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Participatory sensing in Kenya: preconditions for successful implementation

Dorothy Mwongeli Kalui[1], Geoffrey Muchiri Muketha[2,*], Jared Onsomu[3]

[1]Department of Computer Science, Meru University of Science and Technology, Kenya. [2]Department of Computer Science, Murang'a University of Technology, Kenya. 3 University of Nairobi, Kenya

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ABSTRACT

An increasing number of participatory sensing applications have been developed in recent years. Since these applications can be used for personal and community levels to address real world problems, the players of location based services (LBS) are already exploring their environment. One approach could be to especially address these users' necessary preconditions for successful implementation in order to increase the Kenyan user base of participatory sensing applications. To achieve this objective, a number of earlier related studies were reviewed with a view of identifying factors affecting successful implementations in Kenya for use in the study. To this end, we conduct a questionnaire-based study involving 100 participants to investigate the possible key preconditions necessary for successful implementation of LBS. In particular, we analyze the potential interests of our participants in sensing tasks based on their demographics and interaction with sensing applications. It results to proposed preconditions of successful implementation in Kenya. The identified preconditions are tested statistically using correlation and regression analysis. The findings based on Pearson correlation analysis (coefficients above 0.8) indicate the preconditions have strong linear relationship and recorded p-values of less than 0.05 meaning that their contribution is significant to successful implementation in Kenya

Introduction

Nowadays, most countries of the world have adopted mobile sensing applications as a new approach to offer participatory sensing (PS) to mobile users. Such application includes GPS enabled devices, such as smartphones, iPad, and Google Glasses. These services let users to receive latest information about their surroundings, save time and make better informed real-time preferences and appropriate decisions. These applications, typically implemented as location based services (LBS), can improve the life quality of millions of potential users. In (Christin, Buchner, & Leibecke, 2013; Manzoor et al., 2013; Tarquini & Morgano, 2013), the applications have become increasingly attractive to solve real world problems, service delivery, generate economic activities and timely response to disasters. Example of applications domain include monitoring diets, dating services, road and traffic conditions and noise pollution

*Corresponding author: Geoffrey Muchiri Muketha Email: gmuchiri@mut.ac.ke

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(Macias, Suarez, & Lloret, 2013). An example of PS request by user is "which is the nearest petrol station heading north". The service provider returns list of nearest petrol station from the current position of the user. The process involves a group of mobile users register to a LBS server that receives user requests or tasks from either a local or online task administrator.

Adopting a new approach such as PS applications to offer practical solutions such as domain of transportation system, health sensing, environmental and disaster management etc. would definitely require components different from the traditional conventional efforts (Shilton et al., 2006). Existing studies identified main challenge facing location based users as the resource utilization which includes energy, bandwidth and computation (Gunasekaran & Rathnamala, 2015). The low participation level of smartphone users due to various reasons such as privacy remains an obstacle that prevents the enjoyment brought by sensing applications. While there is clearly a need for users to contribute and share this information with each other, there is also significant request for greater restriction over the conditions under which this information is shared. Trust is also an issue for concern in participatory sensing (PS) system task requester because tasks are assigned to unknown participants. Malicious participants can report falsified data, and it is difficult to identify them, especially when multiple task contributions are not linked due to privacy protection. Faulty, distorted information can lead to incorrect decisions, probably rendering PS systems useless.

The recruitment of volunteers to contribute to participatory sensing applications is challenging. These applications demand particular efforts in terms of resources (e.g., time, battery lifetime, or data traffic) to the users. Other work has been undertaken to study incentives mechanism of the sensing systems and ensure high turnout of collectors to promote the collection of high quality data (Reddy, S., Estrin, D., Hansen, M., Srivastava, 2010).

Previous research efforts have provided valuable findings and lessons for improving users' experiences and adoption; however, the participants in all of these studies were drawn in the U.S., Europe and China (Chessa et al., 2016; Lin et al., 2012; Marusic, Gubbi, Sullivan, Law, & Palaniswami, 2014). Typically, there is no explicit research for low usage and adoption of LBS application in Kenya and other developing countries in Africa, yet millions of smartphones are shipped to these countries every year (IDC, 2015). The extent, to which these findings about adoption generalize to Kenya, is still largely neither unaccounted nor unknown. Kenya is the largest economy in East Africa, with internet users growth by 5.2 per cent to stand at 39.6 million up from 37.7 million users, representing 69.6% of the population (CAK, 2017). Since this number is increasing at remarkable rate, it makes mobile phones an admirable platform for sensing phenomena in the country. Generally speaking, Kenya has different environment such as level of technological advancement, policy environment etc. from the developed countries such as Europe, USA and emerging economies such as China.

We have therefore conducted a preliminary questionnaire-based study involving 100 Kenyan participants belonging to different demographic groups. Based on the answers of our participants, we investigate the multiple factors on their claimed acceptance and adoption to LBS. Among potential factors, we especially consider demographics, sensing application devices and modalities. Our analysis also examines different aspects of challenges to participants' adoption of LBS and then suggests possible solutions for increasing adoption of these applications in Kenya. In this paper we define preconditions as those areas that must go right to create favorable environment necessary for successful take up of mobile sensing applications.

The rest of the paper is organized as follows: Section 2 describes related work, Section 3, the study method, section 4 presents' results of the study and finally section 5 presents discussion and conclusion.

Related works

A Mobile Sensing System (MSS) requires a user level application running on the phone for reading an internal phone's sensor, or external sensors in the Wireless Sensor Network and transmitting sensed data to the Web. Location-sharing applications, though currently unfamiliar to most users, could soon see significant adoption in many countries. LBS deliver customized services to mobile users based on their location. LBS target at providing point of need information to users. Popular examples of LBS include: delivering closest points of interest based on the real-time location of the mobile user, advising of current conditions such as traffic and weather, personalized dating services, providing personalized, location aware and context-sensitive advertising based on mobile user attributes and choices, and providing routing and tracking information(D. M. Kalui, Guo, Zhang, Xie, & Yang, 2015; Macias et al., 2013; Vergara-Laurens, Mendez, Jaimes, & Labrador, 2016). Latest studies confirm that LBS are among the most sought feature by developers with a global market share of $13B in 2013 and have anticipated future growth. Future location-based applications/ services will use the data generated by the new mobile devices for delivering enhanced user experience (Sathe, Melamed, Bak, & Kalyanaraman, 2014).

There are several challenges that have limited the development and growth of PS. These challenges have slowed down the massive adoption and implementation of LBS applications in Kenya. Challenges are defined as the limiting number of issues that are the important factors prohibiting the growth of PS systems. Based on literature review of earlier research, several logistical issues have also been identified as prohibiting the growth and adoption of PS, they include: Multiple application issues, mobile sensing applications are largely standalone applications. This refers to having multiple applications that provide different services such as stand-alone apps for restaurants, buses, weathers, gas stations, hospitals, etc. Besides, some applications for mobile sensing experience technology failure; Preference or customized settings,(Jun, Chin, & Siau, 2012) supported lack of preference or customized settings as a factor inhibiting the adoption of PS. Personalization is about "building customer loyalty by creating a meaningful one-to-one relationship through understanding the requirements of each individual; Education i.e., acceptance to technology, the user acceptance of technology is important issue resulting to advertisers continue to use of SMS to ensure that the message is received. There are multiple applications and competitions that have led advanced technology as well as availing various aspects of LBS to users. Nevertheless, users do not essentially comprehend that they are using LBS or what it means and how it can be used to their benefit (Roos & Coetzee, 2015);Connectivity cost, in terms of cost of data bundles earlier studies (standard newspaper ,may 2, 2017.), the authors mentioned the cost of internet connectivity as un affordable. In the work (Kieyah, 2012) observed that there is direct relationship between affordability and competition; Real time information, in earlier studies (Jun et al., 2012) information provided by providers should be real-time, up-to-date, correct, accurate, complete, and relevant to the requester; Usefulness and awareness of LBS, (Guo et al., 2016; Reinhardt & Heinig, 2014) discussed the benefits of PS in improving life of users as well as solving real world issues; Complexity of use, some of existing LBS search interfaces is complex and difficult to use as explained in (Jun et al., 2012);Speed refers to user ability to obtain information fast from location-based services. When a user sends a request how fast the requested information is delivered to her/ him e.g., app should respond with minimum delay and search results shall appear instantaneously; vicinity based search should be as easy as possible (Christin et al., 2013).

	Percent (%)					No of respondents				
Component/area	NI	SI	I	VI	EI	NI	SI	I	VI	EI
Cost of wireless data services	19	7	35	22	17	13	5	24	15	12
Lack of real time information	21	18	28	26	7	14	12	19	18	5
Lack of customized/ preference setting	12	21	37	21	9	8	14	25	14	6
Privacy concerns	9	1	25	31	34	6	1	17	21	23
Education	34	12	28	16	10	23	8	19	11	7
Complexity of Use	34	21	21	22	1	23	14	14	15	1
Slow speed	13	12	36	14	25	9	8	25	10	17
Usefulness/Benefits not clear	15	21	36	14	14	10	14	24	9	9
High power consumption and battery	9	21	28	28	15	6	14	19	19	10
Keeping track of multiple apps	21	18	31	16	13	14	12	21	11	9

Table 1: *Identified preconditions by respondents for implementing LBS*

The proposed preconditions for implementing LBS

In this section we investigate and propose the factors that discourage respondents from using a variety of available LBS as depicted in Table 1. In order to achieve our aim, we used a 5-point Likert scale with the following linguistic labels: Not Important (NI), Somewhat Important (SI), Important (I), Very Important (VI), and Extremely Important (EI).

We performed significance tests for each of the selected variables which represent the preconditions. Findings show that all the predictor variables (preconditions) are making unique contribution to successful implementation of LBS in Kenya since all p-values are 0.00. In addition, amongst the identified preconditions there is positive linear relationship meaning that an increase in any of the predictor variables leads to an increase in the predicted variables.

Therefore we conclude the following; Privacy concerns require enhanced protection by LBS providers to increase user usage. This is one of most discouraging factor that deters most of participants (90%) from using LBS applications. Slow speed inhibits participants from making use of available LBS. This means if speed improves more Kenyans (above 75 % of participants) will use LBS; Cost of wireless data service, affordability encourages many users to access internet services. This confirms that majority of Kenyans perceive cost of data bundle as expensive affecting their online presence and online services; High power consumption and battery, improvement in power consumption and battery will result to increased usage of LBS in Kenya. About 71% of participants are keen on battery life as well as efficient power consumption for convenient LBS services. Keeping track of multiple apps on mobile device, if we have technology that support integrated multiple applications, usage of LBS will increase in Kenya.

This study confirm tracking multiple application discourage majority of Kenyans (i.e. over 60%) from installing LBS applications in their mobile devices; Usefulness/Benefits not clear, increased awareness of benefits associated with usage of LBS applications increases adoption. The study found out that a reasonable number of participants (64%) are not aware or do not see benefits of using LBS applications; Lack of customized/ preference setting, availability of customized and personalized location-based services to user's preferences, set likes and dislikes, when user wants information delivered to him/her, control which information to send, etc. encourages many people to utilize LBS applications. Therefore, usage of LBS in Kenya is positively influenced by availability of preference settings; Education i.e. user acceptance of technology, higher education level leads to better understanding of LBS applications. This implies that with educated population acceptance of technology such as LBS

LBS component	Average	Ranking by importance
Security of users' information	4.32	1
Applications should not take a lot of memory space	4.07	2
Information provided should be real-time, up-to-date, correct, accurate and relevant	4.17	3
One or two applications that integrate all the services such as traffic, restaurants, weathers, hospitals	4.00	4
Technological and economic shortcomings i.e. network coverage and infrastructure	3.99	5
Ability to get information fast from LBS	3.96	6
Location-based services should be easy to use and convenient to use	3.91	7
Data bundle prices	3.90	8
Non erratic power supply and improved battery life	3.67	9
Interoperability between smartphones, operating systems and applications	3.63	10
Broader publicity and awareness of LBS its features, and usefulness	3.43	11
Specific, detailed, and useful reviews of Products and services	3.39	12
Ability to customize and personalize LBS to user's choices etc.	3.37	13
Ability of devices and services to be aware of current locations	3.34	14
Valuable information and benefits to be gained from using LBS e.g. discount	3.16	15

Table 2: *Ranking of respondent's LBS areas of improvement*

would increase; Lack of real time information, adoption of LBS is positively influenced by provision of real time information. This implies with availability of up-to-date, correct, accurate, complete, and relevant many users will use LBS services in Kenya; Complexity of use, availability of easy to use, convenient to use, and with easy and simple search interfaces increases usage and perception of LBS applications.

Table 2 shows the order of importance for each suggested solutions based on the average ranking scores from section 4 answers of the questionnaire in an ascending order. Security of users information being the most important followed by memory space and valuable information and benefits of LBS being the least important.

The difference between most important area of improvement and the least important one is more than 1 i.e. 1.16. Security of user's information needs more attention and highest priority for Kenyans to embrace LBS applications. These ranking of importance can serve as the criteria for selection of which area to be addressed urgent by the relevant authority. The implications for this is funding thus require a structured priority based approach guided by the ranking of importance.

Discussion and Conclusion

Overall, Kenyans are willing to use LBS for quality life and convenient. In addition, LBS have a potential to bring about positive changes at the societal scale. However few areas need to be addressed to reduce their fears and acceptance of these applications. The relevant authorities and stakeholders should develop strategies to support deployment of LBS application by creating conducive environment.

The main of objective of this study was to investigate preconditions necessary for successful implementation of LBS application in Kenya. With advancement of GPS devices and availability smartphones in Kenya, the topic was worth consideration. In addition as noted earlier, Kenya has recorded increased internet penetration with over 70% of the population having access which can allow them to enjoy wide range of LBS. To achieve better insight of this area, we sought to understand the demographic characteristics of Kenyans that may influence the usage of LBS as well as sensing modalities. We identified the relevant preconditions for successful implementation of LBS and offered solutions to increase the use of this applications.

The study aimed to investigate and present the key preconditions necessary for successful implementation of LBS in Kenya. Findings from this study present an insight of significant preconditions and suggest common solutions to improve the adoption of LBS by Kenyans. The following were some of participants' expectations: adequate privacy, modern infrastructure; fast speed; low power consumption and long life battery; integrated LBS apps and simple of use; affordable data services; customized LBS to their choices and dislike; timely accurate valuable information and benefits. This work considers the viability of such emerging technological platforms, through the appropriate combination of technological design, policy framework, and balance of incentives and safeguards for implementing technological solutions at the service of the person.

Further research, should analyze each of area of improvement identified in this study impact on adoption of LBS; try to establish whether some areas are more critical than others in Kenya context. Focusing on different demographic characteristic e.g. gender, income would provide more insight on product and service since a demographic changes further influence adoption of LBS.

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