Towards Next Generation Mobile Applications for MOPS: Investigating emerging patterns to derive future requirements

Tamara Ginige[1], Athula Ginige[2]

[1]*School of Business, Australian Catholic University, North Sydney, Australia*
tamara.ginige@acu.edu.au

[2]*School of Computing and Mathematics, University of Western Sydney, Australia*
a.ginige@uws.edu.au

***Abstract* - During last few decades, mobile phone usage in the world has grown rapidly and it has become the most popular form of electronic communication. Depending on the connectivity, the world population can be classified in to a 3-layred pyramid. At the top there are about 1.5 billion users who have access to modern networks using their computers and Smartphones. There are about 2 billion people at the bottom of the pyramid who have no means of communication. At the middle of the pyramid (MOP) there are about 3 billion people who have mobile phones but are not part of the modern internet. Most of these people are living in the developing countries. Developing suitable mobile phone applications for MOPs to become part of the next generation networks, has positive implications from technology, business, as well as humanitarian perspectives. This also opens up a very large new market segment.**

We researched emerging patterns to derive broader requirements for developing next generation of mobile applications for MOPs. Though developing countries use mobile phones mainly for voice calls and sending text messages, research indicates that there will be affordable Smartphones for MOPs in the future. This factor is further supported by the mobile growth in the developing countries. Currently, 90% of the world population is covered by a mobile signal, 76% of the world population has a mobile subscription and that of developing countries is 67%. Researchers have started to develop mobile applications for MOPs in areas of health, education, agriculture, fisheries and mobile banking with the aim of improving their livelihood. We also identified connectivity and empowerment provided in Web 2.0 based applications were major reasons for the rapid growth of the social networking and micro blogging web applications. Ways to aggregate micro blogs to derive real-time information is emerging. This capability is very important to develop applications that provide information on prevailing market prices and demand to a fisherman or a farmer, or the demand for a service to a bricklayer, a carpenter or a taxi driver.

Based on our research findings, next generation of mobile phone applications for MOPs can be based on Smartphones. These applications should empower them to be information users as well as information producers. The information provided by the users need to be intelligently aggregated to identify useful information related to their livelihoods in near real time. Such applications would result in up lifting of economic conditions of the MOPs and transformation of social processes.

***Keywords* -- Mobile applications, Middle of the Pyramid (MOP), micro blog aggregation,**

I INTRODUCTION

There has been an explosive growth in the area of mobile communications in the last few decades. We have also seen a rapid increase in Smartphones with data and multimedia capabilities. According to Gartner, Inc. Smartphone sales to end users reached 54.3 million units, an increase of 48.7% from the first quarter of 2009 [1]. Most adults and teenagers in many developed countries and some in developing countries now use a mobile phone for their daily activities. These devices are having a significant impact on the way people live, entertain, work and communicate with each other.

From a technology driven perspective Jain has shown that the world population can be classified into three distinct classes as shown in figure 1 [2].

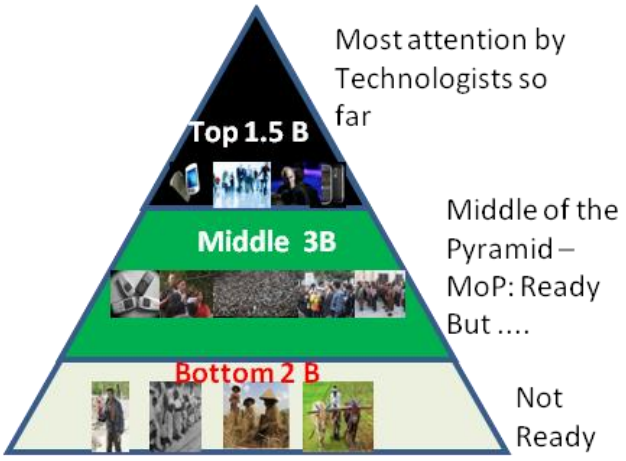

Fig. 1: Network Access Pyramid of Users

At the top layer of the pyramid (about 1.5 Billion) have access to modern networks using their computers and Smartphones; at the bottom of the pyramid (about 2 Billion) are the people deprived of any modern means of communication. At the Middle of the Pyramid (MOP) are about 3 Billion people who have mobile phones but are not part of the modern Internet. The middle of the pyramid has been growing and is now about half of the world's population.

Jain has also shown that development of appropriate applications to enable Smartphones commonly used by MOPs to become part of the next generation networks, has positive implications from technology, business, as well as humanitarian perspectives [2].

The people who belong to MOP are mostly living in developing countries. Previous studies have indicated that the investment done in telecommunications has facilitated the economic growth [3-4]. The spread of modern fixed line telecommunication networks were responsible for the economic growth between 1970 and 1990 [5]. Though developed countries were able to enjoy this growth, it was proved to be difficult for developing countries due to the lack of investment in the infrastructure and lack of networks. In his study, Waveman observed that the mobile phones in developing countries are playing the same important role that fixed telephony played in more developed countries in 1970 and 1990. Mobile phones have complemented fixed telephony in developed countries and it has substituted for fixed lines in many developing countries [4].

At present most mobile applications have been developed mainly focusing on the needs of the top 1.5 Billion of the world population. As MOPs are ready in terms of technology and connectivity but has no useful applications at present, developing mobile applications to this segment of the market opens up a new market that is twice the size of the current market.

In order to arrive at characteristics of suitable mobile applications for MOPs we undertook a research study based on the inductive research approach. In inductive reasoning, we begin with specific observations and measures, then detect patterns and regularities, formulate some tentative hypotheses that we can explore, and finally end up developing some general conclusions or theories [6].

For our study we reviewed literature and collected relevant information in the following four areas.

1. Advances in mobile phone technologies and review of new value adding that can be done to applications based on these advances.
2. Mobile growth in developing countries to identify the potential and impact.
3. Mobile applications currently in use in developing countries to identify the reasons for using mobile applications and any existing needs that have not been met.
4. Evolution of the Web to identify the factors that enabled the rapid growth of web applications.

In the next four sections of this paper we present the findings from our literature review in the above four areas. Then using inductive reasoning we identify the desired characteristics of next generation mobile applications for MOPs. Finally, we present our conclusions.

II Advances in Mobile Phone Technologies

We reviewed the advances in mobile phone technologies to identify the emerging capabilities as well as price performance tradeoffs. This will assist us to identify value adding that can be done using these capabilities and the associated cost.

Currently, developing countries mostly use mobile phones for voice calls and text messaging. However, Kalil argues that the capabilities of semiconductor industry to double the number of transistors on a computer every 12 to 18 months (Moore's law) means that there will be more affordable Smartphones in the future [7]. Smartphones have a wide range of features such as touch screens, built-in cameras, mini keyboards, GPS, media software, Wi-Fi connectivity, barcode readers and have capabilities to support sophisticated applications such as secure e-commerce and m-commerce.

Development of Smartphones and sophisticated applications will lead to the development of more advanced networks which are capable of sending and receiving data at higher speeds. This means that people and businesses in developing countries will be able to gain better access to global internet resources. Very encouraging factor to support this is the growth of mobile phone usage during past decade in developing countries, for example, in sub-Saharan Africa 60 per cent of the population now has access to a mobile phone [8].

Thus one can conclude Smartphones with Internet capabilities are within the reach of MOPs.

Economies of scale resulting from large number of users have given raise to new business model for distribution of applications for mobile phones [9]. Today there are many app stores on the web where one can download the applications for mobile phones at a cost that is order of magnitude less than the cost of an equivalent application for a computer. Some of these applications can be downloaded free of charge. Capabilities one can obtain from these applications make Smartphones a very useful device further justifying the cost.

III Mobile Growth in the Developing Countries

In this section we analyse the growth of mobile phone infrastructure as well as mobile phones in developing countries to identify the size of the potential market segment.

The International Telecommunication Union (ITU) has done many studies to find out the telecommunications connectivity around the world. As shown in figure 2, by the end of 2009, 90% of the world population was covered by a mobile cellular signal. This is a very encouraging statistic considering the mobile signal coverage in 2003 was only 61% [10].

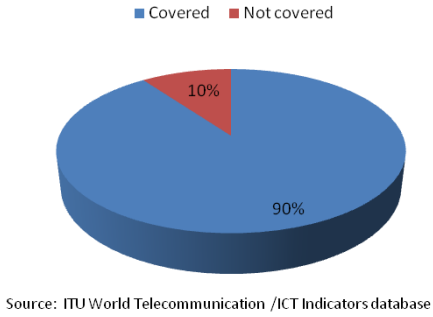

Fig. 2: Percentage of world population covered by a mobile cellular signal in 2009

ITU reported that by end of 2009 (Figure 3), there were an estimated 4.6 billion mobile cellular subscriptions in the world, corresponding 67% of the world population [11]. It has also reported that mobile cellular penetration in developing countries passed the 50% mark reaching an estimated 57 per 100 inhabitants at the end of 2009.

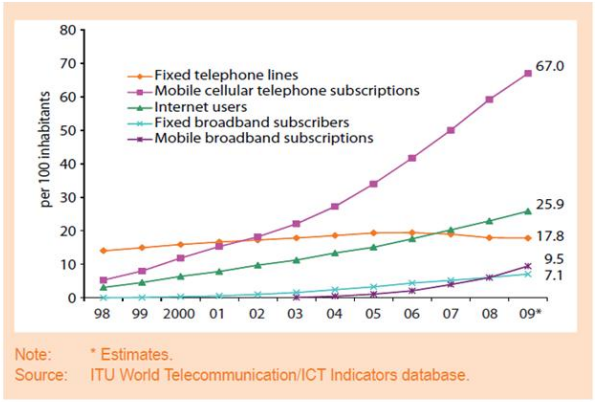

Fig: 3: Global ICT developments 1998 - 2009

ITU also reported that there is a decline in the growth of fixed- line telecommunication structure globally. Both mobile and fixed broadband subscriptions have been growing but the statistics indicate that mobile broadband subscriptions in the world are growing better than the fixed broadband subscriptions (Figure 3).

From these observations we can conclude that people are increasingly using mobile devices to access applications that are based on data services in addition to basic voice and SMS services.

ITU report further analysed the growth in mobile cellular subscriptions in developed and developing countries. They have pointed out that it is less expensive to implement a mobile infrastructure than a fixed-line telecommunication infrastructure structure. This is one reason for the above growth; especially in developing countries. There are other reasons as well. The state owned monopoly on fixed telephony has become less dominant due to privatization of mobile services. This has increased the competition which has brought better services and cheaper costs for the customer. As a result, in many developing countries where there are very limited resources, mobile subscription has grown rapidly (Figure 4).

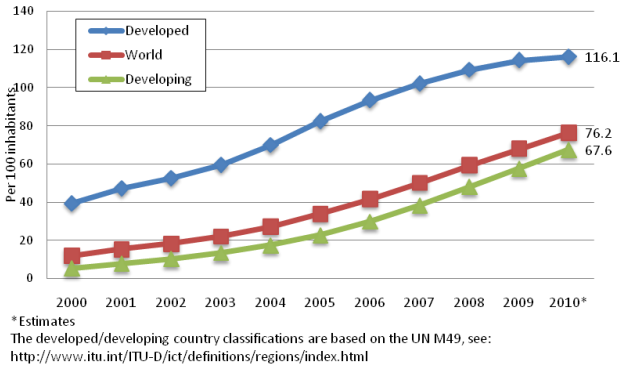

Fig: 4 - Mobile cellular subscriptions per 100 inhabitants, 2000-2010*

Based on the above analysis we can make following observations. Already 90% of the world population is covered by a cellular mobile signal. Competition as a result of breaking down the monopolies has brought the cost of mobile services down hence increasing the mobile phone usage. Because of the wide mobile signal coverage under right set of economic, social and business conditions one can expect the current mobile cellular subscriptions in the developing world to grow very rapidly.

IV MOBILE APPLICATIONS IN DEVELOPING COUNTRIES

In this section we analyse the mobile applications currently in use in developing countries to identify factors that motivate use of mobile applications and emerging underlying patterns.

A. Mobile healthcare applications

Mobile communications have been used to improve the health systems in many developing countries. In developing countries like Uganda and Mozambique, on average there is one doctor for every 20,000 people [12]. Lack of necessary tools and equipment for diagnosis has made the situation for health workers in these countries even more challenging. New mobile diagnostic equipments have been developed to address some of these issues. For example, the researchers at University of California Berkeley have developed a portable, affordable microscope called CellScope that enables health workers in remote areas to take high-resolution images of a patient's blood cells using the camera, process and analyze these images, and then transmit the images to experts at medical centers [13]. This device can reduce both the cost and time of performing critical disease diagnoses, as well as provide early warning of outbreaks in poverty-stricken regions in the world.

Another initiative taken by the same university is to use Smartphones to support an innovative voucher-based program for the treatment of STI (Sexually Transmitted Infections) in East Uganda [14]. In the voucher program, health care providers are reimbursed directly for treating sexually transmitted infections after the patient has received services. This project has the dual goals of reducing claim processing time and improving communication between the health care providers and the voucher program. Currently team members are testing the Smartphones platform and developing plans for eventually handing off maintenance and training to local partners for uptake in an expanded voucher-based program.

Many studies on usage of mobile phone and mobile communication have indicated that they are extensively used to collect healthcare information for healthcare research [15], telemedicine [16], in off –site medical diagnosis [17] and in HIV treatment in rural areas [18-19]. Above is further supported by the fact that there is a sharp increase in the Smartphone health apps. Kailas has shown that there are already in excess of 7,000 documented cases of Smartphone health apps [20]. Though it is a challenge for the user to choose the correct mobile platform, the number of health apps across many platforms have also increased [18].

B. Mobile Educational Applications

There are number of studies that have been done to implement mobile educational applications in developing countries. Muyinda has created a framework for developing mLearning applications for learners in developing countries like Africa [21]. He argues that learning context in developing countries like Africa is different from those of developed countries due to the reasons such as the physical infrastructure, ICT access and usage and mobile phone acceptance. Yet he states that it is possible to provide cheap, just-in-time, just-in-place, interactive support for distant learners using mobile devices.

Both Kumar and Power have carried out studies to investigate the opportunities that mobile devices provide in learning and teaching in India and Bangladesh respectively [22-23]. Even though there are still issues such as infrastructure, affordability and availability of mobile technologies in developing countries, both authors indicate

that mobile devices are perfect vehicles for making educational opportunities accessible to rural children in developing countries.

C. Mobile Agricultural and Fishery Applications

In many developing countries agriculture and fisheries plays a major role in the country's economy. In his study, Jensen investigated the effect of mobile phones on fishing industry which is one of the important industries in Kerala, India [24]. Fisherman sell their catch almost locally as they do not have money to invest on proper storage and also due to difficulties in taking them to far away market places due to high transportation costs. More importantly, local fishermen do not have any information on their market conditions such as the competition, other suppliers and buyers. As a result, there was greater inefficiency in the process, high price dispersion and waste. After the introduction of mobile phones, Jensen observed that the fisherman were able to exchange information about the market better and as a result, the price dispersion was reduced, fish were allocated efficiently across the market, waste was reduced. He has shown that this leads to important welfare improvements for both fishermen and consumers; fishermen's profits increased by 8%, consumer prices declined by 4% and consumer surplus increased by 6% [24].

Aker carried out a similar study to investigate the effect of mobile phone coverage between 2001 – 2006 on grain market [8]. She found that the introduction of mobile phones reduced the price dispersion by 10%. As a result, consumers benefitted with lower prices and suppliers gained higher profits.

Low-income countries such as India and Africa thrive on micro-entrepreneurs. Globally micro-entrepreneurs count for 50% - 60% and in Africa alone this number is 90% [25]. The way the small businesses are run in these countries depends very much on their culture, local business environment, their immediate needs, language skills, infrastructure and support that they have. However there is strong evidence that these micro-entrepreneurs are making use of mobile phones in their businesses. For example, farmers in Uganda use an agricultural information service called Farmer's Friend to receive information on seasonal weather forecast, farming tips, symptoms of common diseases and a text-based system called Google Trader that matches buyers and sellers [25].

Tata Consultancy Services Ltd in India offers a service called mKrish that delivers crop advice to farmers in rural India by cellphone. This service can provide weather information and advice about dealing with plant pests, fertilizer and watering problems and other issues directly to a farmer in the field. It uses remote sensors, a voice-enabled text-messaging service and a camera phone [26]. There are few more similar services across the developing world. China mobile sends farmers information about planting techniques, pest management and market prices via their website 12582.com. TradeNet in Ghana links buyers and sellers of agricultural products in nine African countries and CellBazaar provides a text-based classified ad service in Bangladesh [25].

D. Mobile Banking Applications

Mobile banking is another application area where many applications have been developed in recent years.

M-PESA, a mobile phone-based money transfer service, boasts more than nine million users in Kenya [27] . This mobile application was officially introduced onto the Kenyan market in 2007 by Safaricom, the Kenyan mobile service provider. It facilitates numerous financial services such as checking account balances, making deposits and withdrawals, transferring money and phone credit to other users. To access these services, individuals must register at one of the retail agent outlets, and deposit cash. This cash is thereafter reflected as e-money in a virtual account that is managed by Safaricom. This is called the non-bank led model of m-banking because the customer has no direct relationship with a bank. After this account is created, and an e-money balance established, all of the aforementioned transactions can be conducted via the mobile phone. To access e-money transferred via M-PESA, the recipient must visit a retail agent. They provide the agent with identification, verify the transaction number, and convert the e-money balance on their phone into cash [28].

It has been observed that main use of this system has been for person to person money transfers, pay utility bills, receive small value payments like benefits and salaries from businesses [27] .

Three organizations; CGAP, GSMA and McKinsey have analyzed, unbanked consumers in the Philippines, where two of the global leaders in m-banking operate (Smart, and Globe). One half (1.6 million) of active mobile banking users in the Philippines are unbanked. They have found the unbanked—even the lowest-income segments—actively use informal financial services. Without access to traditional banks, many turn to their families or communities or to pawn shops when they need credit. Nearly 90 percent store money at home, with a household member, a friend, or a village savings club. Some buy assets, such as cows or chickens, as a store of value. These informal channels tend to be unreliable

and expensive [29]. McKinsey & Company have done a study in India as well and found similar use of informal financial services is wide spread [29].

According to their findings low-income households in both countries; India and Philippines cited many of the same reasons—primarily liquidity—for using informal channels. Such households want quick access to funds, so the proximity of outlets and round-the-clock availability are essential. Few banks can meet these needs, because typically outlets are centered in urban areas and the unbanked mostly live in the countryside. Although more than 50 percent of the unbanked in India have considered using banks, only about half have done so, and their survey showed that distance is one of the top five obstacles. These households also need flexible repayment terms, and here again banks fall short. Even when low-income workers do have access to a nearby traditional bank branch, they can find the environment alien and intimidating [29].

Above discussion shows the potential for banking applications. It also highlights the importance of understanding the needs of the users and creating suitable information systems that can be accessed through mobile applications at all times.

V EVOLUTION OF THE WEB

Next we analysed the evolution of the Web to identify the factors that enabled the rapid growth of web applications. These underpinning reasons for rapid growth of the Web and the popularity can provide very useful insights into development of next generation mobile applications.

The growth of the early web now known as Web 1.0 was due to the connectivity it provided that made it very easy for people to publish their information and others to find the information that they were looking for. It had the notion of two groups of people; information producers and information consumers. The search engines evolved to make it easy for information consumers to find the information.

In the second generation of Web applications known as Web 2.0 the notion of above two groups of people started to blur [30]. The same people who consumed information also became the information producers which can be seen as an empowerment of previously passive information consumers. Toffler has called these people prosumers; who are both producers and consumers [31]. Emergence of new applications such as blogs and wikis, and websites such as Wikipedia and YouTube are a result of this empowerment.

Thus one can identify connectivity and empowerment as two important characteristics that fuelled the rapid growth of the Web.

In recent times the connectivity provided by technology to share information evolved on to making social connections through websites such as Facebook, MySpace, Flikr etc. Being able to make social connections further facilitated the rapid growth of web users. These initial social connection networks are now evolving into many professional and marketing networks such as *Linked* in resulting in new business models.

The concept of blogging has now evolved into micro-blogging; a new form of communication in which users can describe their current status in short posts distributed by instant messages, mobile phones, email or the Web. Twitter is a popular application based on micro-blogging.

In June of 2010, Twitter reported having 190 million users posting at a rate of 65 million posts per day [32]. What sets Twitter and other micro-blogging services apart from other Web services is the time stamp and geo coordinates, allowing others to know where and when users' posts have come from. Posts can also contain topic tags, links to other documents on the Web, and references to other users of Twitter.

Micro-blogs can be seen as people documenting events in their day to day lives sometimes once a day, but more often every hour or every few minutes. This information on its own may not be of that much value. But once we aggregate the information from very large number of people based on date, time location, theme etc it provides an excellent view of what is happening now on a given location providing us with very valuable near real time information [33]. Next generation of mobile applications can exploit this possibility to obtain latest information in relation to a user query; whether it is the prevailing market price of vegetables for a farmer who is about to sell his produce or availability of a doctor and the road conditions to a patient in a rural town who is about to make a long journey to get some medical treatment or where one can go to find shelter in the face of a natural disaster.

Rapid growth of Social Networking websites and micro-blogging services highlight another characteristic of the users that needs to be considered when developing mobile applications. It is the willingness of users to share information either with a defined group or publicly. One can consider Twitter or micro-blogs as a way of one documenting and sharing the activities of the person on a daily, hourly or sometimes even at much shorter time intervals [34]. Though individual blogs may be insignificant, if we can find ways to

aggregate the information in micro-blogs we have a new way to obtain information on a global scale closer to real time.

VI Synthesizing Requirements for Next Generation Mobile Applications for MOPs

From the above analysis we can identify the following emerging patterns and requirements for next generation mobile applications for MOPs.

From our analysis of advances in mobile technologies, we were able to conclude that Smartphones with Internet capabilities are now within the reach of MOPs. The very large mobile market will enable applications for Smartphones to be sold at very competitive prices greatly extending the available range of applications for Smartphones. This in turn will become a positive incentive for MOPs to invest in Smartphones.

Another important factor that we observed in our review was that 90% of the world population is now covered by a cellular mobile signal. This together with suitable applications under right set of economic, social and business conditions will enable the already high (about 67%) current mobile cellular subscriptions in the developing world to grow even further.

In our analysis we discovered few applications that have already been successfully deployed among MOPs. These are in areas such as health, education, agriculture, fishery, and mobile banking. Some of these applications especially in the area of health have been developed as a way to overcome various resource constraints (such as lack of trained doctors, physical access difficulties etc) when implementing various programs. There have been experiments to understand how to use mobile devices to deliver education in developing countries. The underlying model has been teachers creating contents for students in rural communities to access via mobile devices mimicking the transmission model of learning. Not much work has been reported based on co-creation models where learner is also empowered to create information to be shared with others. This co-creation model is what has underpinned the rapid growth of Web 2.0 applications such as Wikipedia and YouTube as we saw in our analysis of how the web evolved. Thus next generation of mobile education applications need to be based on a co-creation model.

In the fisheries and agriculture sector, being able to access current market information in real time has helped to reduce the price dispersion, improve the ability to meet the buyers demand, reduce waste (especially in case of perishable goods) and increase profits.

Thus being able to provide prevailing market information in near real time is a very useful feature to have in next generation of mobile information systems for MOPs.
We found success stories in mobile banking such as M-PESA in Kenya. The ability to quickly transfer money between two people or between an institute and a person has been a very useful feature in these applications.

Studies done in India and Philippines related to mobile banking shows still a vast majority of people use informal methods when it comes to fulfilling financial requirements even though these methods are not reliable. Main reason for this is that the prevailing banking structures cannot provide the flexibility and 24/7 access the users want. Thus a next generation mobile information system for the banking sector needs to find ways to fulfill these needs.

We identified empowering users to be both information consumers and information producers to be one of the major factors for the rapid growth of social web applications. Already micro-blogging applications such as Twitter provide this empowerment on mobile devices. The challenge is to find the relevant and meaningful information one wants at the correct time, from millions and millions of micro blogs. This requires intelligent ways to aggregate information from micro blogs to identify events that are taking place at personal, local, regional and global level. This is a major requirement for next generation of mobile applications for MOPs.

At present what we have is many standalone applications that will run on our Smartphones. The next generation of mobile applications needs to be part of a much large mobile information system. These systems should be capable of receiving information from a large number of users, aggregating this information in near real-time and making this aggregated information available to users. There should be functionality for users to quickly find information in real time to enhance their day-to-day activities. If access to such information results in better profit margins that will have a positive influence on wider adoption of Smartphones among MOPs. Once the running expenses are covered this will enable them to use the mobile phones to find information related to their wellbeing and education. One day they might even be able to use their mobile devices for entertainment.

C.K. Prahalad noted in "The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits," that for decades companies have learned how to package things small enough and distribute them wide enough to reach the low-income market. Satchels of shampoo, small bars of soap and bottles of cola can be found in the most remote places in the world [35].

This is a very important observation that is equally valid when developing next generation of mobile applications for MOPs. As these devices and applications will be used by people in low-income markets it is very important to have payment plans to suite their situation. Ideally they should be able to pay for these devices, applications and bandwidth usage as they generate income.

VII NEW MOBILE APPLICATION SCENARIO

To demonstrate how the above synthesized requirements can be used to develop new mobile applications we have developed a new application scenario for a case study that has been reported earlier. For this we used the case study reported by Jensen on the effect of mobile phones in fishing industry [24].

In the above study every fisherman coming to the shore with a catch of fish has to phone few people on shore to get some idea of the prevailing market conditions along the shoreline. The fishermen then individually need to aggregate the sparse information that they have received and decide where they should take their boats to optimize their income. If there is a provision for people on the shoreline to inform one coordinator of the prevailing market conditions at the time, who then aggregates this information and make them available to the fishermen coming to the shore, this will result in a much better system. The predications about the current market demands at various locations along the shoreline will be now more accurate as this was derived using information coming from many locations. Each fisherman needs to communicate only with the central location to get the aggregated data for the whole shoreline, making this process more efficient.

Next phase is to replace the manual aggregation of information provided through the mobile devices with a system that can automate the aggregation of this information. This can lead to many more people along the shoreline being able to provide the information about their need for fish on the day resulting in a much accurate picture of the prevailing demand. Once such a system is in place it can easily be extended to other commodities such as vegetable, staple food etc. When this happens the fishermen who were mainly the consumers of the aggregated information can also become information producers by informing their needs for vegetables and other commodities. The farmers and merchants on the shore line can now become consumers of this new information. Rapid growth of social networks have shown us such type of empowerment enabling users to be both information consumers and produces give rise to new ecosystem.

VIII CONCLUSIONS

Mobile technologies further enhanced the connectivity and enabled us to have connectivity on- the-go. This opens up whole new set of possibilities as the user is no longer tied to a fixed location computer to get connected. But it also introduces some new challenges mainly due to the size of the display, available computing power which also impact the battery life per charge. Another challenge is the cost of on-the-go connectivity which is still relatively expensive compared to the cost of wired connectivity which makes it necessary to optimise the information being exchanged.

As there are over 3 Billion people who falls in to the category of MOPs when classified based on the type of connectivity that they have, there is a very large market for applications for this group of people. As our analysis has shown these applications should support their livelihood and be able to enhance their economic situation in order for them to meet the ongoing costs associated with using these applications. In order to compensate for any shortcomings in their literacy levels, multi model user interfaces are required for these applications. Applications that empower users to be both information consumers as well as producers will greatly assist in achieving very high adoption rates. This would be similar to the way Web 2.0 evolved. The information that users provide can be intelligently aggregated to derive useful near real time information that can be provided back to the users in response to their queries. This should be a unique feature of the next generation of mobile applications.

To implement some of these features, we need to conduct new research. Wide spread adoption of these applications will result in a transformation of social processes and up lifting of economic conditions of the MOPs. This will be similar to the e-Transformation that we have witnessed a few years ago resulting from connectivity and empowerment of users provided through fixed location desktop computers [36].

REFERENCES

1. Tudor, B. and C. Pettey (2010) *Gartner Says Worldwide Mobile Phone Sales Grew 17 Per Cent in First Quarter 2010*. Gartner Newsroom.
2. Jain, R., V. Sing, and M. Gao. *Social Life Networks for Middle of the Pyramid*. 2011; Available from: http://ngs.ics.uci.edu/whitepapers/SLN_whitepaper%20110212.pdf.
3. Lam, P.-L. and AliceShiu, *Economic growth, telecommunications development and productivity growth of the telecommunications sector: Evidence around the world.* Elsevier, 2010.
4. Waverman, L., M. Meschi, and M. Fuss (2005) *The Impact of Telecoms on Economic Growth in Developing Countries*.

5. Röller, L.H. and L. Waverman, *Telecommunications Infrastructure and Economic Development: A Simultaneous Approach. American Economic Review.* American Economic Review, 2001. **91**(4).
6. Trochim, W.M.K., *Deduction & Induction*, in *Research Methods Knowledge Base*. 2006, http://www.socialresearchmethods.net/kb/dedind.php.
7. Kalil, T. (2008) *Harnessing the Mobile Revolution*. New Policy Institute.
8. Aker, J.C. and I.M. Mbiti, *Mobile Phones and Economic Development in Africa.* Economic Perspectives, 2010. **24**(3): p. 207-232.
9. ACMA, *Emerging business models in the digital economy-The mobile applications market*. 2011.
10. ITU, *Measuring the Information Society*. 2010: Geneva.
11. ITU, *Measuring the Information Society*. 2010: Geneva.
12. WHO. *World Health Statistics*. 2010; Available from: http://www.who.int/whosis/whostat/2010/en/index.html.
13. Berkeley, U. *Portable, Low-Cost Imaging for Monitoring and Disease Diagnosis*. 2010; Available from: http://blumcenter.berkeley.edu/global-poverty-initiatives/mobile-phones-rural-health/remote-disease-diagnosis
14. Berkeley, U. *Smartphones for Better Healthcare* 2011; Available from: http://blumcenter.berkeley.edu/global-poverty-initiatives/mobile-phones-rural-health/smartphones-uganda-health.
15. Blaya, J., H. Fraser, and B. Holt, *E-health technologies show promise in developing countries.* Health Affairs 2010. **29**: p. 244-251.
16. Lindquist, A., et al., *The use of the Personal Digital Assistant (PDA) among personnel and students in health care: a review.* Journal of Medical Internet Research, 2008. **10**(31).
17. Kaplan, W., *Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries?* . Global Health, 2006. **2**(9).
18. Boulos, M.N.K., et al., *How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX.* BioMedical Engineering OnLine, 2011. **10**(24).
19. Fraser HSF, J.D., Nevil P, Karacaoglu Y, Farmer PE, Lyon E, Smith Fawzi MKC, Leandre F, Choi SS, Mukherjee KS, *An information system and medical record to support HIV treatment in rural Haiti.* BMJ 2004, 2004. **329**(7475): p. 1142-1146.
20. Kailas, A., C. Chong, and F. Watanabe, *From mobile phones to personal wellness dashboards. IEEE Pulse 2010.* IEEE Pulse 2010, 2010. **7**(8): p. 57-63.
21. Muyinda, P.B., J.T. Lubega, and K. Lynch, *Mobile Learning Objects Deployment and Utilization in Developing Countries* International Journal of Computing and ICT Research, Special Issue, 2010. **4**(1): p. 37-46.
22. Kumar, A., A. Tewari, and G. Shroff, *An Exploratory Study of Unsupervised Mobile Learning in Rural India* in *CHI 2010*. 2010: Atlanta, Georgia, USA
23. Power, T. and P. Shrestha, *Mobile technologies for (English) language learning: An exploration in the context of Bangladesh*, in *IADIS International Conference: Mobile Learning* 2010: Porto, Portugal.
24. Jensen, R.T., *The Digital Provide: Information (Technology), Market Performance and Welfare in the South Indian Fisheries Sector.* Quarterly Journal of Economics, 2007. **122**(3): p. 879 – 924.
25. Standage, T., *Mobile Marvels*, in *The Economist - A special report on telecoms in emerging markets*. 2009: London.
26. Totty, M. (2008) *The 2008 Technology Innovation Awards*. The Wall Street Journal.
27. Ochieng, Z., *Kenya's M-Pesa Now has 9 Million Customers*, in *CIO East Africa Magazine*. 2010.
28. Morawczynski, O. and G. Miscione, *Examining trust in mobile banking transactions: The case of M-PESA in Kenya*, in *Social Dimensions Of Information And Communication Technology Policy*, C. Avgerou, M. Smith, and P. van der Besselaar, Editors. 2008, Springer Boston. p. 287-298.
29. Beshouri, C. and J. Gravråk, *Capturing the promise of mobile banking in emerging markets*, in *McKinsey Quarterly*. 2010, McKinsey&Company.
30. Cormode, G. and B. Krishnamurthy, *Key Differences between Web1.0 and Web2.0.* First Monday, 2008. **13**(6).
31. Toffler, A. and H. Toffler, *Power Shift: Knowledge, Wealth and Violence at the edge of 21st century*. 1990, New York: Bantam Books.
32. Schonfeld, E. (2010) *Twitter Now Has 190 Million Users Tweeting 65 Million Times A Day*. TechCrunch.
33. Singh, V.K. and R. Jain, *Structural analysis of the emerging event-web*, in *Proceedings of the 19th international conference on World wide web*. 2010, ACM: Raleigh, North Carolina, USA. p. 1183-1184.
34. Banerjee, N., et al., *User interests in social media sites: an exploration with micro-blogs*, in *Proceeding of the 18th ACM conference on Information and knowledge management*. 2009, ACM: Hong Kong, China. p. 1823-1826.
35. Prahalad, C.K. and H.C. Fruehauf, *The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits*. 2004: Pearson Prentice Hall.
36. Ginige, A. *A Roadmap, Methodology and Technology Framework to support eTransformation*. in *4th International Conference on Information and Automation for Sustainability (ICIAfS 2008)*. 2008. Colombo, Sri Lanka: IEEE Xplore.