application user interface in a browser window on the mobile device. Mobile cloud applications user interface speed is generally slower compared to native mobile applications because cloud applications run on servers. (Claybrook. 2012.)

Binu is an Australian company that promises to turn ordinary mobile phone into a smartphone. Binu is an application platform that provides fast and affordable access to web-based applications and popular Internet services. Binu Users can download Binu into their mobile phones for free. Binu users do not have to download, install and update applications as Binu provides cloud-based applications. Users can just search applications, and use them instantly. (CrunchBase 2012.) With Binu, users can change

user interface to their local language and translate messages, news, articles etc. in any language. Binu compresses data in order to make mobile Internet data use much more cost effective. Users can use Binu to access applications such as Google, Twitter, Facebook and more than 100 other services such as news, sport, weather, health information and books. Binu enables users to interact with each other via social profiles, newsfeeds and chat/messaging. Binu has also its own developers program where developers can use XML-based application platform to develop mobile applications and services for Binu users. (Binu 2013.)

5. RESEARCH METHOD

5.1 Data collection

According to Patton and Cochran (2002), the first step in research is to identify whether the specific research question is best answered by qualitative or quantitative approach. If the question is a qualitative one, then the most suitable way of answering it is to use qualitative methods. Samples in qualitative research are usually selected purposely so that they are most likely to generate useful data for the research. Sample sizes are usually small in qualitative research. (Patton & Cochran 2002.) Qualitative research is concerned with collecting and analyzing information in as many forms as possible. It focuses on exploring smaller numbers of instances or examples. The use of questionnaires in research might be considered quantitative technique, while interviews and observations might be considered as qualitative techniques. In practice, however, interviews may be analyzed in a qualitative manner when numeric data is collected. Surveys might include open-ended responses that would lead to the in-depth study of individual cases. (Blaxter 2010.)

The empirical part of this thesis is based on qualitative research method. Empirical data was collected by organizing and sending a questionnaire by email to a selection of Android application developers who work in developing countries. Application developers email addresses were obtained by going through some of a vast amount of data of over 360,000 applications and their developers. This data was gathered from Android application store by Hyrynsalmi et al. (2012a). A selection of 326 application developers from developing countries and their email addresses were then gathered from this data and used in the questionnaire. This was done by first identifying these email addresses domains by using the list of domains by country (Domains by Country 2007). Then these domains were compared to the list of developing countries (The International Statistical Institute 2013). Now it was possible to identify which of these developers were most likely from developing countries. Among these 326 email addresses, there were domains from 77 different countries. 65 of these 77 countries were developing countries and 12 were developed countries (see Appendix 2). The questionnaire was purposely sent to those application developers whose email addresses were in developing countries.

5.2 Questionnaire

The questionnaire is based on a qualitative research method. The questionnaire was sent to Android application developers email addresses. The questionnaire was sent to 326 application developers from developing countries who have published android applications on Google Play. The questionnaire's objective was to gather qualitative information concerning mobile application development in developing countries. The questionnaire was sent to application developers who had a time period of two weeks to reply to the questions. A reminder email was sent to the developers one week after the questionnaire was sent. Questionnaires results were then collected for later analysis.

There were 55 undelivered emails that did not reach their targets. There were also some automatic replies to the questionnaire email without any responses to the actual questionnaire. The questionnaire was written in English. It is possible that some of the recipients in 77 different countries could not read or write English. The questionnaire was conducted by using Google Drive and it is included to Appendix 1. The questionnaire had many open questions as well as some multiple-choice questions.

The questionnaire included the following questions:

Question 1: Where is your company's headquarters located? Do you have development in another country/countries? If, where?

Question 2: What mobile platform(s) do you work on?

Question 3: Why did you choose to develop on a mobile platform?

Question 4: Do you develop applications for other platforms alongside mobile platform? Please name these platforms?

Question 5: Which are the advantages of using mobile platform instead of using other platforms?

Question 6: Which is/are the biggest problems you have experienced in mobile development?

Question 7: Do you develop applications just for the consumers in your country or for the global market?

Question 8: What is the size of the developer group for mobile applications of your company?

6. FINDINGS

Question 1: Where is your company's headquarters located?

Do you have development in another country/countries? If, where?

From the Table 1, we can say that mobile application development companies' headquarters are located in many different countries. India and Russia have both three headquarters while all the rest of the countries have only one. This could indicate that India and Russia are actively developing mobile applications and have more application developers compared to other countries in Table 1. India and Russia are both great and populous countries that have made considerable investments in their ICT infrastructure in recent years.

The questionnaire was sent to application developers that would most likely be located in the developing countries. Some responses came from developed countries such as Australia and United States of America. Some developers from developed countries might have domains in developing countries as some developing countries (e.g. American Samoa) have no residency requirements for domain ownership.

Table 1: Application development companies headquarters

Where is your company's headquarters located? (Number of replies=22)	
Answer Options	Response Count
Australia	1
Albania	1
Bosnia & Herzegovina	1
Belarus	1
Belgium	1
Germany	1
Hungary	1
India	3
Jordan	1
Kazakhstan	1
Lebanon	1
Macedonia	1
Pakistan	1
Romania	1

Russia	3
Sri Lanka	1
United States of America	1
Vietnam	1

Table 2 shows that most of the respondents do not have development in other countries. Most of the respondents have small development companies. It seems that small development companies do not tend to have development activities in other countries. Small companies might not have much interest or finances to run development in foreign countries.

Table 2: Application development in other countries

Do you have development in another country/countries? If, where? (Number of replies=19)	
Answer options	Response Count
Yes	2
No	17
Another countries	Response Count
Germany	1
Italy	1
India	1
Sweden	1

Question 2: What mobile platform(s) do you work on?

Table 3 shows that almost all of the responders are developing applications on Android. This was an expected outcome as the questionnaire was sent to application developers who publish applications on Google Play. Most of the respondents work also on iPhone OS. Some developers work on platforms such as, Windows Phone, Window RT, Firefox OS and J2ME. Developers choose to develop applications on Android and iOS as both of these platforms are now among the most popular mobile platforms in the world. 15 of these application developers work on more than one platform.

Table 3: Mobile platforms

What mobile platform(s) do you work on? (Number of replies=20)	
Answer Options	Response Count
Android	20
iPhone OS	15
Windows Phone	5
Windows RT	2
Blackberry OS	1
Firefox OS	1
J2ME	1
Smart TV	1

Question 3: Why did you choose to develop on a mobile platform?

Developers have chosen to develop on mobile platform because of several reasons. Mobile platform is a new market that is also growing very fast. Developer 1: *“Because mobile market is growing at massive rate”*. Developer 2: *“Big potential, huge growth.”* Application developers believe that mobile platform is a new and promising field and it is the future in ICT. Developer 3: *“New and promising field.”* Developer 4: *“Mobile is the future in ICT.”* Mobile platform is very popular and can reach many customers. Developer 5: *“To reach more customers.”* Developer 6: *“It is the new trend that is in the hands of everybody.”* Growing smartphone market has introduced developers to develop on mobile platform. Developer 7: *“Because smartphones market is growing very fast and the mobile platform offers another user experience to the customer and is always available to the customer.”* Developer 8: *“To target the mass market.”*

Some developers develop applications for their client’s needs. Developer 9: *“Client requirements.”* Developer 10: *“We had a lot of data on sports and application was the next logical step to offer to our customers.”* People have begun to use more and more mobile devices. Developer 11: *“The world is moving towards mobile and hand held devices which are having processors equally powerful as the PC’s.”* Some developers develop on mobile platform also because applications can generate them profit.

Table 4: Development on mobile platform

Why did you choose to develop on a mobile platform? (Number of replies=20)	
Answer options	Response Count
New market	4
Mobile market is growing fast	4
Mobile is the future in ICT	3
Popular platform	3
To reach customers	3
To fulfill customers' needs	3
To earn money	2
We like to develop mobile applications	2

Question 4: Do you develop applications for other platforms alongside mobile platform? Please name these platforms?

From the Table 5, we can tell that most of the respondents develop applications for other platforms alongside mobile platform. The most popular platform for additional application development was web applications. Windows was the second most popular option for the respondents. Some developers develop for, server backend, Linux, desktop and SMS. Developer 1: *"We mainly focus on mobile platforms, but if a backend part also involved, we develop web applications also."* Developer 2: *"Server backend for mobile applications: php, html, java script."* Developer 3: *"Web and Windows applications."*

Table 5: Mobile platform and other platforms

Do you develop applications for other platforms alongside mobile platform? Please name these platforms. (Number of replies=21)	
Answer options	Response Count
Yes	17
No	4
Other platforms	Response Count
Web applications	8
Windows	5
Server backend	2
Linux	1

Desktop	1
SMS	1

Question 5: Which are the advantages of using mobile platform instead of using other platforms?

According to the responses (Table 6), mobile platform usage has many advantages for application developers. Some developer chose to use mobile platform as mobile applications are small and consume less development time. Developer 1: *“Traditional mobile platform applications are small and less time consuming.”* Developers can benefit from mobile platforms open source feature. Android platforms development tools are free and the registration fee for developers is very low. Developer 2: *“Free development tools, just \$25 registration fee.”*

Mobile applications can be targeted to mass markets and reach more customers. Developer 3: *“Mobile apps are good to target mass and consumer markets.”* Application developers can quickly reach their potential customers through application stores. Developer 4: *“If the application is hosted on App Store it is available all over the world”*. Developer 5: *“It is easy for users to find my applications.”* There are many mobile users in the world. Developer 6: *“Now everyone in the world uses applications and live and breathe mobile.”* Developer 7: *“Mobile is now the trend and users are more and more using their mobile to access the Internet.”* Growing demand for mobile devices has created a great opportunity for application developers. Developer 8: *“People are moving towards the mobile devices thereby creating a huge opportunity for the developers.”* Developers have chosen to develop applications on mobile platform, as it is the latest technology with great popularity.

Table 6: The advantages of using mobile platform

Which are the advantages of using mobile platform instead of using other platforms? (Number of replies=17)	
Answer options	Response Count
Popular technology with great demand	5
Growing quantity of mobile device users	4
Application developers can reach potential customers	3

Customers can easily find applications	3
Open source platform	1
Free development tool and low costs	1
Mobile applications are small and consume little development time	1
Free advertising	1
Uniform access to business services	1
New channels, new expertise	1

Question 6: Which is/are the biggest problems you have experienced in mobile development?

According to the responses (Table 7), application developers have experienced a variety of problems in mobile development. There is a need to develop applications to a variety of different mobile devices. Developer 1: *“So many different devices.”* There are also quite many hardware and software versions to support. It is difficult for some developers to make applications to be consistent and to look the same in different mobile operation systems. Developer 2: *“The biggest problem I faced is to make the apps look the same and consistent in different Android versions.”* Some developer had problems in creating a consistent experience across iOS and Android. Developer 3: *“Apple doesn’t support development on anything other than Apple Mac.”* According to one recipient, Android platform is fragmented. Another developer stated that mobile development has no standards.

It is problematic to move developers from Windows or Web application development to mobile application development. Developer 4: *“Knowhow and experience to move developers from traditional windows/web app to mobile.”* One recipient stated that it is difficult to find competent developers to develop mobile applications. Developer 5: *“Finding competent developers.”* There are difficulties in monetizing applications in order to generate a full-time income. Developer 6: *“Not making enough to pay the bills.”* Google play has some restrictions for developers located in certain countries. Developer 7: *“App stores like Google Play Store not allowing Sri Lankan developers to sell apps due to country restrictions in Google Checkout.”* Because of great competition, it is difficult to get visibility and have featured applications on application marketplaces. Developer 8: *“Marketing mobile*

applications is an extremely difficult task. There is a lot of competition and no way to get your ranking to show up in a features applications.” It seems that application marketplaces are too crowded. The mobile hardware and software industry grows fast. Because of this, it is difficult for application programmers to be aware of rapid change and to be able to use new features in programming. Developer 9: *“It is difficult for programmer to be aware of and use new things in programming.”* Closed source code has created problems for some iOS developer. One developer had faced problems with mobile devices size, memory capacity, battery life and user experience.

Table 7: Problems in mobile development

Which is/are the biggest problems you have experienced in mobile development?	
(Number of replies=20)	
Answer options	Response Count
Hardware issues	5
Developer issues	3
Platform issues	3
Software issues	2
Money issues	2
Google Play’s restrictions	1
No standards	1
Marketing issues	1
Too crowded	1

Question 7: Do you develop applications just for the consumers in your country or for the global market?

According to the responses (Table 8), most of these application developers develop applications for both local and global consumers. Some developers have decided to develop applications just for the local market. Only one respondent has decided to develop applications just for the global market. The results of Table 8 show that the majority of these developers develop applications for local and global markets. Developers might develop applications for local and global markets in order to reach a wider market base for their products. Global mobile application market is usually greater compared to local market. The developers might have chosen to develop applications for the global market as developers in other countries are also publishing

their applications in the global market. Mobile application companies in developing countries should publish their applications globally as application market is generally a global market that reaches to customers all around the world. Revenues from global mobile application sales could generate quite significant source of income to application developers in developing countries.

Table 8: Application development for local and global markets

Do you develop applications just for the consumers in your country or for the global market? (Number of replies=22)	
Answer options	Response Count
Local market	5
Global market	1
Local and global market	16

Question 8: What is the size of the developer group for mobile applications of your company?

From the Table 9, we can say that majority of the responders develop applications in a group of 2-5 persons. The second most popular group size is one. It seems that group size is rarely greater than 11-25 persons. One respondent belonged to the group of 26-50 persons. There was one group of 250 developers. This group was a part of a company that develops Android applications, iOS applications, Windows applications, Windows desktop applications and server-side applications. It seems that bigger application development companies develop applications for a variety of platforms. Big mobile application development companies will most likely have big application development teams while small companies have smaller development teams.

It seems that most of these application developers develop mobile application in quite small groups, as it might be quite easy to begin to develop mobile applications with a small team and set up a development company. According to the responses, most questioned application development companies develop applications in small groups. Most of the replies came from small application development companies with small development teams. It might be more convenient for the developers to develop applications in smaller teams as compared to big teams.

Table 9: Application development group sizes

What is the size of the developer group for mobile applications of your company? (Number of replies=22)	
Answer Options	Response Count
1	6
2-5	8
6-10	3
11-25	3
26-50	1
51-100	0
101-249	0
250-above	1

Additional findings on application development

Table 10 illustrates that questioned application developers have released applications in many different categories. News and magazine, education had a little bigger response count than other categories. Some developers had published applications in more than one category. It is not possible to make any significant conclusions from these findings, as category count is quite moderate. The data presented in Table 10 and Table 11 was generated from the questionnaires results and from the original data that was gathered from Android application store by Hyrynsalmi et al. (2012a).

Table 10: Applications sorted by categories

Applications sorted by categories (Number of applications=20)	
Categories	Category Count
News and magazines	4
Education	3
Communication	2
Music and audio	2
Business	2
Sports	2
Tools	2
Finance	1
Games	1
Travel and local	1

Table 11 illustrates the amount free applications and paid applications according to the questioned developers. Table 11 does not include all of those 22 developers who replied to the questionnaire. Some developers have released free and paid applications. Application developers can choose to sell their applications to their customers or distribute them for free. It seems that most of the developers chose to provide free applications. These developers are most likely using other means to monetize their applications. One common way is to equip free applications with in-application purchase functions. In-application purchase allows developers to sell premium content and virtual goods within each application. Application developers can also earn advertisement revenue from advertisement shown in their free applications. Some application developers might not use in-application purchase or advertisement in their free or paid applications.

Table 11: Free applications and paid applications

Applications sorted by price (Number of applications=16)	
Application type	Count
Free application	13
Paid application	3

7. DISCUSSION

The primary research question of this thesis was:

- How can mobile technology and mobile services help to bridge the digital divide in developing countries?

The main results of this study indicate that mobile technology usage might be one of the best ways to help bridge the digital divide in developing countries. Mobile technologies and services could provide a powerful way to help to bridge the digital divide. In many developing countries there are far more mobile phone users than there are Internet connections in households. Mobile phone-based solutions for information services are popular in developing countries where a significant number of people own mobile phones. The creation of mobile phone based information service solutions should provide one effective way that could help bridge the digital divide in developing countries.

Developing countries have tried to bridge the digital divide by ensuring that the public has better access to use computers. However, it is not easy to provide access to computers in rural areas that have no landline telecommunication or reliable source of electricity. Developing countries could leapfrog the landline telecommunication and start to use mobile telecommunication services. Mobile technology provides an alternative way for people to use ICT and access the Internet. Mobile phones are relatively affordable and easier to use than computers so people in rural areas are able to use them. Developing countries could begin to bridge the digital divide by ensuring that the public has easy access to Internet-enabled mobile devices or computers.

According to Dutta & Bilbao-Osorio (2012) and GSMA (2013a), mobile connection has lower cost, better reach and better functionalities compared to landline telephony. Mobile telecommunication industry can improve technology and create new jobs. Mobile telephone industry has enabled people to have access to information and to connect with other people. Mobile broadband empowers people to have access to use the Internet. Smartphones broadband connection can provide the first and primary way for the people in developing countries to have access to the Internet. Internet shifts from desktop experience to mobile experience in developing countries. (Dutta & Bilbao-Osorio 2012; GSMA 2013a.) This indicates that mobile telephone usage could provide one of the most practical ways to bridge the digital divide in developing countries.

The primary research question of this thesis had two subsidiary questions:

- Sub-RQ1: How can mobile telephone usage benefit developing countries?

Developing countries do not usually have enough computers for their citizens and there are frequent problems with electricity blackouts. Developing countries authorities have tried to improve ICT usage in rural areas by setting up information centers equipped with ICT devices and Internet connection. There is a problem with low Internet connectivity especially in these rural areas where landline telecommunication connection level is low or nonexistent. However, developing countries could skip the landline telecommunication industry and build mobile telephone networks. Landline telecommunication is more expensive to build than network of base stations in countries that have rough terrains.

Mobile phones are the first modern telecommunication infrastructure in many places of rural Africa. Mobile phone usage can increase information travel time for individuals and companies. According to Ericsson Consumerlab (2013), Mobile phone is already the main source of Internet access for Sub-Saharan Africans where people use their mobile phones mainly for SMS, social networking and browsing the Internet. As mobile devices become more sophisticated mobile consumer will have the ability to effectively use the Internet, access information and change their lives in personal and business level. (Ericsson Consumerlab 2013.)

Mobile technology empowers farmers in developing countries to use their mobile phones in order to have information that gives them regular weather reports and latest market prices. Farmers can also use mobile financial services (payment, credit and savings) that enable them to invest in high quality seeds, fertilizers and machinery. Mobile technology can change farming in developing countries to be more sustainable and profitable. This will help to lift millions of people out of poverty. (World economic forum 2012.)

According to studies, mobile phones are the most owned ICT devices in the world. Developing countries can have many advantages from using mobile phones. People can use mobile phones in order to have access to financial, health, agricultural and educational services. Mobile learning can be used in learning situations. Students can use mobile phones to access Web-based content, collaborate with other students and store and retrieve information. Students can read e-books, download study material, use mobile applications and surf online. Teachers can use mobile phones for education as

they use mobile platform to screen educational videos, diagrams and images in the classroom. (Mtega et al. 2012; Kochi 2012; Unesco.)

Mobile telephones and related services can be used for development and economic activity. Mobile phones can improve access to information in developing countries, thereby reducing search costs. Mobile phones are more accessible compared to traditional information mechanisms (personal travel, radio, landline, letters and television). Mobile phone usage can reduce agricultural information costs, as people do not have to travel to markets to obtain agricultural price information. People can use mobile phones to have access to information immediately. The mobile phone sector has created many business opportunities in informal sectors. In Africa, small shops sell mobile phone credits while other shops repair and charge mobile phones. Mobile phone-based applications can deliver financial, agriculture, health and educational services. Mobile phones can be used in collection, measurement and monitoring of health data. People in developing countries could use financial applications in order to pay bills and transfer money between individuals. (Aker & Mbiti 2010; BiztechAfrica 2013.)

- Sub-RQ2: Why have application developers in developing countries decided to develop applications on mobile platform?

The answer for this research question was gathered from the questionnaire (see Chapter 5). This questionnaire was targeted to a rather small number of application developers (326) located in developing countries. 22 of these application developers replied to the questionnaire. According to the questionnaires results, there are several reasons for developers in developing countries to develop applications on mobile platform. Application developers believe that mobile platform is a new and promising field that has big potential to grow. Mobile platform is considered the future of ICT. Fast growing smartphone market has introduced application developers into mobile application development. More and more people around the world are using mobile devices. Application developers believe that popular mobile platform can help them to reach more customers. These questioned application developers seem to be developing on mobile platform, as they believe that mobile is the future of application development.

According to the questionnaires results, mobile platform has many advantages for application developers. Android platforms development tools are free and the registration fee is only \$25 USD. Mobile applications can reach mass markets through application stores. Mobile devices huge popularity has created a great opportunity for

application developers to develop mobile applications. Developers have decided to develop on mobile platform, as it is the latest successful technology. The demand for mobile applications will most likely grow as the number of new smartphone users increases.

It seems that mobile application development should have much greater presence in developing countries where mobile devices are widely used. Developing countries students should have the opportunity to study how to develop mobile applications in their native country. It is important for developing countries to have their own skillful application developers who know how to develop applications for their countries mobile device users specific needs. Developing countries citizens should have access to relevant mobile applications that are available in their native language.

8. CONCLUSION

This thesis' main objective was to study if mobile technology and mobile services could help to bridge the digital divide in developing countries. The digital divide describes a situation where some people have access and skill to use Information and communication technology (ICT) and some people do not. The digital divide consists of different parts such as access to computers, computer literacy and the total cost of using information and communication technology. There should be some ways to help bridge the digital divide in developing countries. Mobile technology usage might be one efficient way to tackle the digital divide in developing countries.

This master's thesis discussed about the digital divide and its presence in developing countries. The digital divide is a complicated problem that has no simple solution. Some developing countries have used different measures to increase the use of ICT by enabling their citizens to have easier access to use ICT services in their communities. There is also a great need to improve ICT literacy in developing countries that are not familiar with using ICT equipment, such as computers or smartphones.

The material for this thesis theoretical part was gathered by going through literature on the digital divide, mobile technology and mobile application development. This literature consists of material that was mainly gathered from several articles and reports. The empirical part of this thesis in (see Chapter 5 and Chapter 6) consists of a questionnaire that was sent to application developers in developing countries. The purpose of the questionnaire was to find out what it is like to develop applications in developing countries.

The findings of this Master's thesis suggest that mobile technology and mobile devices can provide useful tools that could help to bridge the digital divide in developing countries. Mobile technology has rapidly reached a vast number of people in many developing countries. Mobile technology can bring affordable ICT to people in developing countries. Landline telecommunication is often very limited in developing countries. People in developing countries rural areas can for example use their mobile phones to communicate with other people and use the Internet.

Mobile devices such as smartphones provide people the possibility to use different applications and stay connected to other people wherever they are. People can download useful and affordable applications from mobile application marketplaces. The use of mobile phones is one useful way to tackle the digital divide in those developing

countries where people have little or no access to computers or the Internet. Mobile phone usage can make many positive improvements into people's lives in rural areas. Developing countries should skip old landline telecommunication industry and move straight to the mobile phone networks.

The empirical part of this thesis in Chapter 5 and Chapter 6 includes a questionnaire that was sent to application developers in developing countries. This kind of questionnaire could be sent to a much larger group of application developers in order to gather a bigger amount of data on application development in developing countries. This questionnaire was limited to a moderate number of application developers. Future research should be targeted to a considerable bigger group of application developers who work in developing countries. This would produce more accurate results and understanding of the state of application development in developing countries. However, as there are thousands of Android application developers, it might be quite time consuming to identify those developers who work in developing countries. Another limitation of this empirical study is that the questionnaire was sent only to those application developers who publish applications on Google Play. This kind of questionnaire could be sent to application developers who publish applications on other application stores such as Apple App Store or Windows Phone Store.

There should be more future research on the digital divide and mobile application development in developing countries. Suggestions for future research: Study how well mobile phone usage has bridged the digital divide in developing countries so far. Investigate if low-cost mobile devices with limited functions are good enough for the public in developing countries. Study how mobile application development has benefitted the economy of developing countries.

This thesis contributes to the existing knowledge on the digital divide. The digital divide is a rich research area for researchers in different fields. The digital divide could be bridged by using the combined knowledge of different fields on the digital divide. The digital divide consists of technical and social problems. There should be collaboration among social and technical research in order to bridge the digital divide. The results of this thesis indicate that effective use of mobile technology and mobile devices, such as smartphones and tablet computers, could help to bridge the digital divide and provide connectivity to the people in developing countries.

REFERENCES

Agarwal, S., Kumar, A., Nanavati, A. A., Rajput, N. (2008). VoiKiosk: Increasing Reachability of Kiosks in Developing Regions. WWW '08: Proceedings of the 17th international conference on World Wide Web. ACM. Available at: <http://wwwconference.org/www2008/papers/pdf/p1123-agarwal.pdf> (Accessed 4.1.2013)

Ahuja, K. (2008). Network Solutions for Better Connectivity: Kapil Ahuja, Head- India Regional Marketing APAC, Nokia Siemens Networks, India. The eGov Magazine. Available at: <http://egov.eletsonline.com/2008/05/network-solutions-for-better-connectivity-kapil-ahuja-head-india-regional-marketing-apac-nokia-siemens-networks-india-2/> (Accessed 7.3.2013)

Azam, M. (2008). Bridging Digital Divide: Role of Telecommunication Sector. ICEGOV '08: Proceeding of the 2nd International Conference on Theory and Practice of Electronic Governance. ACM. Available at: <http://dl.acm.org/citation.cfm?id=1509204> (Accessed 4.1.2013)

Android. (2013). Available at: <http://developer.android.com/about/index.html> (Accessed 4.4.2013)

Agten, T v. (2012). Distimo. The impact of app translations. Distimo publication September 2012. Available at: <http://www.distimo.com/publications> (Accessed 5.5.2013)

Agten, T v. (2013). January 2013 The impact of price changes. Distimo publication January 2013. Available at: <http://www.distimo.com/publications> (Accessed 5.5.2013)

Aker, J C., Mbiti I M. (2010). Mobile phones and economic development in Africa. Journal of economics perspectives – Volume 24, Number3 – Summer 2010 – Pages 207-232. Available at: http://sites.tufts.edu/jennyaker/files/2010/09/aker_mobileafrica.pdf (Accessed 2.9.2013)

Bélanger, F., Carter, L. (2009). The Impact Of The Digital Divide On E-Government Use. Communication of the ACM, Volume. 52 Issue 4. ACM. Available at: <http://dl.acm.org/citation.cfm?id=1498801> (Accessed 4.1.2013)

Boyera, S. (2007). Can mobile web bridge the digital divide? *Interactions*, Volume 14 Issue 3. ACM. Available at: <http://interactions.acm.org/archive/view/may-june-2007/can-the-mobile-web-bridge-the-digital-divide1> (Accessed 4.1.2013)

Boyera, S. (2006). The Mobile Web to Bridge the Digital Divide? The World Wide Web Consortium (W3C). Available at: http://www.w3.org/2006/12/digital_divide/IST-africa-final.pdf (Accessed 4.4.2013)

Binu. (2013). Available at: <http://www.binu.com/about/> (Accessed 19.4.2013)

Bilbao-Osorio, B. (2013). A new digital divide. World economic forum, April 10th 2013. Available at: <http://forumblog.org/2013/04/a-new-digital-divide-threatens-growth/> (Accessed 8.5.2013)

Bilbao-Osorio, B., Dutta, S., Lanvin, B. (2013). The global information technology report 2013. Growth and jobs in a hyperconnected world. World Economic Forum and INSEAD. Available at: http://www3.weforum.org/docs/WEF_GITR_Report_2013.pdf (Accessed 9.5.2013)

Bilodeau, J., Hoffman, W., Nikkelen, S. (2011). The mobile financial services development report. World economic forum. Available at: http://www3.weforum.org/docs/WEF_MFSD_Report_2011.pdf (Accessed 8.5.2013)

BiztechAfrica. (2013a). Mobile industry leaders meet on harnessing technology for development. BiztechAfrica. Oct. 16, 2013. Available at: <http://www.biztechafrika.com/article/mobile-industry-leaders-meet-harnessing-technology/7063/?section=development#.UmEtufIT6TJ> (Accessed 16.10. 2013)

BiztechAfrica. (2013b). Samsung brings innovation to remote parts of Africa. BiztechAfrica. Oct. 15, 2013. Available at: <http://www.biztechafrika.com/article/samsung-brings-innovation-remoter-parts-africa/7061/#.UmGcfvIT6TI> (Accessed 16.10.2013)

Blaxter, L. (2010). *How To Research* (4th Edition). Open University Press. Berkshire, GBR. 01/2010.

Chen, W., Wellman, B. (2004). The Global Digital Divide Within and Between Countries. *IT & Society*, Volume 1, Issue 7, Spring/Summer 2004, PP. 39-45. Available at: <http://csi.ufs.ac.za/resres/files/ChenWellman.pdf> (Accessed 24.1.2013)

CrunchBase. (2012). Binu. December 13, 2013. Available at: <http://www.crunchbase.com/company/binu> (Accessed 22.4.2013)

Canalys. (2012a). Top 25 US developers account for half of app revenue – Collectively they made more than \$60 million in 20 days. December 4, 2012 Available at: <http://www.canalys.com/newsroom/top-25-us-developers-account-half-app-revenue> (Accessed 23.4.2013)

Canalys. (2013a). 11% quarterly growth in downloads for leading app stores – Together, the four leading stores hit 13.4 billion downloads, with revenue of \$2.2 billion. April 8, 2013. Available at: <http://www.canalys.com/newsroom/11-quarterly-growth-downloads-leading-app-stores> (Accessed 24.4.2013)

Canalys. (2012b). Android apps are too expensive – Apple's more mature, controlled retail environments drives app price competitiveness. February 23, 2012. Available at: <http://www.canalys.com/newsroom/android-apps-are-too-expensive> (Accessed 28.4.2013)

Canalys. (2013b). Mobile device market to reach 2.6 billion units by 2016 – Smart phones and tablet PCs will continue to impact shipments of other phones and notebook PCs. February 22, 2013. Available at: <http://www.canalys.com/newsroom/mobile-device-market-reach-26-billion-units-2016> (Accessed 29.4.2013)

Campbell, P R. J., Ahmed, F. (2011). An assessment of mobile OS-centric ecosystems. Journal of theoretical and applied electronic commerce research. Volume 6, issue 2, August 2011, 50-62. Available at: www.jtaer.com (Accessed 21.10.2013)

Costine, J. (2012). Google Play: 600 Apps, 1.5B installs per month, 20B total, now with byte-sized smart app updates. June 27th, 2012. Available at: <http://techcrunch.com/2012/06/27/google-play/> (Accessed 30.4.2013)

Claybrook, B. (2012). Mobile cloud apps vs. native apps: the developer's perspective. November 2012 Available at: <http://searchcloudapplications.techtarget.com/feature/Mobile-cloud-apps-vs-native-apps-The-developers-perspective> (Accessed 16.2.2014)

Dutta, S., Bilbao-Osorio, B. (2012). The global information technology report 2012. Living in a hyperconnected world. World Economic Forum and INSEAD. Available at: http://www3.weforum.org/docs/Global_IT_Report_2012.pdf (Accessed 8.5.2013)

Domains by Country. (2007). Available at: <http://www.checkdomain.com/list.html> (Accessed 1.1.2013)

Devine, R. (2014). Mozilla announces \$25 smartphone, additional 12 Firefox OS markets for 2014. Androidcentral. February 23, 2014. Available at: <http://www.androidcentral.com/mozilla-announces-25-smartphone-additional-12-firefox-os-markets-2014> (Accessed 26.2.2014)

Deloitte. (2014). Value of connectivity Economic and social benefits of expanding internet access. February 2014. Available at: https://fbcdn-dragon-a.akamaihd.net/hphotos-ak-ash3/t39.2365/851546_1398036020459876_1878998841_n.pdf (Accessed 7.3.2014)

Ekua Awotwi, J., Owusu, G. (2009). Ghana's Community Information Centers (CiCs): e-Governance Success or Miracle? ICEGOV '09: Proceedings of the 3rd International Conference on Theory and Practice of Electronic Governance. ACM. Available at: <http://dl.acm.org/citation.cfm?doid=1693042.1693105> (Accessed 4.1.2013)

Etherington, D. (2013). Google Play offers over 5M eBooks and more than 18 million Songs, one year after its rebranding. March 6th 2013. Available at: <http://techcrunch.com/2013/03/06/google-play-offers-over-5m-ebooks-and-more-than-18m-songs-one-year-after-its-rebranding/> (Accessed 25.4.2013)

Ericsson Consumerlab. (2013). Bridging the digital divide How mobile phones are playing a key role in connecting people in Sub-Saharan Africa. An Ericsson consumer insight summary report November 2013. Available at: <http://www.ericsson.com/res/docs/2013/consumerlab/bridging-the-digital-divide-sub-saharan-africa.pdf> (Accessed 7.3.2014)

Fuchs, C., Horak, E. (2008). Africa and the digital divide. Telematics and Informatics, Volume 25, issue 2, 99-116. Available at: <http://www.sciencedirect.com/science/article/pii/S0736585306000359> (Accessed 19.11.2012)

Fox Buchele, S., Owusu-Aning, R. (2007). The one Laptop Per Child (OLPC) Project and Its Applicability to Ghana. Proceeding of the 2007 International Conference of Adaptive Science and Technology, December 2007, pp. 113-118. Available at: http://wiki.laptop.org/images/1/1f/Buchele_ICAST_OLPC.pdf (Accessed 6.3.2013)

Gorzalanczyk, R. (2008). The activities of the European Union aimed at the Protection of Cultural Identity and Heritage in Information Society. Ethicomp 2008. Available at: http://www.ccsr.cse.dmu.ac.uk/conferences/ethicomp/ethicomp2008/abstracts/ethicomp2008_gorzalanczyk.php (Accessed 2.1.2013)

Gartner, (2011). Gartner Says Worldwide Mobile Device Sales to End User Reached 1.6 Billion Units in 2010; Smartphone Sales Grew 72 Percent in 2010. Available at: <http://www.gartner.com/newsroom/id/1543014> (Accessed 24.3.2013)

Google Play. (2013a). Available at: https://support.google.com/googleplay/answer/2844886?hl=en&ref_topic=3364260 (Accessed 3.4.2013)

GSMA. (2013a). The Mobile Economy 2013. Available at: <http://www.gsamobileeconomy.com/GSMA%20Mobile%20Economy%202013.pdf> (Accessed: 10.4.2013)

GSMA. (2013b). Mobile enabled community services. MECS Vendor Directory 2013. Available at: http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/02/MECS_Vendor_Directory_Feb-2013.pdf (Accessed: 10.4.2013)

Google Play. (2013b). Google Play. Android Developer. Available at: <https://support.google.com/googleplay/android-developer/answer/150324> (Accessed 30.4.2013)

Google Play. (2013c). Google Play. Android Developer. Available at: <https://support.google.com/googleplay/android-developer/answer/136758> (Accessed 30.4.2013)

Gartner. (2013). Gartner says Asia/Pacific led worldwide mobile phone sales to growth in first quarter of 2013. Press release. Stamford, Conn., May 14, 2013. Available at: <http://www.gartner.com/newsroom/id/2482816> (Accessed 2.9.2013)

Hyrnsalmi, S., Mäkilä, T., Järvi, A., Suominen, A., Seppänen, M., Knuutila, T. (2012a). App Store, Marketplace, Play? An Analysis of Multi-Homing in Mobile Software Ecosystems. In: Slinger Jansen, Jan Boch, Carina Alves (Eds.), Proceedings of the Fourth International Workshop on Software Ecosystems, CEUR Workshop Proceedings 879, 59-72, CEUR-WS, 2012.

Hyrnsalmi, S., Suominen, A., Mäkilä, T., Knuutila, T. (2012b). The emerging mobile ecosystems: An introductory analysis of the Android Market. The 21st International Conference on Management of Technology. International Association for Management of Technology.

Hyrnsalmi, S., Suominen, A., Mäkilä, T., Järvi, A., Knuutila, T. (2012c). Revenue models of application developers in android market ecosystem. In: Cusumano, M., Lyerm, B., Venkatraman, N. (Eds): ICSOB 2012. Number 114 in Lecture Notes in Business Information Processing, Springer, Heidelberg, 2012, 209-222.

Hezemans, A. (2013). February 2013 the new apps in the crowd. Distimo publication February 2013. Available at: <http://www.distimo.com/publications> (Accessed 1.5.2013)

International Telecommunication Union. (2013) Statistics. Available at <http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx> (Accessed 12.2.2014)

International Telecommunication Union. (2012). Key statistical highlights: ITU data release June 2012. Available at: http://www.itu.int/ITU-D/ict/statistics/material/pdf/2011%20Statistical%20highlights_June_2012.pdf (Accessed 17.3.2013)

International Telecommunication Union. (2010). World Telecommunication/ICT Development Report 2010 - Monitoring The WSIS targets. 9th Edition, 2010. Available at: http://www.itu.int/dms_pub/itu-d/opb/ind/D-IND-WTDR-2010-SUM-PDF-E.pdf (Accessed 13.3.2013)

International Telecommunication Union. (2011). Mobile App Downloads to Approach 48 billion in 2015. Available at: <http://www.itu.int/ITU-D/ict/newslog/Mobile+App+Downloads+To+Approach+48+Billion+In+2015.aspx> (Accessed 24.3.2013)

International Telecommunication Union. (2013b). The World in 2013 ICT Facts and Figures. Available at: <http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013-e.pdf> (Accessed 31.3.2013)

Jotischky, N. (2010). Press release: Survey reveals bridging digital divide between urban and rural Africa represents major growth opportunity. Informa telecoms & media, November 3, 2010. Available at: <http://blogs.informatandm.com/1393/press-release-survey-reveals-bridging-digital-divide-between-urban-and-rural-africa-represents-major-growth-opportunity/> (Accessed 20.4.2013)

Jansen, S., Bloemendal, E. (2013). Defining App Stores: The role of curated marketplaces in software ecosystems. Proceedings of the international conference on software business. Berlin. Available at: <http://slingerjansen.files.wordpress.com/2009/04/definingappstores.pdf> (Accessed 10.9.2013)

Kumar K, S. (2011). Universal and affordable access is fundamental to bridging the digital divide: Suresh Kumar K, IAS, Secretary Department of Information Technology, Government of Kerala, India. The eGov Magazine. Available at: <http://egov.eletsonline.com/2011/01/universal-and-affordable-access-is-fundamental-to-bridging-the-digital-divide-suresh-kumar-k-ias-secretary-department-of-information-technology-government-of-kerala-india-2/> (Accessed 9.3.2013)

Kochi, E. (2012). How The Future of Mobile Lies in the Developing World. TechCrunch. May 27th, 2012. Available at: <http://techcrunch.com/2012/05/27/mobile-developing-world/> (Accessed 31.3.2013)

Koekkoek, H. (2012a). Distimo Emerging app markets: Russia, Brazil, Mexico and Turkey. Distimo publication – June 2012. Available at: <http://www.distimo.com/publications> (Accessed 28.4.2013)

Koekkoek, H. (2013). March 2013 How the most successful apps monetize their user base. Distimo publication February 2013. Available at: <http://www.distimo.com/publications> (Accessed 29.4.2013)

Koekkoek, A. (2012b). Distimo Apple App Store Performance: The 2012 Top 100 Global Brands. Distimo publication October 2012. Available at: <http://www.distimo.com/publications> (Accessed 2.5.2013)

Lalmas, M., Bhat, R., Frank, M., Frohlich, D., Jones, M. (2007). Bridging the Digital Divide: Understanding information access practices in an Indian village community. SIGIR '07: Proceedings of the 30th annual international ACM SIGIR conference on Research and development in information retrieval. ACM. Available at: <http://www.dcs.gla.ac.uk/~mounia/Papers/StoryBank.pdf> (Accessed 4.1.2013)

Mtega, W P., Bernard, R., Msungu, A C., Sanare, R. (2012). Using Mobile Phones for Teaching and Learning Purposes in Higher Learning Institutions: the Case of Sokaine University of Agriculture in Tanzania. ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 118-129. Available at: <http://www.ubuntunet.net/sites/ubuntunet.net/files/mtegow.pdf> (Accessed 7.4.2013)

Microsoft. (2013a). Microsoft AppFactory – bringing app ideas to life. Available at: http://www.microsoft.com/africa/4afrika/appfactory_egypt.aspx (Accessed 17.4.2013)

Microsoft. (2013b). Build Windows applications by African, for Africa. Available at: http://www.microsoft.com/africa/4afrika/innovation_pillar.aspx (Accessed 18.4.2013)

Mimbi, L., Olu Bankole, F., Kyobe, M. (2011). Mobile phones and digital divide in East African countries. ACM. Available at: <http://dl.acm.org/citation.cfm?id=2072267> (Accessed 12.8.2013)

Magnier, M. (2011). \$35 tablet computer? Yes, from India. The Christian Science Monitor. October 6, 2011. Available at: <http://www.csmonitor.com/Business/Latest-News-Wires/2011/1006/35-tablet-computer-Yes-from-India> (Accessed 20.3.2014)

Napoli, P M., Obar, J A. (2013). Mobile Leapfrogging and Digital Divide Policy Accessing the limitations of mobile Internet access. New America Foundation. April 2013. Available at: http://newamerica.net/sites/newamerica.net/files/policydocs/MobileLeapfrogging_Final.pdf (Accessed 7.4.2013)

One laptop per child. (2013). Available at: <http://one.laptop.org/> (Accessed 20.3.2013)

Otto, L. (2011). Bringing development to Africa: How the mobile phone industry is helping. Consultancy Africa intelligence, 2 December 2011. Available at: http://www.consultancyafrica.com/index.php?option=com_content&view=article&id=9

14:bringing-development-to-africa-how-the-mobile-phone-industry-
ishelping&catid=82:african-industry-a-business&Itemid=266 (Accessed 16.4.2013)

Palli, C. (2012) How Android developers can thrive with Google Play. TechCrunch, May 20th, 2012. Available at: <http://techcrunch.com/2012/05/20/how-android-developers-can-thrive-with-google-play/> (Accessed 23.4.2013)

Patton, M Q., Cochran, M. (2002). A guide to using qualitative research methodology. Medecins Sans Frontiers. Available at: <http://fieldresearch.msf.org/msf/bitstream/10144/84230/1/Qualitative%20research%20methodology.pdf> (Accessed 10.5.2014)

Reda, A., Noble, B., Haile, Y. (2010). Distributing Private Data in Challenging Network Environments. WWW '10 Proceedings of the 19th international conference on World Wide Web. ACM. Available at: <http://www-personal.umich.edu/~azarias/paper/www.pdf> (Accessed 4.1.2013)

Rosenberg, J. (2012a). Introducing Google Play: All you entertainment, anywhere you go. Google Official Blog, March 6, 2012. Available at: <http://googleblog.blogspot.fi/2012/03/introducing-google-play-all-your.html> (Accessed 7.4.2013)

Rosenberg, J. (2012b). Google Play hits 25 billion downloads. Android Official Blog. September 26, 2012. Available at: <http://officialandroid.blogspot.fi/2012/09/google-play-hits-25-billion-downloads.html#!/2012/09/google-play-hits-25-billion-downloads.html> (Accessed 7.4.2013)

Reed, M. (2012). Press release: Africa mobile subscriptions count to cross 750 million mark in fourth quarter of 2012. Informa telecoms & media, November 12, 2012. Available at: <http://blogs.informatandm.com/6384/press-release-africa-mobile-subscriptions-count-to-cross-750-million-mark-in-fourth-quarter-of-2012/> (Accessed 15.4.2013)

Racoma, J. A. (2012) Will the \$49 aPC Android PC help bridge the digital divide? Android authority, September 29, 2012. Available at: <http://www.androidauthority.com/apc-android-pc-118923/> (Accessed 16.4.2013)

Rosenberg, J. (2013). Celebrating Google Play's first birthday. Google Official Blog, March 6, 2013. Available at: <http://googleblog.blogspot.fi/2013/03/celebrating-google-plays-first-birthday.html> (Accessed 21.4.2013)

Selwyn, N., Facer, K. (2007). Beyond the digital divide Rethinking digital inclusion for the 21st century. Futurelab. Available at: http://archive.futurelab.org.uk/resources/documents/opening_education/Digital_Divide.pdf (Accessed 14.1.2013)

Shu, C. (2013). Huawei & Microsoft Team Up To Launch Exclusive Windows Smartphone in Africa. TechCrunch, February 4th, 2013. Available at: <http://techcrunch.com/2013/02/04/huawei-microsoft-team-up-to-launch-exclusive-windows-smartphone-in-africa/> (Accessed 18.4.2013)

Spriensma, G J. (2012a). 2012 Year in review. Distimo publication year 2012. Available at: <http://www.distimo.com/publications> (Accessed 25.4.2013)

Spriensma, G J. (2012b). Distimo. The need for cross App Store publishing and the best strategies to pursue. Distimo publication May 2012. Available at: <http://www.distimo.com/publications> (Accessed 2.5.2013)

The International Statistical Institute. (2013). Developing Countries. Available at: <http://www.isi-web.org/component/content/article/5-root/root/81-developing> (Accessed 1.11.2013)

Unesco. (2012). Mobile learning for teachers in Africa and the Middle East: Exploring the potentials of mobile technologies to support teachers and improve practices. Available at: <http://unesdoc.unesco.org/images/0021/002163/216358E.pdf> (Accessed 8.4.2013)

VIA Technologies, Inc. (2012). VIA Initiatives APC: The 49 Android PC. Available at: <http://apc.io/files/2012/05/PR120522-APC-Final.pdf> (Accessed 17.4.2013)

World computer exchange. (2010). World computer exchange. Available at: <http://www.worldcomputerexchange.org/what-we-do> (Accessed 7.3.2014)

World Economic Forum. (2012). Multiplying agriculture by the power of mobile. World economic forum. Available at:

http://www3.weforum.org/docs/WEF_TC_MFS_mAgriculture_Briefing_2012.pdf
(Accessed 9.5.2013)

Wyche, S P., Murphy, L P. (2012) “Dead China-Make” Phones of the grid: investigating and designing for mobile phone use in rural Africa. ACM. Available at: <http://www.susanwyche.com/wyche.murphy.final.DIS2012.pdf> (Accessed 12.8.2013)

APPENDIX 1: THE QUESTIONNAIRE

Questionnaire on application development

Dear Recipient,

I am Tuomas Tanskanen, MDP student at the University of Turku, Finland. I am conducting a survey on the current state of application development in the developing world. This survey is a part of my master's thesis in which I study why application developers choose to develop applications on mobile platforms.

Could you please set aside several minutes in order to participate in my research and fill the questionnaire below. My thesis would be incomplete without the questionnaire.

Please feel free to add any additional remarks to my survey, or leave blank if you do not wish to answer certain questions.

You can see the current results of this survey after you have sent your answers. I will send you the results of this survey later, as you might be interested to study these results.

Thank you for our time and co-operation.

Sincerely,

Tuomas Tanskanen
MDP in Global IT Management (M.Sc.)
Information Systems Science
Department of Management and Entrepreneurship
University of Turku

1. Where is your company's headquarters located?

Do you have development in another country/countries? If, where?

2. What mobile platform(s) do you work on?

E.g. Android, iPhone OS etc.

3. Why did you choose to develop on a mobile platform?

4. Do you develop applications for other platforms alongside the mobile platform? Please name these platforms.

5. Which are the advantages of using mobile platform instead of using other platforms?

6. Which is/are the biggest problems you have experienced in mobile development?

7. Do you develop applications just for the consumer in your country or for the global market?

- Local market
- Global market
- Local and global market

8. What is the size of the developer group for mobile applications of your company?

- 1
- 2-5
- 6-10
- 11-25
- 26-50
- 51-100
- 101-249
- 250-above

9. The questionnaires results

Please write the email address where you wish to receive the results later.

Never submit passwords through Google Forms.

Powered by
 Google Drive

This content is neither created nor endorsed by Google.

[Report Abuse](#) - [Terms of Service](#) - [Additional Terms](#)

APPENDIX 2: QUESTIONNAIRE DATA

Application developers domains by country (Number of application developers=326)		
Domains by country N=77	Domain count N=326	Developing countries count N=65
Albania (al)	2	x
Armenia (am)	8	x
Angola (ao)	3	x
American Samoa (as)	5	x
Argentina (ar)	4	x
Azerbaijan (az)	2	x
Belize (bz)	3	x
Belarus (by)	5	x
Bangladesh (bd)	1	x
Bolivia (bo)	1	x
Bulgaria (bg)	2	x
Brazil (br)	5	x
Bosnia and Herzegovina (ba)	4	x
Cameroon (cm)	1	x
Cape Verde (cv)	1	x
Chile (cl)	6	
China (cn)	25	x
Colombia (co)	23	x
Dominica (dm)	1	x
Dominican Republic (do)	1	x
Djibouti (dj)	1	x
Ecuador (ec)	1	x
Georgia (ge)	1	x
Grenada (gd)	1	x
Germany (de)	1	
Hong Kong (hk)	6	
Haiti (ht)	1	x
Honduras (hn)	1	x
India (in)	36	x
Indonesia (id)	3	x
Isle of Man (im)	2	
Israel (il)	1	

Jordan (jo)	3	x
Korea, Republic of (kr)	7	
Kenya (ke)	2	x
Kazakhstan (kz)	3	x
Latvia (lv)	3	
Libya (ly)	2	x
Lithuania (lt)	2	
Lebanon (lb)	2	x
Macedonia, the F.Y.R. of (mk)	2	x
Mauritius (mu)	2	x
Malaysia (my)	2	x
Morocco (ma)	2	x
Maldives (mv)	1	x
Mexico (mx)	4	x
Moldova (md)	1	x
Mongolia (mn)	2	x
Nepal (np)	2	x
Pakistan (pk)	1	x
Philippines (ph)	2	x
Palestine (ps)	1	
Panama (pa)	1	x
Peru (pe)	2	x
Russia Federation (ru)	48	x
Romania (ro)	11	x
South Africa (za)	12	x
Sri Lanka (lk)	2	x
Soviet Union (su)	1	x
Samoa (ws)	4	x
Sao Tome and Principe (st)	3	x
Switzerland (ch)	3	
Tuvalu (tv)	8	x
Tunisia (tn)	2	x
Tonga (to)	1	x
Turkmenistan (tm)	1	x
Tokelau (tk)	2	
Thailand (th)	4	x
Turkey (tr)	4	x
Ukraine (ua)	5	x

Uganda (ug)	1	x
Uruguay (uy)	1	
Uzbekistan (uz)	1	x
Vanuatu (vu)	1	x
Vietnam (vn)	2	x
Venezuela (ve)	1	x
Zimbabwe (zw)	1	x