Research Approaches to Mobile Use in the Developing World:

A Review of the Literature[1]

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Abstract

The paper reviews roughly 200 recent studies of mobile (cellular) phone use in the developing world, and identifies major concentrations of research. It categorizes studies along two dimensions. One dimension distinguishes studies of the determinants of mobile adoption from those that assess the impacts of mobile use, and from those focused on the interrelationships between mobile technologies and users. A secondary dimension identifies a sub-set of studies with a strong economic development perspective. The discussion considers the implications of the resulting review and typology for future research.

Introduction

In 2002, the total number of mobile (cellular) phones in use worldwide exceeded the number of landlines. Current projections suggest that the world will continue to add mobile lines faster than fixed lines; indeed, the next *billion* new phone users will use primarily mobiles (ITU 2003; Lanvin 2005). Both the developed world and the developing world are participating in this boom, but in different ways. A report from the International Telecommunication Union called *Mobile overtakes Fixed* explains:

> "the greatest impact of mobile communications on access to communication services—in other words, increasing the number of people who are in reach of a telephone connection of any kind—can be seen in developing countries." [Furthermore] "In countries where mobile communications constitute the primary form of access, increased exchange of information on trade or health services is contributing to development goals; in countries where people commonly use both fixed-line and mobile communications, the personalized traits of the mobile phone are changing social interaction." (ITU 2003)

Although there are now over a billion mobile phones in the developing world, these changes in social interactions in the developed world have captured the bulk of the research community's attention to date. Though the number of studies focused on mobiles in the developing world is growing steadily, these studies have appeared in relative isolation from each other, separated by regions, and by disciplines. Many research communities are interested in the topic: those impressed by the function of market mechanisms underpinning the stunning spread of a new technology across the planet; those concerned with economic development who see the mobile as an enabler of broad-based prosperity; and those concerned with describing the social, and cultural implications of its use. By focusing on areas where economic constraint is a pressing concern, and by extending analysis to a broader range of cultural and social contexts, these researchers are contributing to a broader, more varied understanding of the implications of mobile and personal communication technologies.

This paper reviews current studies about mobile use in the developing world, defined as the nations classified by the World Bank as "Low Income" and "Lower-Middle Income", and identifies major concentrations of research. The review is interdisciplinary, drawing on studies from communication, information science, computer science, sociology, anthropology, design, policy, and economics. Of course, each discipline brings different organizing questions and perspectives, but it is still possible to integrate and compare roughly 200 studies, each of which has mobile telephony at or near the center of its analysis. The review works at two levels. First, it identifies common themes in the literature, many of which are unique the lower-income countries. Second, it categorizes studies along dimensions—the primary dimension distinguishes studies of *the determinants of mobile adoption* from those that assess *the*

impacts of mobile use, and from those focused on the *interrelationships between mobile technologies and users*. A secondary dimension speaks directly to the "developing" nature of the economies in question—some researchers are interested in the ways in which mobile use accelerates, complicates, or otherwise interacts with the process of economic development. These studies share common assumptions with other studies of Information and Communication Technologies and Development (ICTD). The review identifies examples of this ICTD perspective in some studies in each of the categories in the primary dimension.

Table 1: Mobile Penetration by World Bank Income Categories

World Bank 2007 Categorization (GNI Per Capita '06)	*5 Largest Countries*	*Population 2006 (millions)*	*Landlines, 2006 (millions)*	*Median Landlines Per 100 2006*	*Mobiles 2006 (millions)*	*Median Mobiles per 100 2006*
Low Income <$905	India Pakistan Bangladesh Nigeria Vietnam	2,409	75	.9	329	7.5
Lower Middle Income $906-$3,595	China Indonesia Philippines Egypt Iran	2,289	479	10.9	850	30.4
Upper Middle Income $3,596-$11,115	Brazil Russia México Turkey South Africa*	834	181	20.2	571	65.8
High Income >$11,116	US Japan Germany France UK	1,030	535	44.3	935	100.8
World Totals**		6,563	1,270	13.2	2,685	50.8

Sources: Telecom and Population: ITU Free Statistics (ITU 2007), Country Income Categorizations: the World Bank (World Bank 2007). *South Africa studies are included in the review despite upper-middle-income classification **World totals N=208, excludes some small geographies not appearing in the World Bank Classifications or in the ITU statistics

Background

Table One details mobile use across four income categories defined by the World Bank. Of course it is not surprising that the highest concentration of mobiles is in the High-Income nations; the billion people living in these 58 nations owned 935 million mobiles in 2006; a median per-country penetration of 100.8 mobiles per 100 people.

Two distinct stories emerge from the Low-Income and Lower-Middle-Income categories. The 2.4 billion people living in the poorest nations in the world, of which India, Pakistan, Bangladesh, Nigeria, and Vietnam are the largest, owned 329 million mobiles in 2006, a median concentration of 7.5 mobiles per 100 people. In these nations, mobile ownership remains concentrated among relatively prosperous residents of urban areas, but is growing rapidly—the same ITU data suggests a rise from 177 million in the category only one year earlier. Mobiles are more widespread in Lower-Middle-Income nations like China, Indonesia, the Philippines and Egypt, where incomes are between $906 and $3,595 per capita. Median penetration is already a remarkable 30 mobiles per 100 people, and mobile ownership has touched a broader spectrum of these societies, from urban businesspeople to middle class families and youths, as well as people in rural areas. As penetration nears 100% in the high-income countries, the developing world will provide a greater share of future growth.

Despite the a growing number of mobile users in the developing world, their use patterns sometimes receive only a brief mention within broader reviews of the impacts of mobile phones in society. In these cases, "leapfrogging", or otherwise the promise of a sudden spread of mobiles into places where currently there are not many telephones, might be as much of a mention as the developing world gets (Lochoee, Wakeford, and Pearson 2003; Critical Friends of Technology 2003). Other overview texts provide more detail about the regions of the developing world; Rao and Mendoza's (2005) *"Asia Unplugged"* has chapters on the industry structures of various developing countries on the continent, and Schwartz's (1996) book on wireless technologies laid out the technical and policy issues which would challenge the mobile's growth in the developing world.

The most comprehensive treatment of mobile use in the developing world is part of a larger text on about the worldwide social implications of mobile technology—*Mobile Communication and Society* (Castells et al. 2007). As such, it approaches the developing world in two ways. First, it uses studies from the developing world to support broader assertions about the way mobiles relate to everyday life (references from China, or India, might be interspersed among those from Finland, or Tokyo). This underscores

similarities between mobile use in the developing world and the developed world. To highlight *differences*, it offers a chapter that focuses on the impact of mobile telephony in economic development (an example of the ICTD perspective, mentioned above). This chapter frames some critical issues, and then introduces case studies illustrating both the promise and the complexity of designing alternative modes of mobile phone access. However, because the development chapter takes a theme-based approach, and because the other references are interspersed within a boarder review of the general 'mobile society' literature, the review by Castells and his colleagues does not specifically address the full scope of the studies specific to the developing world. That task is the one that this paper sets out to accomplish, linking the 'everyday life' and ICTD studies in one piece.

Methods

Interdisciplinary literature reviews differ from disciplinary reviews in a couple of ways. First, it can be difficult to identify clear boundaries for which sources should be included in the review. Second, it can be difficult to assess which the relative quality or importance of one work versus another. Anthropologists and economists, for example, bring quite different perspectives to bear on the same phenomenon. Despite these challenges, the literature around the mobile in the developing world is still relatively new, and relatively concentrated, such that an inclusive, interdisciplinary review remains possible. This section outlines the process to select documents for the review.

In terms of **topic**, the goal was to cover articles that were "about" a) the mobile phone and b) its use in the developing world. The "mobile" component has three constraints. First, "mobile telephone" refers to the common CDMA and GSM mobile/cellular systems, although occasional references to voice alternatives, such as limited-mobility wireless local loop systems, were included. Other wireless technologies such as two-way radios and satellite phones play an important role in rural development, but fall outside this review. Second, studies which made no distinction between landlines and mobiles were not included. Finally, the review excludes studies that group mobiles together into a broader discussion of ICTs. It is common practice to make assertions about "new media" or ICTs as one interrelated group (Walsham and Sahay 2006). However, some of the studies below highlight conceptual differences in use, usability and symbolic value between PCs (and/or the internet, as accessed through a PC) and the personal, portable mobile phone (Katz and Aakhus 2002; Slater and Kwami 2005).

The review is also restricted to documents that discuss either the developing world as a general concept, or specifically address a nation or set of nations classified by the World Bank as "Low Income" and "Lower-Middle-Income" (World Bank 2007). Of course, there are people using (or not using) mobiles under conditions of economic constraint more prosperous countries. Similarly, there are many prosperous

users in the developing world. Nevertheless, a parsimonious approach was to limit the review to the two lower categories in the World Bank framework, where 72% of the worlds' people now use 44% of its mobile phones. As of 2007, this approach excludes Brazil and Russia, which the World Bank now classifies as upper-middle-income countries. It would also exclude South Africa, which was reclassified upwards into the upper-middle-income category in 2006. However, there is a particularly strong literature about mobile use in South Africa, much of it about those previously without access to telecommunications. Thus, an exception was made for studies about mobile use in South Africa, which are included in the study.

To set the proper **scope**, the review used various approaches to locate documents, including electronic database searches, online bibliographies,[2] edited books on mobiles and society, reviews of article bibliographies, and, in some cases, word of mouth with other authors. The resulting searches uncovered articles across many disciplines and publication venues. Pure technical/engineering studies were not included. Unfortunately, for the most part, the review covers only English-language sources. Thus some articles are surely missing, particularly since the community of interested researchers is growing quite quickly.

The review is primarily of peer-reviewed or edited publications: books, journal articles, and book chapters. In a few cases, papers presented at conferences or in proceedings which utilize full-paper peer review are included. Also appearing are a few of the more influential reports from the development community; either institutions like the World Bank, or specialty consultancies. Though they fall outside the peer review process, these reports are a valuable source for difficult–to-gather quantitative data on users in the developing world. However, this general screen for reviewed articles leaves dozens of interesting initial papers waiting in the wings, many of which have appeared at small conferences dedicated to the mobile society.[3]

In summary, the review is a sample, rather than a census, of roughly 200 documents available as of October 2007. It is fruitless to engage in quantitative comparisons to say that the existence of X articles of one type is in any way more significant than Y articles of another type. However, the sample is sufficiently broad, and timely enough, to represent many of the current/major theoretical and empirical discussions about the significance of mobiles in the developing world.

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[2] As of October 2007, at http://members.aol.com/leshaddon/MobileRefs.html and http://ist-socrates.berkeley.edu/~nalinik/mobile.html
[3] As of October 2007, http://www.scils.rutgers.edu/ci/cmcs/events/ lists many of these conferences

Broad Categories of Studies

In addition to providing a basic narrative/thematic grouping, the review applies some analytic categories to the studies. It does so using two orthogonal dimensions. The primary dimension distinguishes studies of *the determinants of mobile adoption* from those that assess *the impacts of mobile use*, and from those focused on the *interrelationships between mobile technologies and users*.

Many mobile adoption studies seek to explain the phenomenal rates of mobile diffusion in the developing world; others focus on regulatory structures that permit or prohibit mobile adoption. The impact studies span a wide range of contexts: businesses and classrooms, communities and cultures. The rationale for both sets of studies is clear. Having exploded literally before our eyes, rarely has a technology been so amenable to analysis via a "before-after" framing. It is important to describe how and why this boom occurred, and to understand its future direction. At the same time, rarely has a technology seemed to hold such a powerful sway over its users. Boettinger (1977) reminds us that "The telephone was the first device to allow the spirit of a person expressed in his own voice to carry its message directly without transporting his body"; the mobile shares this incredible, almost magical power with its predecessor, and adds mobility and autonomy to the mix (Katz and Aakhus 2002). It is also important to understand how this magic is used, and this is particularly compelling in parts of the developing world, where the economic and social need is so great.

However, as the existence of a third set of studies indicates, there are nuances in the relationship between humans and communication technologies that neither an adoption nor an impact perspective can capture. This basic division is in no way unique to mobile studies. Claude Fischer, in *America Calling (1992)*, a study of the early US landline telephone, lays out a similar typology. He contrasts "impact" studies of the telephone (exhibiting various degrees of technological determinism) with what he sees as a more fruitful set of studies in which the causality is less clear, and the interrelationships between technologies and human systems are complex. Other variants of this "use heuristic" can be found in Latour's (1987) view of socially-constructed technological systems, and in the adaptive structuration paradigm (Poole and DeSanctis 1990; Orlikowski 2000), among many others. In their review of the information science literature, Orlikowski and Iacono (2001) call this class of studies examining the "dynamic interactions between people and technology" *ensemble* studies.

Orlikowski and Iacono also point to Markus and Robey's (1988) article in *Management Science*. Markus and Robey looked at the conceptually diverse set of studies about information technology in organizations, finding that most could be divided into three groups: those where information technology was the dependent variable (were organizations and people chose technologies); those where information

technologies were the independent variable ("impacting" people in various ways); and those "emergent" studies where causality was not discernable. There are many researchers wrestling with these distinctions, and a full treatment of their nuances lies beyond this paper's scope. However, the categories that Markus and Robey present do seem to represent the scope of the emerging interdisciplinary discussion around mobiles in the developing world, and provide the basis for the primary dimension of the review.

Table 2: Common research themes about mobiles in the developing world

General Approach	*Non-ICTD*	*ICTD*
Mobile Adoption (mobile as dependant variable)	Liberalization Diffusion/Adoption	Digital Divide Universal Access
Mobile Impact (mobile as independent variable)	Education; Emergencies; Medicine	Economic Growth (macro and micro); Livelihoods
Mobile Interrelationships (emergent or ensemble approaches)	Appropriation; 'Everyday Life'; Globalization; Design in Context	Evaluation or design of ICTD Projects

The secondary dimension speaks directly to the "developing" nature of the economies in question. Many researchers are interested in the ways in which mobile use accelerates, complicates, or otherwise interacts with the process of economic development. There is a long history of "ICTD" studies exploring the relationships between various information and communication technologies and development; broader reviews of this literature can be found elsewhere (Wilson 2004; Saunders, Warford, and Wellenieus 1994; Kenny 2002; Hudson 2006). Sein and Harindranath (2004) draw on Orlikowski and Iacono's framework mentioned above, to illustrate how the meanings of both "ICT" and "development" are complex. Therefore, instead of isolating the development studies, the review integrates the ICTD perspective across the primary dimension. As Table 2 indicates, both ICTD and non-ICTD topics appear in each of the categories of the primary dimension.

The responsibility for assigning individual studies to these categories lies with the researcher, and is not without challenging cases. Many studies introduce one perspective as a premise or rationale for pursuing another. Diffusion studies might start with a statement or two about how powerful mobiles are, while impact studies might start with an observation about the rapid growth in the number of mobiles in the world. (Indeed, this review's introduction mentions both diffusion and impact in the first few paragraphs.)

Nevertheless, the categories are broad and robust enough to shape the review that commences below, starting with the determinants of mobile adoption.

The determinants of mobile adoption

Diffusion studies

Orlikowski & Iacono (2001) identify the classic "diffusion of innovations" approach developed by Rogers (2003) as a common theme in technology research. This model has also been applied to a diversity of settings and mobile applications, including mobile banking applications in South Africa (Brown et al. 2003), m-commerce in Thailand (Kini and Thanarithiporn 2004), and mobile and pager adoption by "yuppies" in urban China (Wei 2006). Along related methodological lines, quantitative studies have applied the Technology Acceptance Model (TAM) to explain and predict mobile adoption in Nigeria and Kenya (Meso, Musa, and Mbarika 2005), and in South Africa (van Biljon and Kotzé 2007). The theory of reasoned action has been applied in Guinea (Kaba et al. 2006) and in Botswana, Ghana, and Uganda (Scott, McKemey, and Batchelor 2004). Other micro-level diffusion studies examine the appeal of the mobile (versus the fixed line) to companies in Eastern and Central Europe (Vagliasindi, Guney, and Taubman 2006), and in Nigeria (Adeoti and Adeoti in press), using adoption at the enterprise level as the dependent variable.

Instead of focusing on individual needs and behaviors, other diffusion studies are econometric, comparing aggregate measures of mobile penetration within or across nations. Some seek to describe penetration rates using geography and income (Baliamoune-Lutz 2003), income alone (Rouvinen 2006), the quality of the institutional environment (Andonova 2006), or socio-cultural attributes and internet/telecom use (Kamssu 2005). Some fit existing diffusion models (Kumar et al. 2007; Varadharajan 2007; Koski and Kretschmer 2007) to developing-world contexts. Others (Banerjee and Ros 2004; Dholakia et al. 2004) identify distinct patterns of mobile utilization instead of trying to fit all nations to a single model. Similarly, Kauffman & Techatassanasoontorn (2005) develop a model in which "regional contagion" (similarities across borders) helps predict/explain mobile penetration levels.

James and Versteeg (2007) raise an interesting caution which might apply to all the diffusion studies, pointing to unreliable (or under-explicated) measures of mobile penetration and use in Africa, given poor industry data and pervasive pre-paid and shared use.

Regulatory Frameworks and Industry Structures

Another, rather large group of studies bring careful attention to the role policy environments and competitive landscapes play in shaping the availability and affordability of mobile service across the developing world. Perhaps mobile carriers operated in a true *laissez-faire* environment only in Somalia, where for a while there was no operating government. Everywhere else, governments and regulators play a role, allocating spectrum, structuring competition, and liberalizing and privatizing new and existing markets. Though some of these policy interventions are invisible to end-users, the studies below indicate just how varied the landscape is, and how important it is to get the policy, industry, regulatory framework "right".

One important thread in this regard uses penetration and tariff data as inputs to economic models to explore the relationship between mobiles and fixed line telephones. Cross-national assessments in the developing world find users treating mobiles as both a complement and as a substitute (Garbacz and Thompson 2005, 2007), with first-time phone users choosing a mobile line rather than a fixed one. Hamilton (2003) uses national-level penetration and environmental variables from 23 African nations to observe both substitution and complementary effects (depending on income level), and to argue that competition from mobile service actually improves landline availability. Hodge (2005) uses household subscription data to estimate a complement-versus-substitution point in South Africa, finding that prepaid mobiles were more attractive for low-income users with low telecommunications expenditures, despite higher per minute rates. Users preferred prepay plans to the alternative of paying a monthly fee (plus a lower per-minute rate) for a landline phone. Esselaar and Stork (2005) echo Hodge, using a 9-country household survey to find evidence of a substitution effect across a broad stretch of incomes, not just among the poor.

Other explorations are multi-method case studies, introducing the history and unique factors that explain the progression, current status, and future progress of mobile penetration in a nation or region (Steinbock 2003; Rao and Mendoza 2005). Not surprisingly, the dance of government influence, changing technologies, and competitive actors in China—the world's largest mobile market—has received particular attention (Dong and Li 2004; Kshetri and Cheung 2002; Sangwan and Pau 2005). This attention includes assessments of the rise of 3G (Yu and Tan 2005, 2006; Yuan et al. 2006), m-commerce (Kshetri, Williamson, and Bourgoin 2006) and mobile internet (Yan 2003) in China.

Elsewhere, Fraunholz and Unnithan (2004) contrast the structural challenges facing the mobile industries in Germany and India, pointing to India's telecom reforms in 1999 as a key turning point for mobile adoption, while Banerjee and Lennon describe an evolving m-commerce landscape in India with a special

reliance on SMS as a 'killer app'. In Africa, Minges (1999) argues that substitution effects (see above) and availability of prepay, non-subscription plans explain the rapid early growth of mobiles in the Southern African regions, while Curwen and Whalley (2005) outline increasing concentration of mobile networks in the hands of a few major operators. Frempong and Atubra (2001) report on the Ghanaian experience with liberalization of telecommunications markets, highlighting the early success of mobiles, as well as some continuing challenges facing its National Communication Authority. Benn and Kachieng'a (2005) outline the increasing complexities and interdependencies of entities providing mobile data services in the South African market. In Latin America, Ibarguen (2003) holds Guatemala up as an example of successful, liberalization of the wireless spectrum, highlighting its high mobile penetration rates, relative to other Latin American countries.

Indeed, liberalization is a present theme across much of the regulatory work mentioned above. Varoudakis and Rossotto (2004) are critical of the relative lack of liberalization in the Middle East and North Africa; they see higher levels of mobile penetration in competitive markets like Jordan and Egypt than in less competitive ones like Iran, Syria, and Libya. Mureithi (2003) calls for greater liberalization in African markets, in order to bring more competitors into national markets, many of which had only two mobile carriers. Stovring (2004) contrasts the broad successes of liberalized, competitive mobile markets with the poorer record of many African nations' fixed-line privatization initiatives. Wallsten's (2001) analysis reinforces this, finding that between 1984 and 1997 competition from mobile providers in African and Latin America had more impact on overall telephone penetration than privatization of landline providers.

Of course, the mobile and fixed telecommunications providers cannot work in isolation from each other, no matter how fierce their rivalry. As case studies from China (Yan 2001), Bangladesh (Bhuiyan 2004) and India (Srivastava and Sinha 2001) illustrate, there must be adequate provisions for a reasonable interconnection and revenue-sharing between providers, such that calls that originate on one network can terminate on another.

The Digital Divide and Universal Access

Some researchers are less confident that liberalization and competition will be sufficient to ensure universal access or even a high rate of penetration in many countries in the developing world. Many frame this concern using the concept of the digital divide. Coined originally to describe disparities in internet access in the US (Katz and Aspden 1997), it has expanded to describe the worldwide gap in internet access and use (UN ICT Task Force 2002). Some have argued that the mobile phone is a more accessible, less expensive means to 'close' this global divide (Wade 2004; Mbarika 2002; Kenny 2002;

Snowden 2000)—an argument sometimes repeated by the popular press. Others use the "digital divide" to distinguish between mobile phone users and non-users, or between telephone users and non-users. Used in this way, the digital divide is a new reference to the existing inequities historically addressed by universal service and universal access initiatives.

On the "universal access" theme, Dymond and Oestmann (2003) make a distinction between gaps in *market efficiency*, which can be minimized first through liberalization, and *access*, which impacts populations and regions which the market will not serve without specific mandates or incentives by the government or other stakeholders. This dual approach, where liberalization comes first and intervention happens only in extreme cases, can be found in the World Bank's approach to financing telecommunications infrastructure in the developing world (World Bank Global ICT Department 2005).

Some of these interventions, designed to close the access gap, involve regulatory or technological solutions that diverge from the "norms" of national-level licenses for GSM and CDMA spectrum. Via WiFi and voice-over-IP (Best 2003), or by other forms of wireless local loop (WLL) applications (Kibati and Krairit 1999), it is possible to provide wireless (if not actually mobile) telephony to rural populations. However, as studies from India (McDowell and Lee 2003; O'Neill 2003), South Africa (Leijden and Monasso 2005; Gillwald 2005; Barendse 2004) and Latin America (Galperin and Girard 2005) indicate, it can be difficult to align the regulatory environment to balance the interests of customers, small local providers, and the the other communications providers in the country.

Others invoke the digital divide as part of a more explicit argument that access to telephony or computers is essential for economic growth or poverty alleviation. They are, to use the secondary dimension of this review, ICTD papers. In this vein, Shanmugavelan & Wariock (2004) highlight continued regulatory and structural barriers to rural telephony in Africa. They argue that mobile service in Africa remains urban-centric and expensive, and cannot completely replace the need for fixed lines in rural areas. Harwit (2004) calls attention to the continuing rural-urban "digital divide" in China, though he is optimistic that mobiles will help close the gap and improve development outcomes.

Thus there are continuing questions and differing perspectives concerning the right mix (and intensity) of market and non-market forces to bring to bear on the problem of universal access. For example, while Anderson (2006) highlights the success of pre-pay accounts to appeal to lower-income users in the Philippines, Mahan (2003) urges caution about pre-pay. She is concerned that using prepay accounts to extend the network and approach universal service may, in the long run, make it difficult to (a) target the

very poorest users who cannot afford to pay anything for telecom and (b) create an infrastructure which can support more advanced data services beyond voice and SMS in poorer communities.

Overall, the adoption studies identify predictors of mobile diffusion at both the micro and national level. They identify the important role of regulatory structures (particularly liberalization) in speeding mobile penetration, raise important questions about the gaps left even after liberalization, and suggest policy and technical interventions to close those gaps.

Impacts of mobile use

The rationale for *impact* studies is clear: the mobile is an incredibly powerful tool for exchanging ideas at a distance, and for managing daily life. The clearest examples of impact studies come from the ICTD perspective, where researchers are interested in whether mobiles promote or enable economic growth or broader well-being (Sridhar and Sridhar 2006). These studies echo earlier work on telecommunications and economic development (Norton 1992; Hardy 1980; Saunders, Warford, and Wellenieus 1994). Thompson and Garbacz (2007), for example, use a stochastic model to identify a positive effect of telecommunications (but particularly mobiles) on productive efficiency in developing nations. In a paper appearing in a Vodafone report called *Africa: The Impact of Mobile Phones* (2005), Waverman, Meschi, and Fuss (2005) also take the macro view, reporting that higher levels of mobile penetration lead to higher rates of GDP growth, particularly among low-income developing countries. With its clear focus on "impact", the Vodafone study generated much discussion within the ICTD community, and provided additional data at a time when little was available. The volume highlights other research (Williams 2005; Lydon and Williams 2005) finding a correlation between mobile penetration levels and inflows of foreign direct investment. It also offers two studies at the micro level. One uses a survey approach to explore how that mobiles contribute to increased social capital (cohesiveness) within communities in South Africa and Tanzania (Goodman 2005). The other focuses on how people use mobiles to substitute for travel, to start and open businesses, and to keep in touch with friends and family (Samuel, Shah, and Hadingham 2005).

Perhaps the strongest evidence about a microeconomic impact of mobile telephony comes from Jenson (2007), whose research tracked five years' worth of prices for sardines at various landing ports on India's Keralan coast. He found that the arrival of mobiles brought significant and immediate reductions in the variability of price and the amount of waste in the fishing system. Armed with better information, fishermen—most of whom purchased mobiles as soon as they could afford them—are more able to choose to land at a port with buyers willing to purchase their catch. Abraham (2006) too found clear benefits, mostly around reduced price volatility and increased responsiveness, to these fishing communities.

Yet the broader story of the mobile's impact on small enterprises, farmers, and the self-employed is not as clear clear-cut. The productivity gains associated with mobile use by SMEs are scarce or hard to measure (Chowdhury 2006). Additionally, there is a strong intermingling of business (instrumental) and personal uses of the mobile among small business owners (Donner 2004). A survey of urban microentrepreneurs in Kigali, Rwanda, finds that 2/3 of calls were with friends and family rather than to customers or suppliers (Donner 2005). While mobiles could be used to find new customers and expand business networks, they are just as likely to be used to amplify strong ties with existing personal relations (Donner 2006). An extended report by the Gamos consultancy (Souter et al. 2005), looks at the impact of mobile use on rural livelihoods in Africa and India, again finding more use for emergencies and connections with friends and family than for dedicated economic activity. This piece also raises important questions about the distribution of the "benefits" of telecommunications within a community, arguing that those with greater resources are more likely to make use of the technology.

Of course, not all impact is economic. Other studies explore the mobile's impact on other institutions and human domains, such as non-governmental organizations (Rogers et al. 2006). Mutula (2002) ponders the implications of mobile telephones for libraries in Southern Africa. Others consider the mobile as a resource for e-learning in Tanzania (Stone, Lynch, and Poole 2003) and Thailand (Whattananarong 2005). All argue that the mobile's portability, simplicity, and affordability make it a natural fit for education initiatives in places where PCs and internet connectivity may be scarce. Mobiles also seem useful in emergencies, like during the eruption of a volcano in Eastern Congo (Agar 2003). Idowu, Ogunbodede, & Idowu (2003) describe how Nigerian doctors use mobiles to communicate with each other across different parts of a large hospital, and to respond to emergencies when offsite, illustrate ways in which mobiles, in low-teledensity settings, serve functions we might normally attribute to landlines.

Interrelationships between mobile technologies and users

For many researchers, mobiles are (like other technologies) best understood as co-constructed phenomena; there are interrelationships between what the technology is and how people choose to use it. Some studies are more explicit than others are in this regard, and for the purposes of this review, some studies might straddle the impact or interrelationship perspectives. Indeed, a few studies share the structure of this review, integrating the larger themes of adoption, use, and sociocultural situatedness into a single article. Kumar and Thomas (2006) touch on these themes in the comparison of India and China. Others describe conditions in a single country (e.g., Romania (Bonciu and Williams 2006), India (Kumar Mukherjee 2002)) or continent (Africa (Kyem and LeMaire 2006). The review retains an inclusive definition of the interrelationship category. Whenever the research acknowledges the importance of

context, *and* active, choiceful use (as opposed to somehow suggesting impact on a passive receiver), the review places it in the 'interrelationship' set. The result is a rich suite of studies, ranging from politics, to design, to economic development.

Symbols of the modern and the global

A reasonable place to start this section on 'interrelationship' studies is with those that examine the construction of the mobile as a symbol of modernity and capitalism, yet as the lines between 'modern' and 'global' blur, complexities abound. Kavoori and Chanda (2006) express concern about the popular, (unquestioned) construction of the mobile as a desirable item in Indian advertisements, noting instead its power as a capitalist, masculine, corporate, and ultimately dislocating cultural technology. Tall (2004) identifies a process of informal globalization driven by the introduction of mobiles into rural Senegalese villages by the village's émigrés. Pertierra's (2005) exploration of the uses of mobiles in the Philippines is framed as a process of participation in (and resistance to) globalization through the creation of hybrid local and global spaces, mediated via the mobile. Particularly interesting is Zhao's (2004) description of a recent Chinese film that views the mobile in a dystopian light, as a tool likely to destroy individuals and families. Zhao contrasts this with the vision of ICTs represented by the World Summit on the Information Society.

The politics of mobilization and resistance is another domain in which the interrelationship approach to mobile use is proving fruitful. It is almost an article of popular faith that '*Smart Mobs*' (Rheingold 2002) played a role in the removal of Estrada in the Philippines. Pertierra, Ugarte, Pingol, Hernandez, & Dacanay (2002) argue that while it is an oversimplification to say that texting "caused" the political shift, it is true that the SMS-driven protest became an icon for Filipinos' new postmodern, urban, individualist lives. Paragas (2003) also focuses on the interrelationship between democracy and technology, noting how prior reforms and liberalization in the telecommunications markets established the conditions for the text-revolution to occur. Readings of the significance of such SMS uprisings vary. Some (Mudhai 2006; Obadare 2006; Arsenault 2006; Gordon 2007) are optimistic, arguing that mobiles will help give voices to those marginalized by lack of access to other ICTs. Rafael (2003) is more skeptical, focusing on the fetish of communication-as-empowerment taken on by participants in the anti-Estrada uprising, and wondering whether the cries for reform and transparency, mediated by a technical communication platform, represented the demands of a stable middle class rather than a disenfranchised group. Hill (2003) discounts the role of the SMS and the mobile in Indonesia's 2000 elections, relative to that of the Internet. Yu (2004) offers a different interpretation of political text messaging, using the example of SARS to

illustrate how text messing can be used in a form of appropriation, rather than outright resistance, to support civil society in a time of crisis.

Everyday Uses

However, as in the developed world, it might be the times between the crisis—the daily and the mundane—where mobile use is most clearly a product of the particular context into which it is brought. In her analysis on mobile technologies in Asia (including India and China), Bell (2005) asks "so what is a cell phone?" Bell's piece explores appropriation and re-interpretation of the mobile, particularly with respect to local and global constructions of the device. Wei and Kolko (2005) explore how cultural factors and economic constraint influences patterns of mobile use in mobiles are used in Uzbekistan as an extension of everyday behaviour, and yet also posit ways in which the technology might be transforming social relationships by fostering dependence on the device. Paragas (2005) focuses on the way norms of mobile use have emerged on Manila's busses, where theft is constant threat. Other explorations of the role of mobiles in (re)constructing urban spaces and social interactions in the developing world concern Indonesia (Lim 2002) and Morocco (Maroon 2006). The different implications of the mobile's arrival in previously isolated rural areas has been explored in the Philippines (Nagasaka 2007; Strom 2002), India (Seshagiri, Aman, and Joshi 2007), and Nigeria (Manvell 2006)

The practice of leaving intentional missed-calls, or 'beeping', (Donner 2007; Sey 2007) is another example of how the process of appropriation by users in the developing world leads to the creation of 'new' mobile uses that nevertheless reflect and reinforce existing hierarchies, norms, and social relations. Across most of the world where prepay cards and 'calling party pays' are common—users exchange messages over the mobile providers' networks without paying any tariffs at all, or by ensuring that the 'richer guy pays'. Users simply call an intended target and hang up; the "missed call" appears on the receiver's mobile screen, and the receiver (generally) knows that he either needs to pay for a return call, or can decode a prearranged message, such as 'pick me up now' or 'I'm thinking of you'.

Speaking of 'I'm thinking of you' messages, other researchers have explored how mobiles are used in flirtation and romance. Pertierra (2005; 2007; 2006), Solis (2007), and Ellwood-Clayton (2003; 2004) identify how text messaging helps Filipinos expand social networks (through blind solicitations to intentionally wrong numbers) and control their communication (and romantic) agendas, enabling new, rich, flirtatious dialogs. Elsewhere, research illustrates how mobiles' central role in dating, courtship and sexuality has been reflected in the pop culture songs on Jamaica (Batson-Savage 2007).

The mobile has indeed become intertwined with many elements of social life. Other research describes how mobiles enable and alter religious and spiritual practices. Miller and Horst (2005) compare Jamaicans' mobile habits with their religions practices, observing ways in which the two have become intertwined, such that many believe that the mobile's arrival in their town is itself a blessing from god. Ellwood-Clayton (2005) identifies the evolution of a cyber-enabled "folk Catholicism", in which Filipinos have taken to texting not also each other about religion, but also God himself. Agbu (2004) describes the latest supernatural rumors in Nigeria—killer phones which bring disaster on their owners if they receive calls from specific numbers. The mobile handset is both the medium for the transmission of the rumor, and the subject of the rumor itself.

Mobile use crosses the often-blurred lines between personal and economic relationships among and between developing world households. For example, Jamaicans use mobile phones, both communal and personal, to extend hybrid social and economic networks via a process called link up (Horst and Miller 2006). These link-ups can be international in scope; diasporas use mobiles to communicate with relatives back home, mixing social and economic matters, in the Philippines (Paragas 2005; Nagasaka 2007), Jamaica (Horst 2006) and Senegal (Tall 2004). Mobiles also media and re-structure mother-child relationships over distances, simultaneously improving and or perpetuating the difficult situations of mothers who work abroad, leaving their children at home (Uy-Tioco 2007).

The tactics of economic survival extend to small businesses. A couple of studies about mobile phones use among small businesses have moved beyond the 'impact' construction mentioned above, instead exploring the social and economic context in which businesses are embedded. In this construct, it is 'tactics' not 'impact' which is the organizing concept (Kamga 2006). Molony (2006) examines how small businesses in Tanzania use mobiles to manage reputation and appearance, building "virtual offices" using a mobile and a fax, but also tempers his assessment by stressing the continued importance of informal and face-to-face economic interactions. Others question how many enterprises are started (or jobs are found) as a result of the increased availability of mobiles (Miller 2006; Horst and Miller 2006).

Finally, one other set of 'daily life' studies is worth noting—those dealing specifically with the underclass and excluded. The world is not comprised entirely of road warriors (Dholakia and Zwick 2004), and as, many of the studies make clear, people working under economic constraint adopt and use mobiles in different ways. Missed-calling, described above, is one example of an adaptation and appropriation of the mobile's functionality (Donner 2007; Sey 2007). Cartier, Castells, and Qiu (2005) extend further, illustrating how a whole class of ICTs (phone cards, SMS, internet cafes, and limited-mobility 'little smart' phones) have emerged to service the needs of the 'information have-less' in China. Ethnographies

of mobile use by the urban migrant working class in China give a rare glimpse into how (still expensive) mobiles can be both an advantage and a burden to these users (Thireau and Hua 2006; Law and Peng 2005; Chu and Yang 2006; Law and Peng 2007, 2006). The theme of constraint, and the unique strategies it engenders, is the subject of a report by LIRNEasia called *Telecom Use on a Shoestring* (Zainudeen, Samarajiva, and Abeysuriya 2006), and runs throughout the Jamaica work (Miller and Horst 2005; Horst 2006; Horst and Miller 2005, 2006), in a report on rural demand for telecommunication by the consultancy Gamos (McKemey et al. 2003), and in a profile of 'non-users' in Bangladesh (Wong 2007).

Design Approaches: ICTD and Otherwise

An altogether different set of studies, places more emphasis on evaluating existing mobile communication systems or applications, or to designing new ones. Some simply document the evolution of an industry structure—in this case China's—using explicitly social-technical (Damsgaard and Gao 2005) and actor-network theory (Lee and Oh 2006) perspectives. The majority, however, focus on the interplay of social, economic, and cultural factors with existing patterns of mobile use to inform the next generation of applications and infrastructure; some of these studies have an ICTD focus, others do not. Most of these studies come from the computer science or design perspectives, rather than the traditional social sciences, but they draw on the same 'interrelationships' between technologies and people, and seek to improve them.

The cultural context/design studies focus on the usability, appeal or design of the handset and the systems running on it. For example, cross-cultural differences may require changes in the hardware itself. Language differences create particular challenges for text messaging interfaces (Lin and Sears 2005, 2007; Pornpanomchai, Batanov, and Dimmitt 2001). Others suggest that different cultural conditions will lead to different attitudes towards, and or usage patterns of, mobile handsets (Blum, Chipchase, and Lehikoinen 2005; Yan and Gu 2007), or will require different marketing approaches (Wang 2005). For example, Konkka (2003) stresses the importance of sharing and 'collectivist' approaches to the handset to Indian consumers, and also reviews the challenges of integrating "Hinglish" (Hindi and English) into the user interface. Sun (2003) argues that 'localization' for the Chinese context should account for the particular genres of messaging that are likely to emerge, while Caporael and Xie (2003) consider how PDA/calendar software is used differently by American and Chinese users. Other studies in this vein examine the tension between the mobile phones, as marketed, and traditional values in China (Yu and Ting 2003; Sun 2004, 2003; Li 2001), and the implications for m-commerce designs of different approaches to gifting money (Singh 2007).

A growing body of studies mix analyses of context, needs, and choice from an explicitly ICTD perspective. Many of these approaches focus rather narrowly on new mobile technologies and applications, developed to address needs associated with the various common sub-fields within the economic development domain (education, health, governance, livelihoods, etc). For example, researchers have developed m-learning applications which are tailored for low-income settings (Wang et al. 2005; Traxler 2007; Traxler and Leach 2006; Adesope, Olubunmi, and McCracken 2007; Ford and Botha 2007). Others propose and evaluate mobile applications in microfinance (Sathe and Desai 2006; Parikh, Ghosh, and Chavan 2003; Parikh 2006; Parikh et al. 2006); m-banking (Cracknell 2004; Ivatury 2004; Sihvonen 2006); m-commerce (Dholakia and Kshetri 2004); rural supply chain management (Javid and Parikh 2006); agricultural information systems (Islam and Grönlund 2007), and m-government (Narayan 2007). The application of mobile communication technologies in the public health domain has also begun (Kaplan 2006; Iluyemi et al. 2007), notably in the fight against HIV/AIDS in Africa (Woods et al. 2007; Lester, Gelmon, and Plummer 2006).

Many of these new applications leverage the ubiquity, customizability, and reach of mobile telephony to put communications (or processing) power into situations where PCs and traditional internet applications have been ineffective or impractical (Williams, Sweet, and Mohr 2006). However, some researchers are working outside the domains of particular development challenges, suggesting adjustments or applications of the mobile platform to address the broader context of users in developing countries, such as interfaces or dedicated applications for low-literacy/low-resource settings (Bhamidipaty and P. Deepak 2007; Parikh and Lazowska 2006; Jones and Marsden 2006); mobile social software (Kolko, Rose, and Johnson 2007); mobile web standards (Boyera 2007); digital libraries (Marsden 2003); and software to allow users to monitor their telecommunications expenditures (P. Deepak and Bhamidipaty 2007).

Studies with an ICTD focus can also focus quite broadly, using 'interrelationship' lenses to suggest reforms at the top-level institutions that shape telecommunications policy. In this broader vein, Courtright (2004) argues that established institutions like the World Bank need to account for local socio-cultural and institutional conditions when designing policies and programs to encourage rural connectivity; others call for improved analytic capacity and transparency to involve civil society in ICTD policymaking (Samarajiva and Gamage 2007), and in governance to improve disaster-warning procedures (Samarajiva 2005). Similarly, Kerrets (2005) questions the utility of outcome-only analyses, using a case study of Kenyan mobile licensing procedures to demonstrate the importance of qualitative analyses of policymaking processes, embedded in complex cultural, political, and social systems. Alhassan's (2004) work raises concerns about the interaction between communication technologies and globalization. He argues that the policy dialogue around ICTs in Ghana (particularly mobiles) is too narrow, limited to that

of 'economic fundamentalism' and neo-liberal market values, thus succumbing to a form of globalization that excludes rural communities from meaningful participation.

Shared Mobiles

It is only an accident of the shape of the review framework that perhaps the most famous image of mobile use in the developing world, Grameen's "Village Phone", appears in the review's last section. Under the Grameen model, a microentrepreneur borrows money for a special mobile phone configured for multiple-user accounts and rural access via powerful antennas. The entrepreneur purchases minutes in bulk, which she re-sells to customers in her village. She gets a livelihood, and her village gets connectivity. Grameen reports over one hundred thousand villages already served, and is now is rolling its model out beyond Bangladesh, into Uganda, Rwanda, and elsewhere. Academics have assessed the approach, not only in terms of business efficiency, scalability, and sustainability, but also in terms of gender empowerment and social transformation (Aminuzzaman 2002; Aminuzzaman, Baldersheim, and Jamil 2003; Bayes 2001). These evaluations of "shared use" contexts are good examples of the 'interrelationship' perspective, as applied to ICTD. They describe local needs and context, suggest or assess the design of a mobile-based system to meet these needs, and discuss the broad social impacts of its use. Socio-cultural factors are treated as both determinants of the design of the system, and as factors which are influenced by its introduction and use.

To meet the demand of those who cannot afford a handset of their own, other shared use systems are spreading around the world. These can range from formal, franchised phone shops (Reck and Wood 2004), mandated as part of South Africa's universal service policies, to temporary, grey-market "umbrella ladies" who offer little more than a lawn chair and a handset (Sey 2006). Skuse and Cousins (2007) explore calls made from such mobile phone shops in rural South Africa. Similar to other studies mentioned above (Souter et al. 2005; Donner 2005), they find that the majority of calls are with friends, family, and extended networks rather than for business reasons. On the one hand, the opportunity to manage these shops falls mostly to the relatively prosperous, perhaps exacerbating income divides. At the same time, the calls made by users (and the extent of their outlay on them) indicate some utility, particularly as they connect rural and urban areas. Despite recent studies (Samuel, Shah, and Hadingham 2005; Goodman 2005; Seshagiri, Aman, and Joshi 2007; Chavan 2007; Konkka 2003), the dynamics of shared phones outside of formal phone shops are not well understood (Donner 2005). Indeed, Strom's (2002) piece on the Filipino village questions the utility of the shared mobile for the rural village at all, arguing that most communication is local, and that shared phones are unreliable and frustrating.

This section has illustrated the rich range of studies employing an "interrelationship" perspective to mobile technologies and the people who use them; from ICTD projects to emergencies, to bus rides and flirtation, the mobile has already become woven into everyday life around the globe, and a myriad of initiatives are underway to further this process.

Discussion

Compared to disciplinary literature review articles, it is more difficult an interdisciplinary review to identify specific priorities for the literature, since there is not actually *one* literature. Given that the papers covered in this review range from instrumental ICTD case studies to critical analyses of the mobile's role in globalization, there is sure to be a similarly wide range of perspectives represented in future research.

Yet the variety is itself interesting. Through the (rough) application of Markus and Robey's (1988) classifications, the review illustrates how the range of current studies about mobiles in the developing world shares characteristics with research approaches to other technologies. The review identifies a secondary, orthogonal dimension where some studies have an explicitly ICTD focus while others do not; the resulting matrix of studies illustrates the range of perspectives and priorities brought to the topic by a growing and collectively interdisciplinary group of researchers.

At the broadest level, the review helps capture a picture of a still-evolving communication technology that is distinct, but by no means monolithic. It is distinct because, quite simply, it is neither a landline telephone nor a PC/internet connection. The studies show how mobiles have been adopted/experienced/appropriated (depending on one's chosen research frame) in ways that differ in significant ways from other technologies. This is not to say that we should not identify commonalities (Sandvig and Sawhney 2006)—much of the value of the mobile in the developing world is as a landline substitute—but there are times when grouping the mobile along with the landline the internet in a discussion of "new media" or "ICTs" can be counterproductive (Slater and Kwami 2005).

Nor is the mobile monolithic. As the third set of studies makes particularly clear, a variety of researchers are examining the mobile in the developing world from a perspective that includes an analysis of the mobile as a complex artifact (Fortunati 2005), with properties and significances particular to regions/cultures/populations making use of it. By organizing around themes instead of regions, this review has avoided making assertions about particular regional differences in use patterns. Yet some variation within and across regions is apparent. The review illustrates how policy, pricing, marketing, and technical and aesthetic design decisions interact with cultural, contextual, and social preferences, economic constraint, environmental factors, as well as with other communication technologies, yielding

many distinct modalities of use. Even within nations, there are broad differences visible via the 'use heuristic', particularly between prosperous urban and resource-constrained rural contexts. The acknowledgement of variation is important, because some suggest we can attribute to the mobile handset some universal/global properties which are enabling certain behaviors (particularly individualism) in the developed and developing worlds alike (Katz and Aakhus 2002). This is not a debate, but rather a matter of framing; it is possible to both attribute some universal properties to mobile use without excluding the regional and contextual variations highlighted in this review.

Implications for further research

Against this tapestry of multiple perspectives and disciplines, any recommendations for future research must be open-ended. The following are illustrative, trending towards integration across the cells in the matrix in table II.

Increase integration between ICTD and non-ICTD studies. In one of their pieces on mobile use in Jamaica, Miller and Horst remind us that "people's lives cannot be compartmentalized into separate categories such as economic, social, religious and cultural…they are all part of the same person's experience and concerns" (Miller and Horst 2005). The complexity afforded by the interrelationship approaches is particularly useful for understanding 'development impact', even if that understanding requires a much broader view of behaviors and uses. Research on the development role of mobiles will be stronger when it draws on non-ICTD research, and vice-versa, since economic constraint is a major factor structuring mobile use in the developing world. Similarly, development is not strictly economic. Studies assessing the mobile's role in health, education and governance can straddle the line between "development" and the everyday. Indeed, it might be nice if, in five years, the two-dimensional approach used to categorize studies in this review became difficult to replicate, because so many studies bridged the ICTD and non-ICTD perspectives. Current illustrations of this integrated approach are found in work by Miller and Horst in Jamaica (Miller and Horst 2005; Horst 2006; Horst and Miller 2005, 2006), by Molony (2006) with Tanzanian small businesses, and in the review by Castells et al (2007), which integrates references from the developing and developed world literatures throughout their general, global argument.

Understand linkages between rich and poor communities. With some notable exceptions (for example, (Souter et al. 2005; Molony 2006; Horst and Miller 2006; Skuse and Cousins 2007; Seshagiri, Aman, and Joshi 2007; Nagasaka 2007), there still relatively few detailed studies of rural users. This makes sense, given the way adoption has extended beyond cities only as connectivity becomes available. But by focusing on the urban, cosmopolitan, politically mobilized users in the developing world,

researchers may miss emerging and distinct patterns of mobile use—in places where a) the mobile is the only phone, b) shared models of access are important, and c) issues of economic scarcity are paramount in the decision-making about what and when to communicate. Tall (2004), for example, indicates that in one village he surveyed, virtually every mobile in the community was purchased by a family member living outside the village. Samuel, Shah and Hadingham (2005) describe how once a week, one resident of a village in Tanzania takes all seven of the village's mobiles down to a nearby town with electricity to charge all seven mobiles. Clearly, these are usage patterns quite different than what we see in London or Tokyo, or even Beijing or Manila. There remains a need, as articulated by McKemey *et. al.* (2003), to document the different needs and motivations of rural and poor users (and non-users) of mobile telephony in the developing world.

Similarly, integrating the relationships between rural and urban users into a single analysis will help reveal ways in which the mobile mediates intra-national (and international) social and economic networks. Work on link-ups in Jamaica (Horst and Miller 2005), migrants in China (Cartier, Castells, and Qiu 2005), and with rural-urban networks in South Africa (Skuse and Cousins 2007) all help illustrate the complex linkages between cities and the countryside, which are currently a critical issue for the developing world. All integrate social and economic factors into their discussions. Mobile-based telecommunication may alter these dynamics, including those around remittances and migration (Oestmann 2003).

Disaggregate the artifact. Looking both within and around the handset can yield a better understanding of the mobile as a complex technology. First, within the handset lie a myriad of features and functions, which are used/appropriated in different ways by different groups. For example, mobility is clearly an important advantage for the functioning of organized political resistance in the Philippines (Pertierra et al. 2002), for the support of Indian fishing communities (Abraham 2006; Jensen 2007) and for the creation of semi-private spaces for conversation (Pertierra 2005), But, where else? It would be helpful to delve deeper to explore how the utility of mobility compares to basic connectivity, or how texting compares to voice (Snowden 2000), or how voice compares to newer features such as mobile-internet, m-commerce, or m-banking.

Second, the technology is not just the handset. As the large body of work on the regulatory environment and diffusion patterns make clear, pricing, network features, and even signal availability have a huge impact on how mobiles are actually used (as, for example, substitutes for complements to landlines). As long as penetration remains relatively low, shared mobiles (formal and informal) will remain common

(Sey 2006). Further review of how pricing impacts user choice will uncover other emergent behaviors and implications.

Finally, mobiles do not exist in a telecommunications vacuum, even in places were landlines are scarce. In many developing-world contexts, there is a different ecosystem of communication options, of cybercafés and public phone booths, of face-to-face encounters and the ubiquitous television. Extending on the complement-or-substitute inquiries mentioned above, it would be helpful to understand mobile use as part of this distinctive and changing overall communication dynamic (Haddon and Vincent 2005). Though it is tempting to frame the spread of mobiles in the developing world using binary or absolutist terms—mobiles 'leapfrogging' landlines, or rendering PCs redundant—PCs, landlines, and mobiles (not to mention TVs) are likely to interact and co-exist with each other for a long time (Edgerton 2007). Further research should capture the nuanced interplay of these devices across various contexts in developing world.

Conclusion

As far as the technology is concerned, there are innumerable interesting topics for exploration in the developing world, where the distinct forces of cultural variability and economic constraint will enrich our understanding of mobile use for years to come. It can be difficult to be mindful of all the variability, but cultural, economic, and regulatory factors all play a role in structuring the use of a billion (or more) handsets in the developing world. The ICTD studies highlighted in this review illustrate the underlying hope that mobiles can contribute to livelihoods and well-being in resource-constrained settings. At the same time, the "daily life" studies illustrate the ways in which users in the developing world experience many of the same joys and frustrations as people elsewhere on the globe; that use of this complex, powerful device simultaneously alters and reflects the complex social ties which support societies.

At the same time, researchers will undoubtedly continue to look beyond the mobile itself, focusing on its use as a way to explore broader topics such as "development", "modernization", and "globalization". Indeed, even the experience of a single individual, such as migrant worker in China, the middle-class protester in the Philippines, or the urban microentrepreneur in Nigeria can provide insight into how mobile use reflects and structures each of these large-scale social processes. In this vein, much work remains. As mobile adoption continues to race ahead—as the next billion users join the mobile community—their choices about how and when to use the technology use will contribute to (or stall) economic development, will represent (or reframe) the meaning of modernity, and will help structure (or resist) globalization itself.

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