DIFFUSION OF MOBILE COMMUNICATIONS TECHNOLOGIES: A CASE STUDY OF LESOTHO

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ABSTRACT

In many parts of the world, factors such as age, culture, gender, and geographical location generally have an influence on the rate of adoption of rapidly evolving technologies as is typical with mobile telecommunications devices and managed data services. In a least developing country characterised by a human development index less than 0.5, questions arise as to how published data actually reflect the *acceptance*, *diffusion* and *penetration* of such rapidly evolving technologies. The *diffusion* of mobile telecommunications is an important issue for policy makers, investors, and providers of mobile telecommunications devices and managed data services. Extant literature inadvertently subsumes that *acceptance*, *diffusion*, and *penetration* are synonymous descriptors for technology adoption. This paper challenges this notion as we continue to examine how mobile wireless communications devices and associated managed data services diffuse in a least developed country.

Key words: Technology diffusion; Mobile communication devices; Managed data services; Digital inequality; Mobile wireless communication; Virtual telecommunications

INTRODUCTION

The human development index (HDI) which is published annually (UNDP HDR, 2016) makes the point that "human development is for everyone – and no one can be left out". The HDI is a broader proxy that "simplifies and captures only part of what human development entails". It "is a summary measure of average achievement in the key dimensions of a long and healthy life, being knowledgeable, and having a decent standard of living". In the modern context, being knowledgeable and having a decent standard of living would include the use of mobile devices to access the ubiquitous capabilities provided by information and telecommunications technologies (ICTs).

An indispensable capability of ICTs is the availability of virtual telephony and telecommunications via mobile devices and the provisioning of managed data services. Chen and Dahlman (2006) reiterate that advancements in ICTs form the backbone of the knowledge economy as the relatively low usage costs of associated software and hardware devices continue to revolutionise telephony and telecommunications. Over ten years ago, an OECD publication (OECD Innovation and Growth, 2007) stated that the unbundling of ICT software from hardware devices coupled with the break-up of telecommunications monopolies, often spur major waves of innovation. The publication asserts that "investment in ICTs is positively correlated with uptake and diffusion of innovation", thus fostering networking, informal learning and co-operation between firms. The inference here is that the

diffusive nature of ICTs motivates firms to explore new business models to provide innovative managed data services that facilitate virtual telephony and telecommunications.

Telephony and telecommunications via the composite technologies of mobile hardware devices, networks, and software are widely available in most parts of the world. Irrespective of a country's HDI classification, globalisation tends to accelerate the pervasiveness of mobile communications technologies and associated services. Therefore, it is essential to examine how these composite ICT technologies diffuse in a least developing country characterised by HDI less than 0.5. The discussion in this paper is premised on the hypothesis that the diffusion of such technologies is particularly important to policy makers and investors, as well as to firms that do business in the ICT sector.

Given that the case study country has an HDI <0.5 with interesting geographical and cultural characteristics, and as part of an ongoing study, section 2 of this paper recapitulates the preceding paper by Mabea & Amadi-Echendu (2016). Section 3 contains a focused review of literature on the diffusion of mobile wireless communication devices. As we reiterate in section 4, the main contribution of this paper is an argument that *acceptance* and *diffusion* are not necessarily synonymous descriptors of technology adoption.

CASE STUDY ENVIRONMENT

The presentation in this paper follows from Mabea & Amadi-Echendu (2016) which examined models of technology acceptance and explored other factors that influence the adoption of mobile wireless communications technology in the case study country. As reproduced in Figure 1, the study reaffirmed the importance of the psychological parameters of the acceptance models but, more importantly, it provided empirical data to explain how factors like age, cost, geography, gender and physical interaction influence the adoption of mobile devices and associated managed data services in the case study country. The study reported in Mabea & Amadi-Echendu (2016) was conducted in 2013/2014, and since then, the migration to 4G technology and increased provisioning of customised personal services have become well established in most parts of the world.

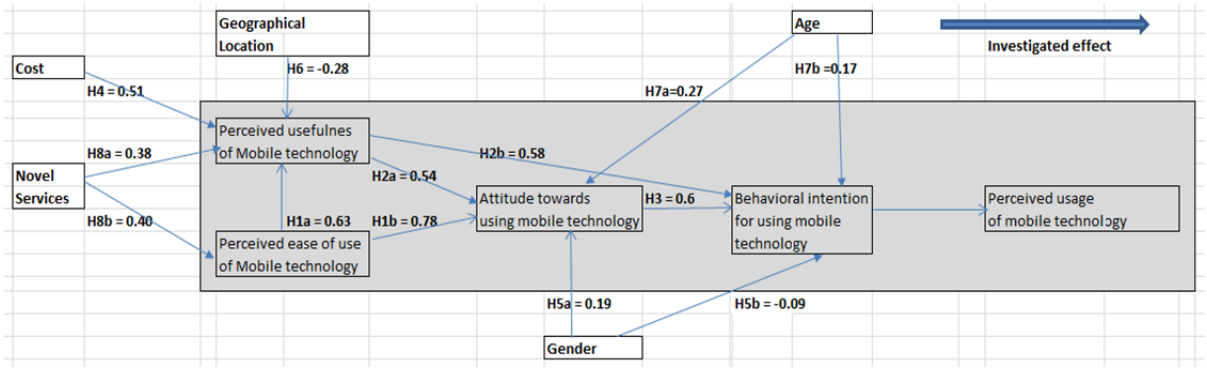

Figure 1. Mobile technology acceptance model (Reproduced from Mabea & Amadi-Echendu, 2016)

From the technology point of view, mobile wireless technology continues to transcend phases or generations with improved noticeable differences between the generations (Böhlin et al., 2009), thus, different generations are being adopted at different speeds. The rapid and massive uptake of 3G devices were as a result of the introduction of the data capabilities and associated managed services provisioning. Yamakawa et al (2013) surmise that, for various reasons, countries and economies respond differently to waves of technological advancements, and thus influencing how particular technologies diffuse in particular regions. Some countries are already deploying 5G technology, others are only beginning to implement 4G, yet there are parts of the world where 2G networks are still in operation.

With an HDI <0.5, the case study country not only exhibits interesting geographical and cultural characteristics but also, it is relatively unclear how mobile ICTs diffuse given the intermingling challenges of urban migration (densification), urban sprawling (sparsification), and indigenous ruralism. As stated in a 2015 review of ICT (Wade Publications, 2015), Lesotho's "overall strategic objective of ensuring the delivery of a universal, affordable and high-quality service which includes rural areas and low-income subscribers … has proven fairly costly, given [the country's] rugged mountain landscape, underdeveloped road and electricity networks, and sparsely populated rural areas". Supply-side statistics provided by the International Telecommunications Union (ITU, 2017) indicates that, by the end of 2016, about 8.2% of households had a computer, 27.9% had Internet access at home, and 27.4 %of individuals are using the Internet. The statistics show a remarkable increase compared to 6.4, 4.3, and 5 percentages respectively reported in 2013/2014.

Lesotho Communications Authority (LCA, 2017) report indicates that there is extensive 3G and 4G coverage with relatively affordable broadband prices but, 'extremely low broadband take-up'. The demand-side data from the report surmises that "32.45% of people have used the Internet, … about 83% of rural dwellers are not connected to the Internet while half of the urban areas are connected". Furthermore, about 90% of urban residents own mobile phones compared to 72.3% of rural residents. Discrepancies between the supply-side statistics (ITU, 2017) and demand-side data (LCA, 2017) provide impetus for detailed studies on how mobile wireless devices and managed data services diffuse in such a country.

CONCEPTUAL MODEL FOR THE STUDY

In literature, many published studies (see, for example, Oliveira & Martins (2011), and Lai (2017)) inadvertently subsume that *acceptance*, *diffusion* and *penetration* are synonymous descriptors for technology adoption. Consequently the words are used interchangeably when referring to technology adoption (see also Etim, 2010). Theory on technology diffusion also encompass terms like acceptance, penetration and adoption (see, for example, Ajzen, 1985; Davis, 1989; Tscherning and Damsgaard, 2008). Rogers (1995) defined diffusion in terms of time-dependent communication of innovation through certain channels between and betwixt social networks. Malebo (2007) posits that technology diffusion may be characterised by constructs such as relative advantage, compatibility, complexity, *trialability*, and *observability*. Moore (1991) describes diffusion based on the life cycle of technology adoption, which more or less depends on changes in the behaviour of the population within a geographic and/or economic region. The studies by Rich (2002), Michalakelis et al (2008), Gruber and Verboven (2001), Gupta and Jain (2012), Islam et al (2012), Yamakawa et al (2013), Sultanov et al (2016), and Wong et al (2016) all refer to the diffusion of innovation and

technology in various countries around the world including Bangladesh, Greece, India, Kazakhstan, Malaysia, Norway and Peru.

The ongoing study that we discuss in this paper takes the viewpoint that *acceptance*, *diffusion* and *penetration* are collective but, not necessarily synonymous descriptors of technology adoption, hence we apply the Oxford Dictionaries meanings of acceptance, diffusion, and penetration respectively as:

- *acceptance* - the action of consenting to receive or undertake something offered, the process or fact of being received as adequate, valid, or suitable
- *diffusion* - the spreading of something more widely, the intermingling of substances by the natural movement of their particles.
- *penetration* - the depth to which something has moved into or through ….

With respect to the diffusion of mobile technology, Mahajan *et al* (1985) developed equation 1 :

$$\Delta Y_t = \phi(t)(\delta - Y_t) \quad (1)$$

where, Y_t represents the total number of mobile users in a given time period t, δ represents the number of potential users, and $\phi(t)$ is the diffusion coefficient. Comin *et al* (2008) measured technology diffusion using equation 2:

$$Y_t = \frac{m_t}{M} \quad (2)$$

where M is the number of potential users, and m_t is the number of users that have adopted mobile technology at time t. Tacero *et al* (2003) used equation 3 to estimate the maximum limit of diffusion:

$$\gamma = \frac{\frac{\delta}{(1-q_a)} - 1}{2} \quad (3)$$

Where δ is the tele-density, q_a is the percentage of the population below a certain age and without mobile network coverage, and γ is the percentage of the population with multiple subscriptions. Wu and Chu (2010) combined the Gompertz, logistics and Bass models to derive equation 4

$$N(t) = K\frac{1 - e^{-(p+q)t}}{1 + \frac{q}{p}e^{-(p+q)t}}. \quad (4)$$

where N is the total number of adopters in interval (0,t) and p is the innovation coefficient and q in the imitation coefficient.

An interesting challenge discernible from each of the preceding diffusion equations is how to determine the number of potential users assuming that demographical factors such as age, culture,

gender, geographical location, and income generally influence the psychological parameters like attitudes, intention, perceived ease of use, and usefulness of mobile wireless communications devices and managed data services. As we continue with our study, we have chosen to examine the diffusion of mobile wireless communications devices and managed data services in the case study country by applying equation 4. Thus, for purposes of data collection, we redefine the imitation coefficient q in equation 4 as the diffusion speed with the following parameters:

Diffusion speed (q) =f{GDP, POP, USFIMP, REGIMP, SCATTERSET, CST} (5)

where GDP is the gross domestic per capita, USFIMP is the universal service fund impact, REGIMP is the regulatory impact, SCATTERSET is scattered settlement factor, and CST is the cost per minute.

SUMMARY **OF THE PAPER**

It is widely accepted that the ubiquitous ICT pervades every aspect of human endeavour and provides an indispensable dimension to the measurement of human development. As a consequence of ICTs, digital inequality manifests as a major challenge in many countries, especially in least developing countries with low HDI. Many international publications arising from surveys of such low HDI countries often times manifest discrepancies between supply-side and demand-side data regarding the acceptance, adoption, diffusion, and penetration of mobile wireless technologies. Perplexingly, extant literature inadvertently subsume that the words *acceptance*, *adoption*, *diffusion* and *penetration* could be used as synonymous descriptors for technology adoption.

In the preceding paper (Mabea & Amadi-Echendu, 2016), we obtained some insight into the interplay between demographic factors and psychological parameters relating to the *acceptance*, *diffusion* and *penetration* of mobile telecommunications devices in the case study country. The ongoing study that we have briefly presented in this paper takes the viewpoint that *acceptance*, *diffusion* and *penetration* are collective but, not necessarily synonymous descriptors of technology adoption. Our approach is to apply a strict definition of the diffusion of technology and this is reflected in our choice of a mathematical model as expressed in equation 5. We believe that data thus obtained will augment existing information, and that further insight into the diffusion of mobile wireless communications should provide increased understanding necessary, not only for policy and regulatory intervention but also, for investment and creation of business models that can be applied to redress digital inequality in the case study country.

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