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Research article

Innovation and scaling of ICT for the bottom-of-the-pyramid

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Abstract

Scaling represents successful diffusion that ensures sizeable impact and earnings from information and communication technology (ICT) innovations in emerging markets. Practice can still be shaped by dualistic views – innovation *vs* diffusion, pilot *vs* scale-up, lead firm *vs* other actors, technical *vs* social. Synthesising the literature that challenges these dualities, this paper creates a systemic perspective that is particularly appropriate for scaling of ICT to bottom-of-the-pyramid (BoP) markets. That perspective is then instantiated through the case study of a successfully-scaled ICT innovation that has reached millions of poor consumers: the Kenyan m-money system, M-Pesa. It finds that scaling of this ICT system can be understood as a four-stage process of exploratory, incremental then aggressive growth, followed by (attempted) standardisation. Throughout these stages of scaling, ongoing adaptive innovations have been fundamental and have been both necessitated and shaped by the BoP context. These innovations have been more socio-technical than technical, and have emerged from a growing variety of actors and locations closer to poor consumers than the lead firm. The lead firm has buffered the unfamiliarity of BoP markets by approaching them through the 'middle-of-the-pyramid' and by intensive learning. At times, its planned 'shifts' in scaling strategy have triggered adaptive innovations. At other times, emergent innovations and learning lead to incremental 'drifts' in lead firm strategy. ICT firms wishing to scale goods and services for BoP markets must therefore recognise the multi-locational, continuous, and emergent nature of innovation, and develop processes to monitor and address those innovations.

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Introduction

There is growing interest in developing products and services that address the bottom-/base-of-the-pyramid (BoP): those 2–3 billion who are the poorest of the world's population and who have traditionally been underserved by the larger firms of the private sector (Prahalad, 2009).[1] The aim is the 'win-win' of finding new markets and new sources of growth and profit for the firm, but also facilitating socio-economic development among the poor. ICTs have very much been a part of this: a number of Prahalad's original examples were ICT-based and recent years have seen a growing interest of ICT firms in addressing this market (Simon, 2011), and a growing number of pilot projects that have experimented with ICT innovations within poor communities (e.g., Kuriyan *et al.*, 2008; Futterman and Shuman, 2010).

Alongside these accounts of pilot projects is other literature that examines the workings of ICT projects at scale in emerging markets (e.g., Bhatnagar and Singh, 2010; Leishman, 2010a). However, this has left a 'missing middle' knowledge gap around the process of scaling: an understanding of how ICT projects in these markets move from pilot to full-scale; something that many of them fail to do (Heeks, 2008). As Walsham and Sahay (2006: 17) note: 'a key problem remains the issue of scalability … the literature contains very little discussion of how to tackle this important problem'.

Within traditional discussions of scaling, there is sometimes an implicit duality that moves briskly from pilot (during which innovation is the key process, with the lead firm responsible) to scaling (during which diffusion is the key process, with other stakeholders responsible). Other literature from information systems, BoP studies, and innovation studies – discussed further in the next section – starts to move us beyond these dualities. It recognises different types and strategies of scaling. It identifies the possibility of steps within

the scaling process. Moreover, in particular, it recognises an integral relationship between scaling and innovation; particularly that scaling is necessary for ICT innovations (as objects) to have broad impact – for example, to reach a BoP market, and that ICT innovation (as an activity) is necessary for scaling to be successfully undertaken.

However, the 'missing middle' means there has so far been little detail on these processes, especially the specifics of commercial scaling of ICT systems for the BoP. We know little about the dynamics of scaling, about the particular impact of the BoP context, or about the changing relation between scaling strategy, the process of scaling, and the nature of innovation within that context. This, therefore, is the purpose of the current paper. Its aim is to provide detailed analysis of the scaling of one particular ICT innovation that was successfully targeted at BoP consumers – the case of M-Pesa in Kenya – and to understand the role played by incremental innovations during the scaling process.

Of relevance to all those with an interest in ICT innovation in emerging economies, it will be especially relevant to those concerned with ICT innovation for the BoP. It explains the different stages that can occur during ICT scaling, and the varying lead firm strategies associated with those stages. It demonstrates how locus and nature of innovation change during scaling as a necessary part of addressing the BoP market, and identifies the changing role and risks for the lead firm that arise in response to necessary growth of the network of actors involved.

This begins, in the next section, with an examination of three main areas of literature relevant to ICT innovation and scaling for the BoP. Synthesising these sources, it constructs a systemic perspective on these processes that moves beyond dualistic simplicities in relation to the process and nature of innovation, and to actors' roles and strategies. However, this systemic framework is just a construct from the literature. Hence, we use an empirical case to instantiate the framework in order to provide specific details.

We introduce this as a case from the fast-growing field of 'm-banking': the use of mobile phones to deliver financial services, often to those at the BoP who are 'unbanked'. We select M-Pesa as our case study because of its relative longevity and success in scaling. It has grown from a pilot in 2006 to a system of 15 million users in 2012 – many drawn from poor communities – with more than US$8 billion moving through the system each year.

Our 'Findings' section analyses the trajectory of this ICT innovation into five phases, describing the shift in focus from MoP to BoP, the growth of M-Pesa's 'innofusion network' that pushed the locus of innovation away from the lead firm, and subsequent lead firm developments in seeking to regain control, and also to add further functionality to the service. The 'Discussion' section analyses these phases into a four-stage model, and discusses the nature of innovation, its impact on scaling strategies, and the role and risks for the lead firm. The paper ends with conclusions that return back to the key issues about the nature and strategies for ICT scaling for BoP markets, about the nature and strategies of ICT innovation for BoP markets, and about the relationship between scaling and innovation.

Conceptualising ICT scaling and innovation

Scaling-of-innovation and innovation-for-scaling are issues of relevance to a number of areas of research literature. Here, we will particularly draw on three: information systems and the sub-area specifically interested in IS in developing countries; international development and the sub-area specifically interested in serving BoP markets;[2] and innovation studies.[3]

Especially within the first two bodies of literature, one can find three common, general messages about scaling – particularly scaling of ICT for emerging markets (Monteiro, 1998; IIRR, 2000; Franzel *et al.*, 2001; Braa *et al.*, 2004; Sahay and Walsham, 2006; Heeks, 2008):

(a) That scaling is important: it ensures greater developmental impact for innovations and brings larger revenue streams. ICT innovations typically have network effects: the greater the scale, the greater the benefits to users, but also critical mass/'chicken-and-egg' effects: they need to reach a large-enough scale to achieve scale economies, and for other users and distributors to be aware of the innovation, and to be motivated to adopt it (Mas and Radcliffe, 2010).
(b) That scaling is challenging and problematic, with cases of ICT innovations that have failed to scale in emerging markets.
(c) That research specifically focused on the topic of scaling is rare, with a significant identified knowledge gap on the issue: that being a key impetus behind this current paper.

Reiterating this last issue, work specifically on scaling of ICTs for emerging markets is lacking. More generally, research using the term 'scaling' is relatively rare, but it is arguable that 'scaling' and 'diffusion' are closely related, if not synonymous, and that we should begin investigation of scaling by drawing on work on diffusion of innovations. Before doing this, though, we clarify our own usage that (successful) scaling is a particular type of diffusion in which a new technology that has been piloted subsequently reaches a large and differentiated user group over a multi-year period.[4]

Schumpeter (1939) is often credited as the origin of the idea that innovation is a core source of economic development for both firms and societies. However, he also helped found the notion of dualities within innovation studies: in his case between invention (creation of a new idea) *vs* innovation (its application to products and processes) (Schumpeter, 1947). Some also see in his work a further – albeit implicit – distinction between these processes and 'diffusion' (spread of those products/processes), a distinction reinforced by Rogers' (1962) seminal work that largely separates out innovation processes and responsibilities from diffusion processes and responsibilities.

The dualistic perspective remains a powerful one informing both research and practice. For example, some literature on ICT scaling and on scaling for the BoP – including advisory material guiding firms – adopts a simple and dualistic model (e.g., Magnette and Lock, 2005; Qiu, 2007; Davidson and Leishman, 2010; World Bank, 2011). It divides scaling into two stages: pilot and scale-up. Piloting is associated with innovation, scale-up with diffusion. Roles are clearly differentiated: the lead firm is responsible for innovation, other stakeholders are not.

As we will argue below, other literature already exists to challenge each of these dualisms but the investigative analysis of what exactly should be put in their place has been very limited, particularly when considering the scaling of ICT innovations for emerging markets such as the BoP.

Our investigative contribution therefore has two parts. First, in the remainder of this section, we use existing – albeit disparate – literature to build a more nuanced model of scaling ICT innovation for emerging markets, discussed in terms of four components: processes, roles and relations, the nature of innovation, and organisational strategy.[5] Second, we apply and assess that model in light of a real-world case study.

Processes

At its bluntest, there is an assumption that scaling and innovation as processes are separate (Smits *et al.*, 2007). It is the pilot stage during which innovation occurs, delivering an artefact that is subsequently scaled through a process of diffusion (Hartmann and Linn, 2008). That this assumption is often false has been demonstrated generally. For example, later editions of Rogers' (2003: 115) key work note the belated recognition that 're-invention' occurs during diffusion as technologies are 'modified to suit the individual's particular situation'.[6]

This is especially likely to be needed when delivering ICT to BoP markets. One characteristic of this particular context is the significant 'distance' in many senses between the designers of new ICT systems and those in poor communities in developing countries, leading to a poor fit between initial designs and contexts of use (Heeks, 2002). A second characteristic is the heterogeneity of consumer groups within these markets, so that a design for one group may not fit the needs and context of other groups (Nakata and Weidner, 2012; Prahalad, 2012)

Both characteristics create an imperative for innovations – what drawing on information systems studies we may call 'adaptation', 'improvisation', or 'bricolage' (e.g., Ciborra, 1999; Tjornehoj and Mathiassen, 2010) – which address specific local resource availabilities, ICT capabilities, working practices, culture, and so on (Jacucci *et al.*, 2006).

In part from this also emerges the notion that scaling is not a monolithic activity. Rogers' (2003) S-curve of diffusion gives a hint of this, and there are examples from work on information systems in developing countries that demonstrate that scaling is not a uniform, homogenised process and may consist of steps or phases (e.g., Braa *et al.*, 2004; Sahay and Walsham, 2006). However, there is little sense of what those steps or phases might be.

Roles and relations

Because of the need to bridge the distance, noted above, between innovators and consumers when serving BoP markets, there is work that challenges the dualistic view that the lead firm will take sole responsibility for innovation. For example, during the pilot phase or the early stages of scaling, there may be 'co-invention' in which the lead firm engages in partnership with local stakeholders in a process of learning and modification (i.e., in a process of innovation) that creates a new product or service (London and Hart, 2004).

This literature also highlights the importance of partnerships and networks during the later stages of scaling. For example, most models of scaling innovations for the BoP recognise the role of a network of agents who take responsibility for close and often interpersonal interactions with the end users of the innovation (Anderson and Kupp, 2008; Ramani *et al.*, 2012). However, those agents are generally seen as passive distributors of the product or service: a channel rather than an actor, and without responsibilities for innovation.

The insufficiency of such a view is readily recognised, with evidence from the scaling of ICT systems that agents are active innovators (Sahay and Walsham, 2006). This has, indeed, been recognised in some of the more recent BoP literature though without, as yet, a detailed analysis of the nature of innovations undertaken by these lower-level actors (e.g., Simanis and Hart, 2009).

For the BoP, such analysis would need to move beyond the shared innovation models found in some co-invention/co-creation literature and practice, which finds lead firms working with just a few key partner innovators (Dahan *et al.*, 2010; Kolk *et al.*, 2010; Sarker *et al.*, 2012). Agents are so multitudinous – forming the 'atomised distribution' model essential to serving BoP markets (Nakata and Weidner, 2012) – that an innovation network rather than innovation partnership will need to be envisaged.

This is a view consistent with 'systems of innovation' models and literature. These see innovation as deriving from the interactive behaviour of multiple distributed actors – lead firms, distributors, users, policy makers, and others – who are all connected (Freeman, 1995). Such system approaches have been applied in emerging markets (Lundvall *et al.*, 2009a; Lundvall and Intarakumnerd, 2006). In such settings, innovation systems tend to be less well defined and formally outlined than might be the case in developed countries. Innovation in lower-income contexts is conceptualised as emerging from the 'doing, using and interacting' of a loose constellation of actors, interacting in evolving – sometimes informal and interpersonal – relationships (Lundvall *et al.*, 2009b).[7]

We should thus utilise the idea of a relatively fluid innovation system in understanding ICT innovation for BoP markets. However, the term 'innovation system' can still create the mistaken impression of a separation between this network of actors and the process of scaling that leads to wide diffusion and adoption of the ICT system. We therefore draw on Fleck's (1993) resolution to this issue, which is the neologism 'innofusion', used to recognise the continuity of innovation during the diffusion (e.g., scaling) of a technology. We will also use the term 'network' rather than 'system' to avoid confusion with discussion of the ICT system.[8]

The nature of innovation

Traditional views have associated innovation with technical change that produces new or modified artefacts (Antonelli, 2007). Separately, diffusion of new technologies was also seen to require innovation (though not explicitly using this label) of business processes and structures, for example, those associated with sales and marketing (Rogers, 2003). This type of social innovation has been given particular weight in relation to serving BoP markets, seen as requiring new business practices (Mair and Schoen, 2007; Pitta *et al.*, 2008).

However, this latter advice has often run ahead of reality. Thus, large ICT firms with interests in the BoP have been criticised for focusing only on technical innovation and for ignoring what are argued to be the more important innovations around distribution, service delivery, and so on (Anderson and Kupp, 2008). This might derive from their technical perspective on ICT, which would see the ICT as an artefact that was separable from its designers, implementers, users, and their activities and context.

This is the 'tool view' of information systems, which has been challenged by the 'ensemble view' (Orlikowski and Iacono, 2001). The latter sees an ICT system as a socio-technical network of technology, people, processes, organisational arrangements, and so on. From this, we can see that the innovations necessary to scale-up an ICT system will not just be technical change or even separately-considered technical and social changes. Instead, a systemic view is needed that encompasses socio-technical changes that may be required to any one of the ensemble of components that make up the full system (Sahay and Walsham, 2006).[9]

Organisational strategy

Within the BoP literature, there is a strong emphasis on recommendations for business. Some of these are quite specific management prescriptions; some are lists of enabling or constraining factors to be taken into account, but there is also discussion of business strategy: normally interpreted as the high-level, centralised decisions and direction that the lead firm is advised to adopt.

One aspect of this is market focus, with emerging markets separated into middle-of-the-pyramid (MoP) and BoP.[10] Firms that have been serving high-income markets are seen to require radically different strategies and business models in order to serve the BoP (Anderson and Kupp, 2008). By contrast, the MoP is seen to necessitate only incremental adaptation of existing business models. Therefore, firms may choose an MoP focus because they find the disruptive innovations and business models necessary to serve the BoP are beyond their present capabilities of skill, knowledge, business structure, and so on (London and Hart, 2004). However, they may also find the BoP to be 'beyond' their business interests – large ICT firms sometimes appear equivocal about opening up the BoP market, seeing it more as a threat to existing custom than as an opportunity (Anderson and Kupp, 2008; Prahalad, 2009).

Those firms that do choose to target the BoP might adopt one of the two scaling strategies (London, 2009). In the learning-oriented model, firms work at scale but are less driven by profitability. Instead, their aim is to work with local partners, testing elements of their BoP business model, and learning from the partners. In the growth-oriented model, the firm's prime goal is to generate profits from enacting a fully-formed, new BoP business model, albeit one in which external partnerships are still vital.

However, this view on organisational strategy is rather compartmentalised and static. In practice, we see there is the possibility for transition. This could be a transition from serving the MoP to serving the BoP (Anderson, 2008). However, it could also be the reverse, with ICT firms abandoning scaled innovations for the BoP and 'retreating' to MoP markets if net income falls (Qiu, 2007).

The view also sees strategy as something planned, top-down, and within the control of the lead firm. Yet that runs counter to the picture of ICT scaling for BoP markets outlined above (IIRR, 2000; Sahay and Walsham, 2006). As an ICT system scales, the innovations necessary for that scaling will create a continuously-changing context for the lead firm. That ICT system will grow not just in size, but also in complexity, creating unanticipated effects. And the growing complexity of the innofusion network will create increasing and more varied loci at which innovation may occur. This is especially likely when scaling for the BoP, given the necessary devolution of responsibilities to 'frontline' actors (Prahalad, 2009).

This means any intentional 'shifts' in strategy from the lead firm may be rejected, adapted, or subverted by other actors within the innofusion network (Edquist, 1997). It also means there will be pressure on strategy to react to the emergent innovations that arise from outside the lead firm. These, too, may be rejected or adapted but – if successful – they will lead to 'drifts' in strategy: emergent and reactive changes during the process of scaling. One can speculate that such drifts may increase as scaling for the BoP takes place, and as the number of non-lead-firm actors increases. Any initial notion of a one-way 'broadcast' of strategy may therefore give way to a more complex two-way or multi-way flow and formation of strategy.

Summary

Dualistic perspectives have been a traditional foundation in the conceptualisation of innovation, of scaling, of ICT systems, and of serving BoP markets. Those conceptualisations are our starting point because they still shape the actions of firms delivering ICT to these markets.

Yet, more recent literature has emerged – from information systems, from BoP studies, and from innovation studies – challenging the dualisms and producing a more complex, systemic view. That latter view can be constructed into a whole from the strands of literature reviewed above, as summarised in Table 1 and Figure 1. However, this is just a construction, a generic and abstract perspective built from different fractions of research literature but within which the specifics – the actual phases of scaling, the nature of and responsibility for innovations during scaling, the exact relation between scaling and innovation, and so on – have yet to be properly instantiated and understood.

Table 1 From a dualistic to systemic perspective on scaling ICT for the BoP

	Traditional, dualistic view	*Developed, systemic view*
Process	Innovation *vs* diffusion (scaling)	'Innofusion'
Stages	Pilot *vs* scale-up	Multiple phases
Roles	Lead firm innovator *vs* other actor diffusers	Distributed network (system) of innovators
Relations	One-way	Two-/multi-way
Nature of innovation	Technical *vs* social	Socio-technical
Organisational strategy	Planned (*vs* emergent)	Planned and emergent over time (shifts and drifts)
Strategic focus	Static: (MoP *vs* BoP; learning *vs* growth)	Dynamic, transitional

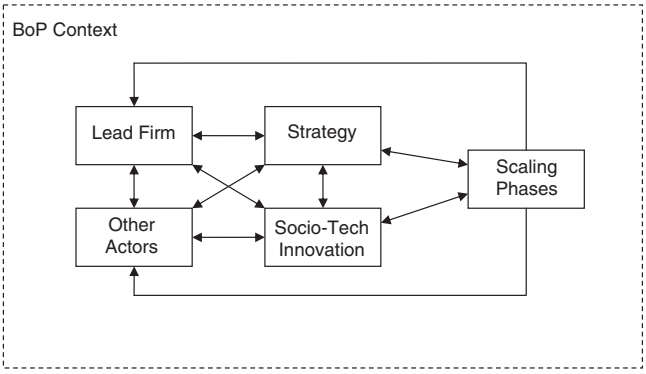

Figure 1 Scaling ICT for the BoP.

This can be viewed as a general reframing of technology diffusion. However, the framework seems especially pertinent to our focus – scaling of ICT into BoP markets – because of features identified above: the heterogeneity of BoP markets, their distance from conventional sites of technical innovation, and their atomised distribution networks relying on interpersonal communication; and the socio-technical nature of ICT systems. In the remainder of this paper, we will investigate a real-world case study of ICT scaling for BoP markets in order to assess the relevance of this framework and to provide more concrete details about elements that have to date mainly been hypothesised.

Investigating ICT scaling and innovation

Case selection

We decided to select an 'm-banking' case study; that is, one seeking to make use of mobile phones to enable financial transactions and services of the type typically provided by a bank. Across the developing world, 'An estimated 2.5 billion adults lack access to basic formal financial services' (Mas and Radcliffe, 2010: 1). Given that many of these 'unbanked' people do have access to a mobile phone, m-banking is seen as a compelling innovation for the BoP that can help the poor have greater, safer access to finance, credit, and savings (Duncombe and Boateng, 2009). More generally, m-banking is in demand in emerging markets as consumers want quick, easy access to financial services while on the move.

There is a pressing need to understand the scaling of m-banking because so many initiatives have been – and are being – launched across the developing world.[11] Yet, the main focus for m-banking research has been identification of financial needs and of effective technical and organisational and regulatory designs, mapping user adoption patterns, and assessing impact (*ibid*). Little, if any, research has specifically analysed the scaling process of this ICT innovation. Within the m-banking literature, there are echoes of some of the points raised above – the need to scale, and the importance of agents and lead firm strategy (e.g., Davidson and Leishman, 2010; Mas and Radcliffe, 2010). However, in other echoes, there are dualistic assumptions about pilot and scale-up that characterise lead firms as innovators and agents as diffusers (Leishman, 2010b; Flaming *et al.*, 2011).

Our selection of m-banking scaling therefore addresses an issue identified as important but also as lacking research, which can illustrate innovation and scaling. In order to operationalise this, we selected the case of M-Pesa, an m-money service in Kenya.[12] M-Pesa provides a well-documented example of an already-scaled ICT innovation. From initial rollout in 2007, it has rapidly grown to 15 million customers with full national coverage in 2012 (Safaricom, 2012c)[13]. It has successfully scaled to less-affluent groups, with considerable reach into the BoP (Jack and Suri, 2010). It is therefore an appropriate choice to help instantiate the constructs developed in the previous section.

Case outline

M-Pesa is a fully-licensed mobile money service run by Kenya's leading mobile operator Safaricom with two core functionalities: conversion and transfer. Customers register to set up an M-Pesa account. They can then *convert* between e-cash and real cash: depositing real cash to load their M-Pesa account or withdrawing cash from their account. Registration and conversion services are typically provided by mobile-money 'agents': independently-owned but officially-sanctioned kiosks or stores. Agents charge small commissions on all transactions undertaken with them, and their work is facilitated by specialised SIM cards that are loaded into their phones. As of mid-2012, M-Pesa had around 37,000 agents in Kenya (Safaricom, 2012c). M-Pesa customers can also *transfer* e-cash from their account to another by sending an SMS containing the recipient's mobile number (which is also their M-Pesa account ID) and the amount, again, with a small charge levied. They might use this to send money to family members or friends, or to pay a provider – anyone from a taxi driver to a local school – for goods and services.

On the policy side, the service is overseen by the Central Bank of Kenya, as a 'non-banking financial service'. This means that although it is not subject to the tight regulatory oversight of banks, the financial nature of the business leads to some central oversight (AFI, 2010).[14]

Methods

In order to analyse this case, we principally utilise a qualitative approach based on primary and secondary data. We draw on interviews with actors within the innofusion network, that is, those involved in the scaling (diffusion and operation) of M-Pesa, who also undertake innovations to assist the scaling process. We also take advantage of the growing secondary evidence available to examine the history and performance of this ICT innovation.

In terms of primary data, 45 interviews were undertaken from February to May 2011 with a number of actors directly related to M-Pesa: service operation managers (2), operational employees (18), dealers (5), agents (14), and other system actors including competitors (6). The focus for the interviews was to understand the diffusion and operation of M-Pesa that underpinned scaling, and particularly to understand the actors' role in ongoing processes of innovation. Given the interest in ICT innovation for poor consumers, there was a focus on stakeholders operating in areas frequented by more marginal groups. These included informal trading centres and markets close to slum areas around the capital Nairobi. Semi-structured interviews were conducted in the place of work, with questions revolving around innovation and the histories of these actors. Typically, interviews lasted for around 1 h, and

there was also time to observe actor practices. In addition, a further nine interviews were undertaken with policy makers and contractors previously involved with the service in order to triangulate data sources and cross-check findings.

Given the longitudinal perspective required when studying the scaling of a technology, at least equal weight as a source of data was given to the extensive documentation that is available on M-Pesa. In particular, we have drawn upon existing research and also reports, proposals, a patent, and publicly-available statistics. Both primary and secondary data are used together in the account of scaling and innovation that follows, the one set triangulating with the other.

Findings

Analysis of data suggests that the scaling of M-Pesa can be analysed into five phases. The phases do not – as Figure 2 might suggest – have instantaneous start and end points, but they can be differentiated on the basis of three main elements: the content and focus of lead firm strategic actions; the structural relations of key stakeholders involved in the initiative's network; and statistical indicators of scale (Figure 2 shows percentage of Safaricom revenue from M-Pesa and monthly growth in local agents).

From initial concept in late 2003, M-Pesa began as a *pilot*, mainly focussing on ICT support for micro-finance initiatives. Following the pilot, the direction changed and early *incremental rollout* can be seen associated with a MoP strategy, using a network of existing partners and incremental change. From early 2008, M-Pesa moved to more *aggressive growth*, as the innofusion network grew and increasing loci of innovation emerged in the network, resulting in some strategic 'drift'. Around the start of 2010, M-Pesa began to make up more than 10% of total revenue for Safaricom, and the initiative was embraced as a driver of firm growth. *Standardisation* can be seen as an attempt to re-establish more control on the drifting innofusion network. In the fifth phase of *functional expansion*, M-Pesa looked to grow by changing strategy: adding new services and integrating M-Pesa into wider financial networks in Kenya. These phases will now be investigated in further detail.

Pilot

The innovation that would later become M-Pesa emerged as part of a 3-year donor-funded research project entitled 'mobile micro-finance'. The project was launched as a joint venture between the Vodafone Group and the UK aid agency DFID's Financial Deepening Challenge Fund. Its aim was to examine the identified growing potential of ICT solutions to assist micro-finance – the provision of small loans to allow poor groups to invest in their livelihoods – in developing countries.

Vodafone Group's (2007) patent that emerged in the early (research) stages of this pilot outlines an account management system for micro-finance institutions (MFIs), where the later core person-to-person (P2P) mobile transfers and agents were just one element of a wider system. However, by the time the pilot was completed, the focus and goals had changed quite dramatically. This can be connected to user trials of the micro-finance system, led by Kenyan mobile operator Safaricom (a subsidiary of Vodafone Group) together with a large MFI, Faulu Kenya (with key actors summarised in Figure 3).

In the first instance, the adoption of the pilot system within the MFI was unsuccessful. System use had detrimental effects through reduced attendance at MFI meetings (Hughes and Lonie, 2007), and integration of the account management system was described as 'not completed in the pilot and resulted in *[the MFI]* effectively running two record keeping systems' (FDCF, 2006: 4).

Alongside this main ICT innovation that largely failed during the pilot, emergent innovative activity took place among customers.[15] The pilot designers were instrumental in supporting this emergent activity by ensuring that pilot activity was tracked (*ibid*), and by allowing emergence to occur both in the technology (for example, by enabling non-MFI P2P transfers) and in wider deployment (for example, by not punishing unexpected uses of the system) (Hughes and Lonie, 2007).

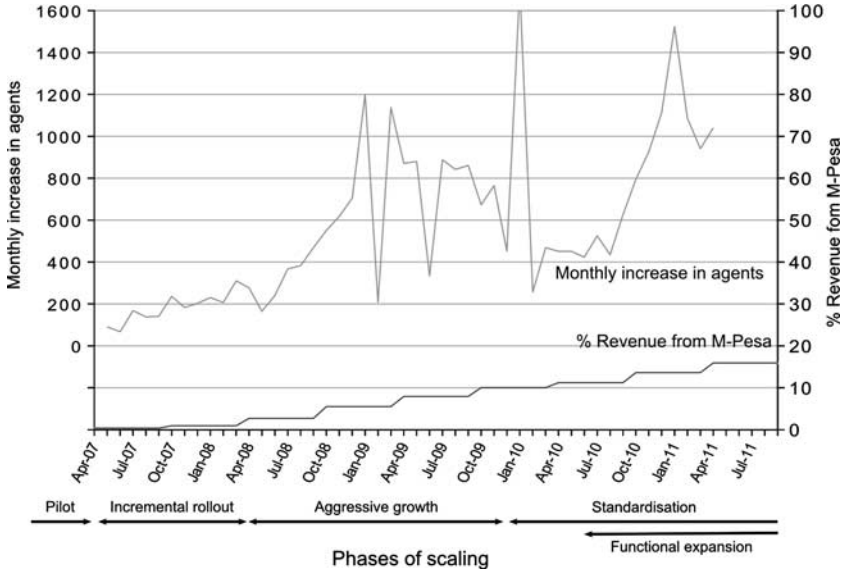

Figure 2 Scaling phases of M-Pesa.
Authors' calculations adapted from Safaricom (2011); Safaricom (2012a).[27]

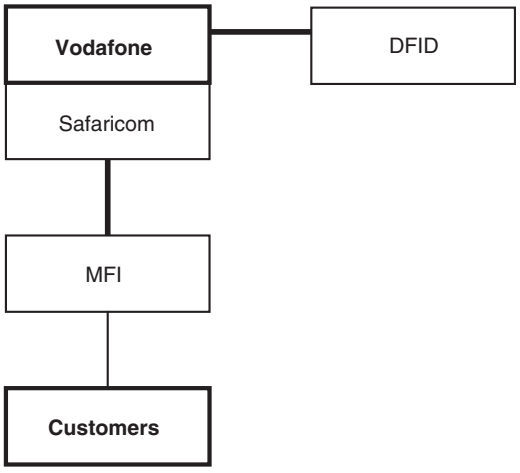

Figure 3 Innofusion network during pilot phase.
Key: Actors in bold are key drivers of innovation; bold lines represent new relations.

It was these two outcomes that resulted in the repositioning of the project towards the form of M-Pesa as it is seen at present. On one hand, MFI resistance suggested that 'a mass market launch with an MFI would be too complex' (*ibid*: 77), whereas on the other hand, the innovation was increasingly being used in interesting, but unexpected ways for so-called 'non essential transactions', suggesting potential new directions (FDCF, 2006).

Incremental rollout (2007–mid-2008)

Given the results of the trial, scaling began with a different-than-originally-intended proposition. Safaricom became the sole lead actor, positioning the product under the 'send money home' slogan and pushing P2P remittances through mobile e-cash transfer, particularly longer-distance remittances between urban and rural areas.

In this phase, strategy focussed towards the MoP that lived in urban areas and already owned phones (see Figure 4). The 400 initial partners (agents) came from Safaricom's existing partner network. Typically, they were airtime distributors ('dealers') with each dealership having multiple stores serving established urban markets, each of which could become an M-Pesa agent. During this phase, M-Pesa customers were not the poorest – they had higher-than-average incomes and rated higher-than-average on other indicators. For instance, results from a sample survey during the first year of M-Pesa found that:

> M-PESA users have typically completed a higher [than average] level of education: for example, 46 percent of users have completed secondary school, and 10 percent have a university degree.
>
> (Jack and Suri, 2009: 13)

Given the changed strategy, both the M-Pesa system and actors (see Figure 5) were reconfigured following the pilot. In the new approach, conversion activities – deposits and withdrawals – became more central to the service than had initially been anticipated. Agents therefore also took on a more central role, expected to deal with higher volumes of cash and e-cash. However, this led to increasing risks related to depleting their cash or e-cash floats during service. The logical reconfiguration to mitigate this risk was to allow so-called 'float management', where dealers were allowed to move cash and e-cash between agents within their dealerships to avoid depletion of float (FDCF, 2006; Hughes and Lonie, 2007). Meanwhile, M-Pesa's growth from pilot meant regulatory requirements came into play. Meeting these included product changes to ensure that M-Pesa conformed to legal and anti-money laundering (AML) rules on agencies with multiple employees, such as software changes on the agent SIM cards to ensure better AML audit trails (Hughes and Lonie, 2007; AFI, 2010).

As scaling began, there were a number of other mismatches between the initial design and the reality of actual use. This occurred at the customer level, such as unanticipated high use of M-Pesa balance checks that resulted in significant network traffic. It also occurred at the agent level. One example given by interviewed agents concerned poor logbook design. The design revealed to customers the amount of cash float held, presenting an unanticipated security risk that led some agencies to be robbed after thieves had checked the logbook to find when float levels were high.

Adaptations were needed during this phase to iron out these problems. In some cases, this came directly from minor service changes initiated by Safaricom such as increasing the cost of balance checks (Mas and Morawczynski, 2009). In others, it came from the other actors within the broader innofusion network. In the logbook case, agents explained that they developed a tactic to hide the incriminating details in the logbook, and interviews confirmed this later became standardised by Safaricom. The firm also reduced agent payments for registration when it found they were focusing too much on this to the detriment of their conversion activities.

This phase, therefore, involved a lot of innovation, much of it driven by Safaricom, as the lead firm. There were some minor changes to the 'technology' of M-Pesa in its widest sense – that is, encompassing the organisational arrangements and procedures that are necessary for the physical artefacts to diffuse and operate, and virtual transfers to occur – but these did not influence the main scaling strategy to drift from its main focus.

Aggressive growth (2008–start 2010)

As reflected in monthly change in numbers of agents (Figure 2), M-Pesa was growing from mid-2007, but then began to grow much more rapidly from early-to-mid-2008. During this aggressive growth phase, as supported by Jack and Suri's (2010: 4) update on their sample survey, M-Pesa moved towards a more intensive focus on BoP users.

> The earliest MPESA users were the wealthiest and most educated, but over time, it is being adopted by people of more varied socioeconomic levels.

This change emerged from the push of lower-income user awareness because of service growth and high-spend marketing campaigns (Mas and Radcliffe, 2010; see Figure 6), and the pull of widespread insecurity that arose in Kenya following election-related violence that began in December 2007.

M-Pesa was not only able to continue to run during this period of tension, but evidence suggests that for some users, M-Pesa transfers provided a vital financial lifeline

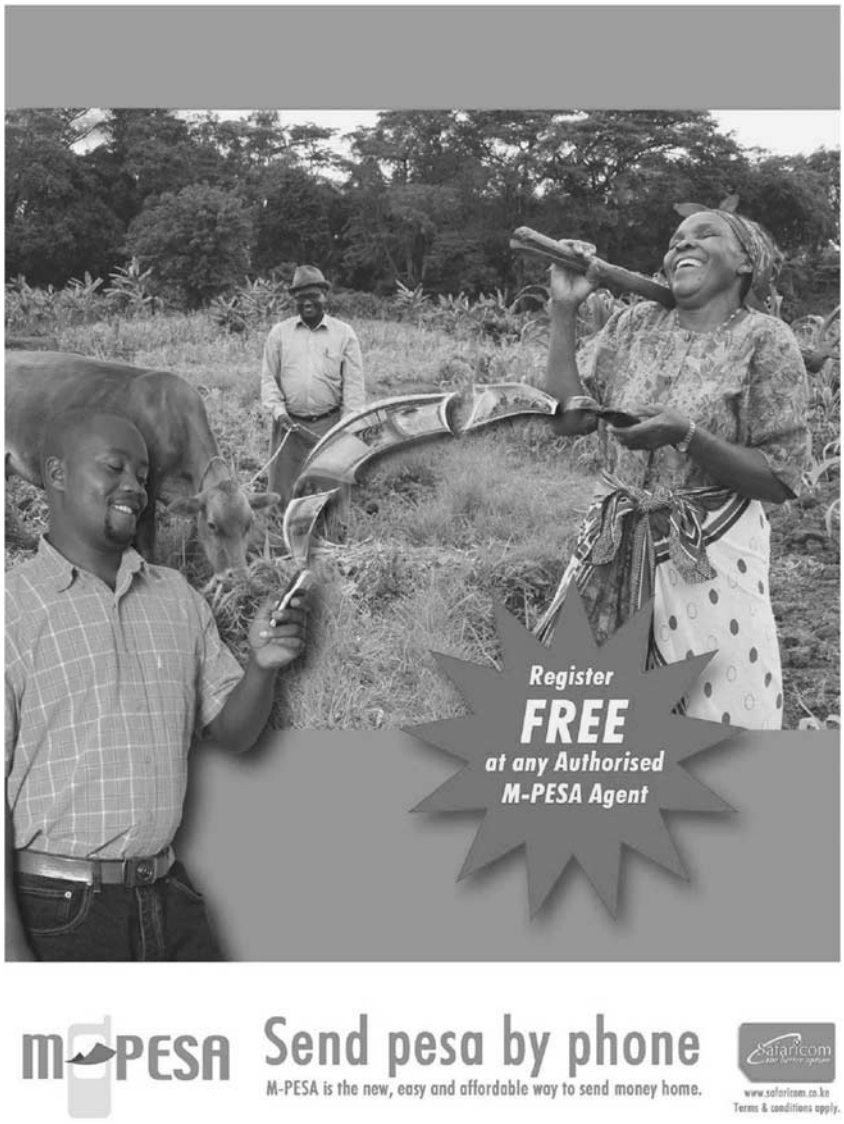

Figure 4 Original 'send money home' marketing of M-Pesa.
An MoP approach, with a well-to-do urbanite transferring e-cash to his rural family.

(Morawczynski and Pickens, 2009; Morawczynski, 2010). While it might be inappropriate to attach a significant national relief role to the presence of the service, the crisis did increase the salience of the marketing campaign. It built awareness of M-Pesa within poorer groups and built a reputation for the service, with stories of its value widely circulating. During 2008, Safaricom managers therefore found the firm's scale-up strategy interacting with rapidly-growing demand. Even as the political crisis settled down in late 2008, Safaricom continued its aggressive growth (Flaming *et al.*, 2011) as competition emerged from the second mobile operator introducing their own mobile money service (Zap), which in its early months seemed like a genuine competitor to M-Pesa (Mas and Morawczynski, 2009).[16]

Safaricom's strategy was growth (though it had not anticipated growing quite so fast). Yet, it was also having to learn and change as growth necessitated working with unconventional partners more closely embedded in poor localities.

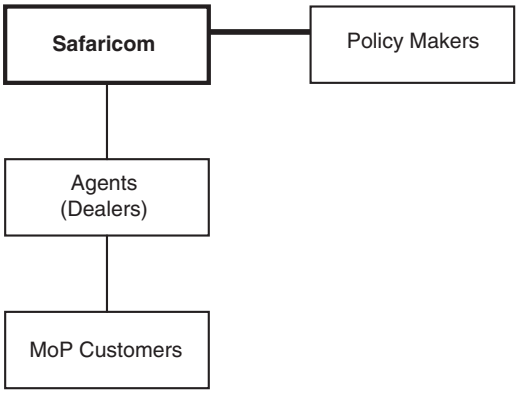

Figure 5 Innofusion network during incremental rollout phase.
Key: Actors in bold are key drivers of innovation; bold lines represent new relations.

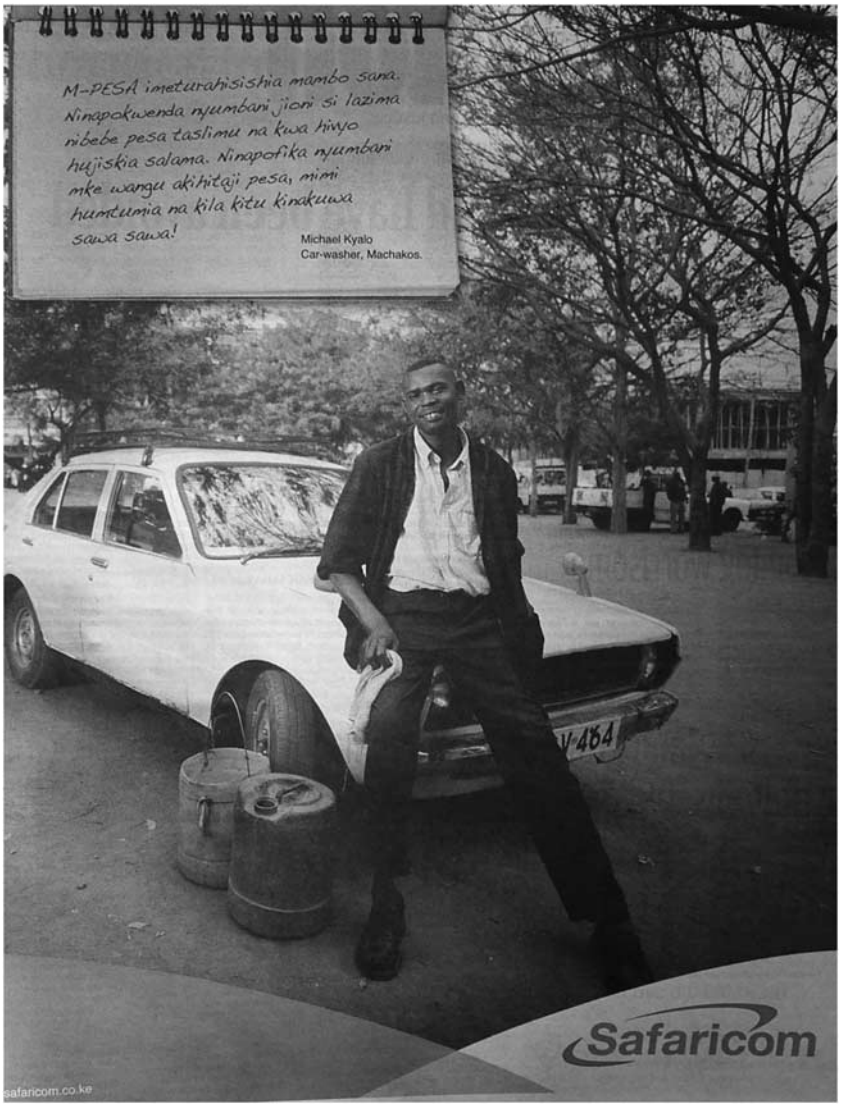

Figure 6 BoP-focused marketing of M-Pesa.
An informal car washer in urban Machakos describes (in Kiswahili) using M-Pesa to send money locally and also the value of the service in keeping money safe when he travels.

Working with these new partners was very much a process of learning and during this phase there was much service delivery innovation (as opposed to innovation of the product itself) related to best configuring the M-Pesa value network for efficient BoP delivery and growth.

The main driver was the addition of new actors into the innofusion network through the so-called sub-agent model. This was initiated by dealers (and increasingly over time many other successful agents) who began to sub-contract M-Pesa agent duties to new entrepreneurs from outside Safaricom's list of existing contacts. As described by one of the early implementers of the project, this allowed increased reach.[17]

> The only suitable outlets to become M-PESA agents are often small family-run stores … it is not commercially feasible for M-PESA to have a direct business relationship with thousands of 'Mom-and-Pop' shops across Kenya.
> (Lonie, 2010: 2)

Interviews and indicators (see Figure 7) suggest high potential earnings for agents in this phase, meaning that smaller entrepreneurs – often located in urban slum-area kiosks or small stores in rural areas – could be financially viable as M-Pesa agents. With Safaricom struggling to keep up with the pace of growth (Davidson and Leishman, 2010), the sub-agent model emerged directly from dealers, acting as an intermediary to sub-agents to help them meet the tough regulatory requirements for agents, and in provision of float management. In exchange, the dealers took a cut of the sub-agent commission (usually 30%)[18] (Flaming *et al.*, 2011).

By 2009, more than 300 dealers and others had become 'master agents', supervising anywhere from a couple up to a hundred or more sub-agents. An example of the effectiveness of this approach in reaching poorer consumers is illustrated in an interview with a master agent, Mary, who had 15 sub-agents. Mary initially ran a small store in the main trading street of a large slum area but took the risk and became an

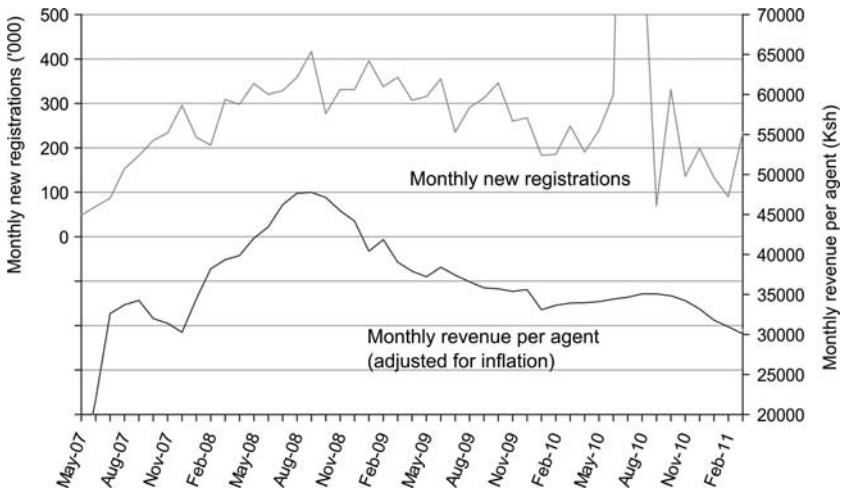

Figure 7 Revenue and registrations at M-Pesa agents.
Authors' calculations drawn from Safaricom (2011), KNBS (2012), Safaricom (2012a).[28]

M-Pesa agent. As interest grew in using the service in the slum, she first added two additional stores herself, but key expansion came during the aggressive growth phase when the sub-agent model allowed her to invest without having to deal with operational issues of each new store:

> You effectively sit back and still get the 30% per month without having to get involved in the daily problems.

The 15 other entrepreneurs – typically for sub-agents – were smaller stores mainly located in more remote, less-affluent parts of the same slum area[19] such that, through this model, the M-Pesa service penetrated to within a short walking distance of even the poorest of slum dwellers.[20]

Service delivery innovation during this phase was being driven by both the master agent and sub-agents. Master agents created the sub-agent model and played a buffering role, lowering risk for agents to operate profitably and independently in ever poorer and more uncertain environments. The sub-agents' innovations were less conspicuous, related to reaching new markets, and pushing the ICT service towards poor consumers. During interviews with such sub-agents, one could see how over time they had been able to innovatively adapt service delivery to these environments. For example, agent Catherine was located in an informal manufacturing area of Nairobi. Over time, she built reciprocal relations with local traders enabling her to use them as 'float balancers' by exchanging cash when her float levels were too low or too high, and thus avoiding risky, time-consuming trips to a master agent or bank.

This was typical of the subtle process innovations interviewees revealed – not just local tactics to get around float problems (e.g., in building informal relations with other sources of finance in more isolated areas in order to maintain a cash float and so ensure conversion service availability), but also by connecting service uses to particular local needs (safety or savings or transfers); through tactics to improve security in high-risk areas, thus allowing service to be maintained where otherwise it might be withdrawn; and via small service adaptations for particular local needs (e.g., varying opening hours according to needs, or varying ID requirements for registration).

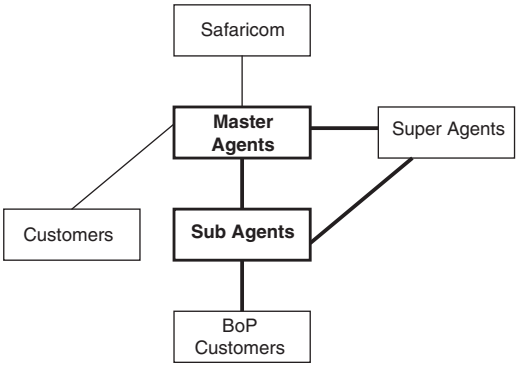

Figure 8 Innofusion network during aggressive growth phase.
Key: actors in bold are key drivers of innovation; bold lines represent new relations.

Thus in this phase, the locus of innovation moved towards the lower levels of the innofusion network in the form of master and sub-agents making BoP-relevant adaptations, with sub-agents being embedded in BoP locations and relations. Yet Safaricom still played an important role. First, by allowing this multiplicity of service innovations to occur, and second, in providing the 'scaffold' that helped service innovations become more viable. One example related to float management, mentioned previously.

Float management was initially imagined to occur between geographically-close agents within small dealerships. However, the emerging sub-agent model resulted in increasingly large and scattered networks of agents with float management becoming a challenge. Notwithstanding the local adaptations noted above, master agents reported spending ever-more time transporting money for their sub-agencies. In time, Safaricom responded to this in their strategy, through 'scaffolding' to support float management for the sub-agent model. It created a new role: the 'super agent' (see network summary in Figure 8). These were typically banks that allowed isolated agents to undertake float management more easily via their local bank branches.[21]

In sum, this phase started with an intentional shift in strategy by the lead firm – to push its new ICT system as far

and quickly as possible to a BoP audience. However, making that happen required adaptive innovations to the organisational arrangements and procedures that enabled M-Pesa to operate. The locus of those innovations was much closer to the 'front-line' of the BoP: among those delivering the service to end users. In turn, though, those emergent innovations drove growth and caused Safaricom's own strategy to drift a little as it responded to those innovations.

Standardisation (start 2010–2011)

A new phase can be seen to begin in January 2010 when Safaricom announced its 'aggregator model'. This can be taken as a turning point where Safaricom sought to bring the main locus of innovation back under its own control. It was prompted by M-Pesa's continuing expansion and its increasing articulation in Safaricom as an innovation at the heart of the firm's future revenue growth, with value-added service delivery to the BoP now a core, accepted part of the firm's overall portfolio (see Safaricom, 2012a).

In M-Pesa manager interviews, this shift in strategy was also linked to concerns that the sub-agent model was becoming problematic in terms of management and control, with one stating:

> There are many problems, such as sharing of commissions. HQ [master agents] determines the level of commission for its sub-agents but sub-agents have no idea what they are owed ….Some agents are also moving their tills around the country without permission.

Some master agents were seen as increasingly unreliable and unprofessional, and growing complaints about poor quality of sub-agents were seen to stem from poor training and selection by master agents (i.e., sub-agents not being able to manage float properly; sub-agents not being able to effectively handle all aspects of the service; and sub-agents being susceptible to security problems such as thefts and scams).

The changes took the learning of the previous phase – where the push for growth had led to a rather chaotic proliferation of actors and innovations – and applied that learning to allow more management control over the service. For Safaricom, the innofusion network spawned by aggressive growth was now too complex. In the new aggregator model, M-Pesa would continue to work in a hierarchical structure, but the master-and-sub-agent model was ended. The number of top-level agents was reduced from hundreds previously to just 8–10 (now renamed aggregators), each responsible for 2000–4000 agents (Mas and Ng'weno, 2010). The intention – as indicated by Safaricom interviews – was that the new class of aggregators would take increasing and devolved professional responsibility for selection, training, and quality monitoring of the agents.

However, during research, it was unclear how fully the aggregator system had been implemented. According to M-Pesa managers, the change was supposed to take 6–8 months, but sub-agent field interviews – 18 months later – indicated the process was still ongoing, with some interviewees unaware of the new model. While some agents had migrated to a new model, many smaller agents still existed as sub-agents, suggesting the two models were uneasily existing in parallel, as shown in Figure 9.

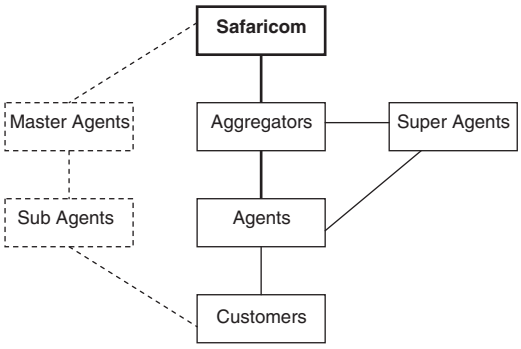

Figure 9 Innofusion network during standardisation phase.
Key: actors in bold are key drivers of innovation; bold lines represent new relations; dotted lines represent non-standardised components.

Interview and other field data suggested the slow progress of standardisation resulted from the conflicting interests of the former master agents, particularly those who had built networks of micro-franchised sub-agents and stood to lose significant amounts of sub-agent commission that would potentially migrate to the new aggregators. As one commented:

> … we don't have much say with them [Safaricom] … dealers are feeling demoralised. There is room for someone to come up with an alternative and maybe dealers would take them up.

At the time of research, the master agents seemed to have enough leverage to resist (or at least foot-drag on) these changes. This particularly related to their relationship building with sub-agents that occurred in previous phases, through reciprocities such as loans of money, staff, equipment, and other ongoing aid (Flaming *et al.*, 2011). Indeed, interviewed sub-agents, particularly smaller sub-agents in poorer areas, felt they would struggle to meet the financial requirements of the aggregator model and questioned whether they would be able to 'go it alone' without the buffering of, and close relationships to, master agents.

In sum, this strategic change – an attempt to drive a top-down innovation into a, by now, very large and complex network that contained multiple interests and many actors with experience of themselves innovating – seems to have been widely problematic. While there is no doubt that Safaricom's diagnosis of problems emerging from the innofusion network had some validity, the new strategy sought to shift both managerial control and the locus of innovation upwards. Not only did this meet the inertia of lower-level interests, it also tried to break the crucial (albeit sometimes problematic) master-agent-to-sub-agent relations that were demonstrably central in successfully pushing the ICT service towards poorer groups. This was a strategic shift, then, which ran partly counter to the nature and interests of the created innofusion network, and thus ran into difficulties.

Functional expansion (mid-2010–)

In parallel with its efforts to impose standardised procedures and control over the rapid scaling-out of the money transfer service to new areas and customers, Safaricom also began a functional expansion. This sought to move away from just P2P

financial transfers into a focus on the wider domain of m-money – the use of M-Pesa in payments and integration with banking services. This increase in the scope of offered services arose as new registrations began to decline, as the market started to approach saturation and as fewer new users became available, as shown in Figure 7.[22] Thus, increasing the average revenue per user was seen by managers as crucial to future growth. Second, the new phase connects to a second wave of competition stemming from the government's publication of 'agent banking guidelines' (CBK, 2010). This policy permitted several successful Kenyan banks to operate agency services (in a similar way to M-Pesa) to reach wider populations.

There were *ad-hoc* m-money activities in previous phases of M-Pesa, which helped Safaricom learn about this new type of service, in much the same way that the MFI-related piloting had helped it learn about money transfer. However, a significant increase of focus can be detected from May 2010, when Safaricom launched M-Kesho, a service that allows connection between M-Pesa and a bank account. From then on, they continued to secure an increasing number of partnerships: for instance, with ATM providers for e-cash conversion and with shops and businesses for direct payment or repayment as outlined in Figure 10.

In terms of market focus, some additional services joining the network have related to the needs of the poor.[23] In general, though, this new shift reflects a strategy that refocused innovations on MoP users with a rich ecosystem of m-money services being made available for more affluent customers, whereas for most poorer users services remained unchanged (Stuart and Cohen, 2011). Alongside field data from interviewed managers and high charges for the new services, this is illustrated by Safaricom's advertising (most BoP consumers will not be customers of the banks shown in Figure 11). One small agent, Ali, who mainly services local street sellers explained that the changes introduced during this phase meant little to his lower-income customers:

> I have not seen any effect. My customers prefer to come to an agent. They do not know how to operate an ATM. They use M-Pesa for safe keeping at night and paying suppliers, they do not shop in Uchumi [a supermarket where M-Pesa payment was introduced].

That is not to say that these innovations will always remain focused only on the MoP. Talking with agents focused on BoP customers, one can detect agent-driven adaptations that go beyond transfers, such as the use of M-Pesa as an 'overnight safe' for cash by micro-enterprises (see Ali's quote above and the quote in Figure 6). Further examples found during fieldwork include micro-payments between informal traders and micro-savings for poorer slum dwellers.

However, there are barriers that will need to be overcome if these lead firm-driven innovations are to scale-out as money transfer has done. Agent interviews highlighted latency of the service problematising micro-payments, and commission levels that limit demand for some of the innovations by making them prohibitively expensive. Interviewed start-up

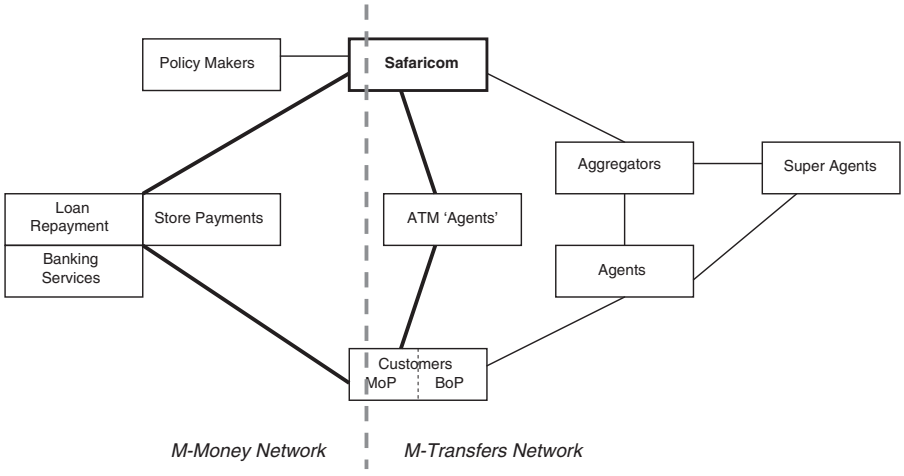

Figure 10 Innofusion network during functional expansion phase.
Key: Actors in bold are key drivers of innovation; bold lines represent new relations.

Figure 11 Marketing the broader functionality of M-Pesa.
M-Pesa service shown at the centre of a network of banks.

ICT firms interested in using M-Pesa for wider payments among BoP groups lamented the lack of an open interface for service integration with M-Pesa. This had restricted the type of firms that can integrate their business into M-Pesa to only those with significant resources. These issues may be addressed by the type of top-down innovation seen during the *incremental rollout* phase earlier. However, they would no doubt need to be complemented by emergent, lower-level service delivery innovations of the type seen during *aggressive growth*.

In sum, functional expansion has in some sense 'turned the clock back', focusing a new round of innovation on MoP customers. However, just as – earlier – transfers moved from MoP to BoP, so it seems feasible the same will happen with m-money services.[24] (Quite likely the same cycle will be repeated again with as yet unforeseen additional ICT innovations in the future.) A mix of top-down innovation plus lower-level innovation (allowed and facilitated by the lead firm) will be needed to help scale-out these new services.

Discussion

Drawing on empirical study, scaling of ICT innovations – at least, of this particular ICT innovation – can be understood as a four-stage iterative model, illustrated in Figure 12. We argue that two loops of this process are detectable, one specifically related to bringing mobile transfers to BoP groups (as outlined in the first four 'Findings' sub-sections). The later functional expansion (final sub-section of 'Findings') can be read as part of a new scaling iteration for the new (albeit closely related) innovation of m-money systems, which will run in staggered parallel to the scaling of m-transfers. The content of these stages will now be discussed and analysed in further detail.

Pilot/exploratory scoping

Exploratory scoping may take the form of a discrete pilot study but might alternatively occur concurrently with diffusion and implementation of other products/services, as in the M-Pesa case's second iteration. It involves lead firms making a first implementation of wider ICT innovation strategy. As noted above, in the BoP literature, such activity is related to the idea of 'co-invention' (London and Hart, 2004),[25] where multiple actors in the innovation system are seen to be shaping the ICT innovation and the broader socio-technical system around it. Simanis and Hart (2009) conceive co-invention as a long-running activity with deep partnership and participation – aligned with the iconic story of Muhammad Yunus developing his Grameen projects while living with farmers. However, the M-Pesa pilot suggests something different. Co-invention occurred over a comparatively short (2–3 month) trial period within the overall pilot, and involved the lead firm creating the framework for activity and adaptation but then 'standing back' somewhat. It closely observed the user community in action, provided a space for emergent adaptations rather than quashing them, and built metrics and processes that allowed analysis of adaptations and their capture and incorporation into future stages of scaling.

While the contrast between the co-invention seen here and that described by Simanis and Hart may not be that great – there was still co-participative skill building and focus group activity – we suggest that a relatively hands-off approach might be particularly useful for co-production of ICT innovations during piloting. Generically, this approach may be relatively quick; may lead to a more genuine simulation of what rollout will look like compared with a situation where the lead firm is micro-managing the trial; and may (only) somewhat address critiques of the deep participation approach related to power and 'steering' of innovation (Arora and Romijn, 2012).

In addition, there may be a particular relevance of this approach to ICTs. Compared with other potential BoP innovations (e.g., agricultural seeds or household products), ICTs are more flexible – and thus allow for more emergent, unanticipated uses – and they can be more readily and quickly adapted, sometimes by the end-users, sometimes by intermediaries within the local innovation system. ICT metrics – that is, details of how the technology is being used – are also more quickly and easily accessible for analysis during exploratory stages than might be the case for other technologies. Such arms-length approaches are especially useful in allowing exploratory scoping to move from being simply a test of the ICT innovation by the lead firm to building a more realistic innofusion network of actors during the exploratory stage, and to better analysing the wider socio-technical issues involved in scaling any ICT system.

A risk for lead firms in this stage might arise if they are too set in their idea of what is being implemented and how it is being implemented, resulting in adaptation being curtailed or

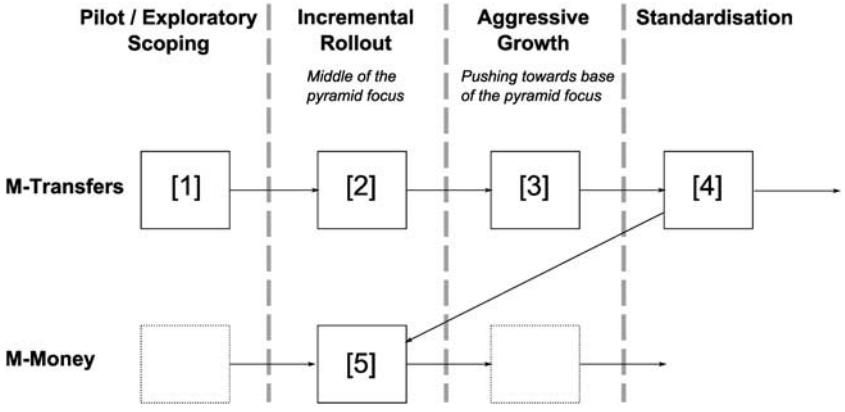

Figure 12 Four-stage model of scaling.
Linking the five phases from the M-Pesa case study.[29]

ignored. Even when exploratory stages build room for adaptation, such activities may not be followed up and integrated into the core innovation. The M-Pesa pilot managed to avoid these risks, even though the original focus of innovation was sufficiently well-established that it had been patented by the time the pilot was occurring.

Incremental rollout

At the point of incremental rollout, the ICT system might look significantly different to that of the previous stage. The incremental rollout stage can principally be seen as a second learning stage, with the focus of learning being the multiplicity of changes needed to initiate rollout whether related to customers, policy, delivery systems, and so on. As outlined in the notion of 'innofusion', it is crucial at this stage that the innovation is not taken as solidified – as a set ICT system simply to be diffused. Instead, there must be room for the ICT system and the configuration of the innofusion network to be adjusted as problems relating to scaling emerge.

For firms looking to reach the BoP, simultaneously developing new innovations and expanding into new markets is a very difficult task (London, 2009). M-Pesa reflects this. The initial focus on existing Safaricom customers, markets, and partners was a good strategy as the firm sought to solidify its ICT innovation at scale, leaving the push towards BoP markets until later. Whether or not that push actually occurs is an identified risk for the transition from this to the next stage of scaling. The lead firm may choose to stick with a comfortable but smaller profit from the MoP, without the impetus to risk reaching down towards the BoP (Arora and Romijn, 2012).

In the case of M-Pesa's first cycle of scaling, the structure of the ICT innovation even in the incremental stage can be seen to maximise network effects and to facilitate further penetration from the MoP into the BoP (Anderson, 2010). This relates to the original idea of urban to rural remittances, which from the core MoP market pulls rural users into the system through transfers. Further, the structure of the transfer tariffs and sufficient coverage of agents encouraged and enabled registration among rural users.

This pull of less-affluent users into the service (combined with the exceptional external conditions that emerged at the end of this phase) can be seen to have built BoP demand, and it was this that drove a transition towards a greater BoP focus. Many ICT innovations have similar networked architectures and we suggest that similar approaches to exploiting network effects might be applicable with other ICT innovations, where services are intentionally structured in ways to induce growing BoP demand.

At the time of writing, it was too early to predict whether something similar will occur with m-money services and M-Pesa's second cycle of scaling. Functional expansion is typical of ICT scale-outs in emerging markets (e.g., Anderson, 2008) and, as noted in the 'Findings' section, the likelihood is that these will diffuse to the BoP, but perhaps more slowly given the bundle of new services does not yet contain a strong MoP-to-BoP pull innovation. However, as noted in the literature review, there are also cases where functional expansion represents a retreat from BoP focus back to MoP focus in order to raise revenue (Qiu, 2007), and this does remain a risk, albeit very small in M-Pesa's case, that we revisit below.

Aggressive growth

In this stage, innovations begin to more aggressively move towards BoP customers. In the M-Pesa case, the core ICT innovation (i.e., hardware and software) was already well aligned to BoP groups having been appropriately refined during the earlier pilot stage (although in other ICT cases there might be a need for further product innovations – for example, this might be necessary to enable m-money services to fully penetrate BoP markets). However, the overall business model was not so aligned, thus requiring changes that mainly consisted of service delivery innovations and the reconfiguration and adaptation of the innofusion network to reach a growing market of diverse consumers.

This demonstrates the way in which serving the BoP requires different business models to those suitable for other markets. The latter models may be based on the notion of simple market transactions for the purchase and delivery of services (Ramani *et al.*, 2012). However, the interaction between agents and customers is anything but a simple market transaction, being rooted in a common context of resource constraints, uncertainty, and strong community relations. The result was a need for agents to innovate, as seen, around float management, opening hours, ID requirements, meeting specific financial needs, addressing security concerns, and so on.

During this stage, the lead firm will likely link to additional partners who are more embedded into these BoP contexts. Key for such expansion is that the locus of innovation moves away from the lead firm towards the wider innofusion network, so that innovation now guides strategy and the lead firm is more reactive according to emergent local innovations. As during the exploratory scoping stage, moving the locus of innovation involves giving other actors more power to innovate, allowing adaptability in ICT services, and not punishing adaptations.

However, in this stage there is an additionality. The ICT system and innofusion actors are likely to be better established and for their local adaptive innovations to scale, additional 'scaffold' from the lead firm is likely required. This means a structural and functional capability within the lead firm not merely to monitor innovation at the periphery, but also to determine whether to quash, tolerate, or adapt and diffuse those innovations. In the case of M-Pesa during aggressive growth of the m-transfer service, localised service delivery innovations resulted in Safaricom responding and helping to support those innovations. By contrast, it is not yet clear that such a supportive framework is being made available by Safaricom for the adaptations that will be necessary to diffuse m-money services into BoP markets.

Thus, the move in the main locus of innovation towards the BoP front-line does not mean that the lead firm becomes passive. Instead, it lets the broad innofusion network take the lead on at least part of strategy, and where wider limitations emerge because of growing complexity, the lead firm should look to build 'scaffold' that supports and magnifies emergent adaptations.

Standardisation

The actions of the lead firm during aggressive growth can be seen as scanning the innovations that result from the diffusion of their ICT service to new and different groups, and then identifying, supporting, and scaling those that are relevant to general market growth for their service. However, allowing the

locus of innovation to move down the value chain, and scaling to ever-more different groups and locations, increases the number and variety of local adaptations and increases the complexity of the overall ICT system.

Some of these adaptations – while perhaps necessary to reach particular segments of the BoP market – may be seen by the lead firm to create an incoherence between the innofusion network's operation and its own goals (e.g., with emergent adaptations that raise costs, create new service risks, or run counter to regulatory requirements). These may also be seen to raise barriers to the overall goal of reaching the largest possible number of system users. From a situation where the diktats of scaling to the BoP mean it must 'let a hundred flowers bloom' and become somewhat reactive, the lead firm is therefore likely to wish to impose some centralised control and put itself back into the proactive driving seat of innovation.

Indeed, such a process – the standardisation of structures and processes, and their institutionalisation – is seen as critical in order to embed and sustain not just the scaled innovation, but also the ownership of the BoP value chain by the lead firm and its internal commitment to BoP markets (Braa *et al.*, 2004; Smits *et al.*, 2007). The risk is – without this consolidation and embedding – ICT firms may drift away from the BoP (Qiu, 2007). Thus, firms may *wish* to standardise in order to reduce complexity and to more easily manage innovation, but they may *need* to do so in order to maintain their BoP focus.

In theory, this would be a matter of taking from all parts of the innovation network the best emergent adaptations, and then seeking to consolidate and impose them from the centre, as happened with some of the M-Pesa service delivery innovations, and, conversely, seeking to stifle those innovations that were seen to run counter to its business strategy.

In practice, though, this did not quite work out as intended for Safaricom. As an ICT innovation scales and as its innofusion network becomes larger, more diverse, and more complex, the need for some standardisation grows. Yet, simultaneously, as the innofusion network grows, its accreting size and 'weight' make it more conservative (Monteiro, 1998). Lead firms are caught in a bind, with the need to make changes and the difficulty of making changes growing simultaneously from the same root. It thus becomes more difficult to impose some standards, at least those that certain actors see as disadvantageous. Selection, presentation, and incentivisation of standardised innovations become ever-more risky, difficult, and skilled activities for the lead firm.

Addressing this risk requires lead firm knowledge of the important relationships and reciprocities that build up in the lower levels of the network as an essential part of aggressively scaling an ICT innovation into a BoP market. Any subsequent standardisation will need to preserve such relations or support them in alternative ways, and the literature notes the importance of keeping agents onside during large ICT system deployments (e.g., Mas and Radcliffe, 2010).

Second, although standardisation moves the locus for innovation control back to the lead firm, that should not be at the cost of restraining innovation elsewhere in the value network. This would be risky – BoP consumers and contexts are evolving as much as any other, and localised adaptive innovations must continue if the existing ICT system is to maintain operation and profitability, let alone if new ICT innovations are to be rolled out. Lead firms therefore face a very tricky steering operation – manoeuvring between the different requirements of the various poles of a growing set of actors.

Conclusions

Some literature of relevance to scaling and innovation of ICTs for the BoP still adheres to the notion of simple dualities that separate pilot from scale-up, scaling from innovation, lead firm from agents, technology from system and context. That literature, and those dualities, have also influenced business practice.

Other literature has already shown these dualities to be invalid and – when synthesised – suggests they should be replaced by the more systemic perspective summarised in Table 1 and Figure 1. However, there has been very little analysis of the actual process of scaling ICTs for the BoP, or of the innovations that take place during that scaling. It is here that this paper makes its main contribution, summarised in Table 2, from both the findings and discussion above, and showing how the systemic framework derived earlier can be both supported and instantiated in practice with greater detail of its components revealed.

The importance of ICT scaling has been demonstrated. Scaling has provided significant revenue and profit for the lead firm; significant revenue and livelihoods for the tens of thousands of dealers and agents involved in service delivery; and a much-valued service for millions of users at middle and bottom of the pyramid. Scaling overall has followed Rogers' S-curve of diffusion: incremental growth succeeded by steep growth which then slows as the market saturates, but with new waves of functional innovations starting the cycle once again.

Where Rogers segments the diffusion curve by type of adopter, here we have substantiated the idea there might be steps or phases during scaling with a four-stage model, and with the suggestion this could represent a repeating cycle for each new functionality added to the ICT service. Despite the historical approach adopted, though, this is still just a cross-section in a continuing story – we do not know what comes next for m-transfers or for m-money, and while we can identify the likely relation between the two, there is always the possibility that new MoP services will struggle to reach the BoP or might even reflect some refocusing away from the BoP.

In all this, innovation has been continuous, widespread, and vital to the process of ICT scaling. M-Pesa has evidenced innofusion in action: innovation is both integral and essential to ICT diffusion and adoption by BoP consumers, and is undertaken by all actors in the network. Indeed, what is striking is how crucial emergent innovation has been – especially in the pilot, but throughout all stages of scaling – and that innovation elsewhere in the network may be a challenge to the lead firm, but its centrality to BoP scaling means they should not see it as a problem.

Both the need for and the nature of innovation have been shaped by the BoP context. The distance from consumers to core technical innovators creates mismatches that further innovation has to address. Resource poverty has driven cost adaptations, and also changes to payment and float management methods. The heterogeneity of BoP markets demands localised adaptations; adaptations that agents within the atomised distribution networks are often responsible for, building on the strength of social capital and interpersonal communication within poor communities. Beyond this, the

Table 2 Summary of scaling and innovation of ICT

Scaling stage	*Pilot/exploratory scoping*	*Incremental rollout*	*Aggressive growth*	*Standardisation*
Innofusion network activity	Adaptive trial: • Experimenting with new technology • 'Co-invention' via emergent modification	Clarifying system: • Testing core innovation and responding to mismatches • Building acceptance	Emergent, supported innovation: • Adapting to specific BoP needs • Lead firm 'scaffolding'	Controlling innovation: • Standardising and institutionalising absorbed best practice • Improving control of innovation
Innofusion network roles	Lead firm with sample of all potential actors esp. end users	Lead firm with established partners	Adding new BoP agents to reach BoP market	Attempted lead firm simplification of direct relations
Nature of typical innovation	ICT core	ICT margins Service delivery core	Service delivery 'frontline'	Management process and delivery structure
Organisational strategy	Planned then emergent	Largely planned	Emergent and planned	Largely planned
Strategic focus	BoP and MoP	MoP – learning	BoP – learning and growth	BoP – growth
Risks	• Product too well set out before trial • Not allowing adaptations	• Diffusion mentality • 'Getting stuck' in MoP stage	• Capacity of partners • Lack of scaffold	• Top-down imposition • Breaking BoP-relevant relations • Resistance from other innofusion network members

responsibilities for, nature, and strategic impact of these innovations are all shaped by the BoP context, as discussed next.

While the BoP context has required continuous innovation throughout ICT system scaling, the nature of innovation, innofusion network members, and the main locus of innovation have all changed. End users were arguably the main innovators during the first pilot phase, but their role faded somewhat to be replaced by the lead firm, and then a growing set of actors within the M-Pesa delivery channel.[26] Key innovations are increasingly likely to come from this wider network of actors, and their innovations may be more relevant to pushing ICT systems towards less affluent groups. This has not been co-invention or co-creation in the conventional sense of a set of closely-related partners. Instead – because of the nature of the BoP market – it occurs through a large, distributed network of stakeholders working together not only to create value, but also to innovate.

The nature of that innovation has spread throughout the ICT system along what may best be understood as a socio-technical continuum. A few innovations have been to the technical artefacts, but the bigger picture is the relative lack of technical innovation necessary after the pilot. Some innovations have been at the direct interface of the social and technical: ensuring the configuration of the technology to match the specific needs and circumstances of localised consumers. However, most innovations needed for BoP scaling have been to the structures and processes that are the broadest part of the overall ICT 'ensemble', and that are integral to the technology's diffusion and use. Those BoP-serving firms – reported earlier – which have been techno-centric in their approach, are therefore misguided. Technical innovation has arguably been the least important aspect of scaling for these markets, and a much greater focus is needed on innovation within the widest sense of socio-technical systems.

More generally, the case supports the claim that strategies and business models for BoP markets are different from conventional models that serve high-income customers. They have been different in terms of structures, organisational arrangements, pricing, service delivery, and other elements. Safaricom has buffered these differences in two ways: first by transitioning from high-income to low-income markets via mid-income, providing a basis for less-disruptive change but also indicating that scaling for the bottom of the pyramid may actually begin with the middle of the pyramid; second, and related, by learning and adapting intensively during the earlier periods of diffusion and thus providing a firmer foundation for periods of high growth.

As predicted from the literature review, though, it would be a mistake to see business strategies – at least, their specific business model content – to be wholly within the control of the lead firm. While Safaricom largely determined the timing and content of its main strategic shifts, it had to increasingly contend with a network of technology and actors of growing diversity and complexity. That network – seen as an innofusion network – was the source of innovations and unexpected effects that forced the lead firm to react, creating some incremental drifts in the specifics of its approach.

Scaling ICT innovations to poor groups will thus depend on how lead firms enable the innofusion network, encourage innovation, and flexibly respond to the innovation that emerges. This will include development of a 'scaffold' of structures and processes that allows them to identify innovations and then take them down one of three

routes: stifle, ignore, or support by diffusing (perhaps also adapting).

Top-down shifts in strategy therefore become increasingly hard to diffuse as the ICT innovation scales; a challenge for lead firms reflected in the patchy progress with Safaricom's standardisation. While necessary in order to maintain internal commitment and external efficiency and control, this attempted institutionalisation of a particular way of delivering the ICT system to the BoP therefore hangs in the balance. It is a reflection not merely of the diffuse sites for innovation within the innofusion network, but also of the diffusion of power during scaling. The image is a little much but there is still a whiff of the lion-tamer trying to herd 10,000 cats, with lead firms begetting a network that 'grow'd like Topsy' and which they need to both facilitate but also control; the latter being an increasing challenge.

Indeed, all of these activities, and each one of the stages, bring both challenges and risks that the lead firm – and other innofusion actors – must negotiate. Such are these risks that it may be worth stepping back to admire M-Pesa a little more. Although there are dozens that have scaled, none of the other m-money initiatives worldwide has yet been quite as successful. There have been a few studies trying to understand M-Pesa's success, but we hope our focus on the process of scaling and the key role of continuous innovation has helped add some insights on this matter. It shows that – where ICT firms can embrace an innofusion network perspective – niche projects can scale to be BoP-focused disruptive innovations that drive core growth.

This is, though, just a single case study of ICT innovation and scaling for the BoP, and we look forward to further studies including those with government and NGO leads. We can say at least that this case is not incompatible with other, more descriptive discussions of ICT scaling for the BoP (e.g., Qiu, 2007; Anderson and Kupp, 2008), and that it has helped provide specific detail for many of the conceptualised constructions that were built from earlier literature. Further studies of M-Pesa could also look at the drivers to transition from one stage of scaling to the next, at the factors shaping innovation, and at the subsequent stages for both m-transfers and m-money.

Notes

1 Prahalad (2009) offers no specific definition of the BoP. He alludes to those who live on less than US $2 per day as being a starting point but argues that 'there is no single universal definition of the Bottom of the Pyramid that can be useful' (*ibid*: 7).

2 Noting a division between development studies and business-for-development, which sometimes take opposing views on the BoP concept (e.g., Arora and Romijn, 2012).

3 Three areas of literature on scaling were read but, by and large, have not been included here either because there were mainly descriptive, or because they dealt with issues unrelated to scaling ICT innovations for the BoP:

- Literature on scaling of health and agro-forestry innovations in developing countries, for example, Uvin *et al.* (2000), Wambugu *et al.* (2011), which focusses largely on best practices for NGOs or state actors and/or on the factors that shape scaling but not the process of scaling itself or the role of innovation within scaling.
- Literature on scaling of educational innovations (typically in US schools), for example, Blumenfeld *et al.* (2000), Elias et al. (2003), which consists mainly of descriptions of specific initiatives with guidance for educational reformers.
- Literature on scaling ICT infrastructure, for example, Tomasic *et al.* (1995), Bolcskei *et al.* (2006), which focuses from a computer science perspective on technical issues.

4 Note we are not including 'roll-out' within this discussion of scaling: the implementation of a large-scale IS, such as an enterprise system, within a single organisation (e.g., Holland and Light, 1999).

5 These four components were selected because they were found as common elements relating to scaling ICT for the BoP that emerged from all three of the bodies of literature surveyed. We recognise that they represent a particular perspective on scaling and innovation, and that there are other aspects – the nature of communication and marketing, the role of trust and social capital, the ethics of serving BoP markets, the nature of different adopter cohorts, the role of power relations between innovation stakeholders, and so on – which could form the basis for research on this topic.

6 Rogers associates this activity mainly with users but, as will be argued below, innovation during diffusion may be undertaken by a wide variety of actors.

7 For further analysis of systems of innovation frameworks in relation to scaling of ICT innovations for the BoP, see Foster and Heeks (2013b).

8 One can see this as equivalent to Prahalad's (2012) notion of an 'ecosystem' of multiple actors that enables innovation and distribution for the BoP.

9 Again, this is something that emerges in later BoP writing: 'This shift in emphasis forces us to move from a product-centric approach to a focus on business model innovation, of which the product is but a subset. Systems thinking is a prerequisite for success in BOP markets' (Prahalad, 2012: 11).

10 Despite reticence to explicitly define the BoP, Prahalad (2009: 7) defines the MoP as those earning '[*US*]$2–13 [*per day*] at 2005 Purchasing Power Parity prices'.

11 Mas and Radcliffe (2010), writing in late 2010, identify 72 m-banking deployments across 42 developing countries recorded by the GSMA's 'Deployment Tracker'. After 24 months, in late 2012, the Tracker showed 140 deployments in 68 countries, particularly in the developing and emerging economies of Africa and the Asia-Pacific region, with a further 104 deployments planned (GSMA, 2012).

12 There are no universally-used definitions, but we can see applications of increasing scope: 'm-transfers' as use of mobiles to transfer money from one device to another; 'm-money' as use of mobiles for money payments and transfers including to and from bank accounts; and 'm-banking' as the use of mobiles to access a fuller range of banking services.

13 Statistics suggest that around 75% of Kenya's adult population are registered with M-Pesa, with Ksh56 billion ($650 million, £410 million) moving in the system on a monthly basis by mid-2012 (equivalent to one quarter of total GDP); a figure growing by c. 40% per annum (CCK, 2012).

14 Further details about the role of policy in scaling of M-Pesa can be found in Foster and Heeks (2013a).

15 Emergent activity revolved around unexpected applications of the service among the 600 trial users including trial users converting cash into e-cash during travel for security (DFID, 2006),

increasing numbers of non-trial users receiving e-cash (Kwama, 2006) and trial users becoming involved in small-scale entrepreneurial selling of airtime (Hughes and Lonie, 2007).

16 Zap initially took custom from M-Pesa but, thanks in part to Safaricom's reaction and first-mover advantage, it did not attain critical mass.

17 This is supported by a comparative study of M-Pesa in Kenya and Tanzania. Camner and Sjöblom (2009) argue that the sub-agent model, not established in Tanzania, can be seen as one of the principal factors that has pushed the growth of the service in Kenya, particularly into poorer areas.

18 It is an open question whether this model was officially sanctioned at a regulatory level. Our interviews suggested that the sub-agent model's existence was an open secret, but it only came to be officially acknowledged later when the aggregator model emerged (see next section).

19 Larger slums in Kenya are inhabited by a large demographic of the population that runs from lower middle class, to working poor, to poor – often in different parts of the same slum.

20 This interview data matches interview accounts from other dealers, who increasingly 'micro-franchised' sub-agents. (This is also documented in Eijkman *et al.*'s (2009) account of a master agent with 106 sub-agents, and Haas *et al.*'s (2010) account of a dealer in another Nairobi slum with 20 sub-agents.)

21 Such a change was possible for smaller sub-agents located in poorer areas because of the dramatic expansion of banks focussed on poor communities in Kenya, particularly the Equity, Co-operative and Family Banks (FSD Kenya, 2009) who became super agents, and were increasingly locating in trading areas in poor communities resulting in complementarity between these two services.

22 Only Safaricom subscribers can actively use M-Pesa. As of February 2011, 78% of all Safaricom users had M-Pesa and 68% of all mobile users in Kenya used Safaricom (Safaricom, 2011). Thus, in a highly competitive market with many other providers, M-Pesa can be seen to be moving towards saturation of the number of users it could likely recruit.

23 These are not for the very poorest but include Kalima Salamo, a crop insurance service for small farmers, and the Jua Kali 'Mbao' pensions plan (for informal traders), both of which link into M-Pesa payments.

24 Indeed, in 2012, Safaricom announced some new lower limits for financial transfer that will begin to enhance the potential for micro-payments within lower-income groups (Safaricom, 2012b)

25 Itself deriving from the notion of 'co-production' in which firms and customers both contribute to innovation (Ramirez, 1999).

26 End users have continued to adapt and innovate – see Omwansa (2009). Although their role was not the focus during the later stages of scaling, they can be seen to re-emerge in the discussion of functional expansion.

27 Number of agents: later growth spikes occurred during scale-out as Safaricom came to agreement with various banks and service providers to use their networks (e.g., January 2010 spike arose from over 500 Equity Bank ATMs becoming 'agents'). Percentge revenue: graph draws on 6-monthly Safaricom revenue results.

28 Revenue per agent can be seen as an indicator of the average volume of transactions – and hence, levels of commission – for the agents. In 2008/2009, the average agent earned $125 per month (c. Ksh9200) as personal income from M-Pesa (which might be one of multiple products offered by the agent); which can be compared with average monthly GDP per capita in Kenya at the time of $75 (Pickens *et al.*, 2009). Registration (showing proof of ID and providing personal details) is the most profitable commission activity for agents. In terms of the new registrations the general trend is of a curve peaking in mid-2008. The massive spike in 2010 relates to government-mandated SIM registration which was undertaken at this time, with all existing Safaricom customers who came forward automatically being registered as new M-Pesa customers.

29 The first phase of m-money can be seen to have occurred chronologically alongside Phases [2]–[4] of the scale-out of m-transfers, rather than being a separate pilot: 'exploratory scoping' may therefore a better term for this stage. As this model was emergent from fieldwork and has not been the subject of secondary literature to date, this m-money phase is shown as a dotted box. As outlined above, the second dotted box corresponds to suggestions that m-money services may expand into BoP provision as part of a future strategy.

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