Embracing complexity: A transdisciplinary conceptual framework for understanding behavior change in the context of development-focused interventions

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ABSTRACT

Many interventions that aim to improve the livelihoods of vulnerable people in low-income settings fail because the behavior of the people intended to benefit is not well understood and/or not reflected in the design of interventions. Methods for understanding and situating human behavior in the context of development interventions tend to emphasize experimental approaches to objectively isolate key drivers of behavior. However, such methods often do not account for the importance of contextual factors and the wider system. In this paper we propose a conceptual framework to support intervention design that links behavioral insights with service design, a branch of the creative field of design. To develop the framework, we use three case studies conducted in Kenya and Zambia focusing on the uptake of new technologies and services by individuals and households. We demonstrate how the framework can be useful for mapping individuals’ experiences of a new technology or service and, based on this, identify key parameters to support lasting behavior change. The framework reflects how behavior change takes place in the context of complex social-ecological systems – that change over time, and in which a diverse range of actors operate at different levels – with the aim of supporting the design and delivery of more robust development-oriented interventions.

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1. Introduction and aim

The success or failure of interventions that aim to change behavior hinge on people thinking, deciding and acting in a certain way. Thus, for interventions to work, it is critically important that they are designed in accordance with how people actually think, decide and act (Datta & Mullainathan, 2014). This is no less true for the design of programmes or policies aiming to change behavior in low income countries. Behavioral science has provided approaches and methods for understanding human behavior, many of which have proven useful for the design and delivery of interventions aimed at low-income populations.

Given that much development research involves the study of complex, adaptive systems, we assume that development interventions must deal with inherently “wicked problems” that are by nature “difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize” (Rittel & Webber, 1973). Wicked problems cannot be solved in a traditional linear fashion, because the problem definition evolves as new possible solutions are considered and/or implemented (Rittel & Webber, 1973).

There is increasing acceptance that interventions that acknowledge individuals’ decision-making processes and the implicit trade-offs required of individuals are likely to be more successful (Banerjee, Duflo, Glennerster, & Kothari, 2010). To date, research to understand individual behavior in the context of development interventions has tended to focus on the use of experimental methods to identify where behavioral insights can be usefully applied to improve the effect of an intervention. Behavioral insights have been particularly successful for understanding one-off decision-making at one point in time, e.g. farmers purchasing fertilizer (Duflo, Kremer, & Robinson, 2011) or families deciding to bring their children to the clinic for vaccination (Banerjee et al., 2010). There is a growing body of work that focuses on understanding ongoing,
repeated behaviors and habit formation, for example, studies have looked at the effect of incentives on long-term habit formation around hand washing in West Bengal, India (Hussam, Rabban, Reggiani, & Rigol, 2016), interventions to reduce household water consumption in the long term in Costa Rica (Datta et al., 2015) and incentives to reduce daytime drinking amongst informal workers in India (Schilbach, 2019). Some studies have focused on shifts in a set of behaviors within a specific environment, for example, energy saving behaviors in the workplace (Klege, Visser, Datta, & Darling, 2018). There are fewer examples of behavioral insights applied to understand behavior in complex change processes, where a set of different behaviors need to change within individuals, or where different actors need to shift multiple behaviors simultaneously (e.g. farmers adopting a package of agricultural inputs, or households adopting clean cookstoves). To effectively apply behavioral insights, it is necessary to know precisely where and when in a process of changing behavior that specific behavioral determinants come into play, as well as the relative importance of various behavioral determinants in the decision-making landscape and the role and influence of other actors on the behavior change process.

Research on resilience and social-ecological systems has attempted to overcome the challenge of explaining behavior in complex change processes, in particular the human dimensions of social-ecological dilemmas (Fabinyi, Evans, & Foale, 2014). However, the research tends to focus on social units, rather than the complex interplay between individuals and the social units. Fabinyi et al. (2014) highlight the failure of social-ecological systems research to acknowledge the complexity and social diversity of studied systems.

In this paper we propose a conceptual framework that aims to integrate insights from behavioural science and complex adaptive system dynamics using service design – a qualitative approach to understanding people in their wider context, and their needs, motivations and behaviours – with the intention of co-creating improved interventions that better meet their needs (Edvardsson, Kristensson, Magnusson, & Sundström, 2012; Patricio, Gustafsson, & Fisk, 2018; Pfannstiel & Rasche, 2017).

Following Imenda (2014) we define “conceptual framework” as a synthesis of concepts and perspectives drawn from many sources, which provides an integrated way of looking at a problem. The purpose of our conceptual framework is to support development-oriented academics, practitioners, and other professionals to understand the behavior change(s) that are required by individuals, over time, to achieve sustained uptake of a new technology or a change in practice. The framework has been developed and refined through a series of case studies and through consultations with development professionals from a variety of fields during a four-year research program. When combined, it is hoped that the framework and the supporting empirical material presented here will demonstrate how integrating insights from service design and behavioral science, against a backdrop of social-ecological systems theory, can support more robust intervention design.

Section 2 sets out the theoretical background. Section 3 provides a generic description of the methodological framework. In Section 4 three case studies are used to describe the framework and illustrate its iterative development. Finally, we discuss the overall contribution of the framework and present suggestions for its future development and application.

2. Theoretical background

The development interventions in focus operate at the intersection of environment and development, within complex adaptive systems, and deal with interlinkages between a multitude of actors and scales. In our conceptual framework, we use social-ecological systems theory as the theoretical backdrop needed for capturing the multi-level system dynamics influencing individual behavior and decision making. The logic of the framework is informed by service design, a user-centered approach to understanding complex systems and by behavioral insights, namely a model of behavioral design developed by Datta and Mullainathan (2014) and the Behaviour Change Wheel (Michie, van Stralen, & West, 2011).

2.1. Social-ecological systems theory

To study interventions that aim to address wicked problems in low-income settings, it is important to consider the complexity of the systems under study. Our conceptual framework relies on social-ecological systems thinking, which assumes that social and ecological dynamics interact as a complex adaptive system (Folke et al., 2010; Levin et al., 2013) in which the macroscopic properties of a system emerge from an interaction among its components, and the interactions themselves can feed back and impact on subsequent development. Thus, social-ecological systems theory views humans, or actors, as part of the complex adaptive system (Berkes, 2008).

In these types of systems: actors interact, often in unstructured and unpredictable ways, which leads to the emergence of cross-scale patterns and feedback loops, influencing interactions between actors (Levin et al., 2013). Thus, the components of a system change as a result of the interplay between the inherently adaptive actors and the developing properties of the whole (Lansing, 2003; Levin, 1999). To add complexity, the macroscopic properties of a system develop from actions at a local scale, in turn feeding back to influence the behavior, options and choices of actors, diffusely and over the long-term (Levin et al., 2013).

Identifying opportunities for creating new feedbacks, or strengthening desirable feedbacks, requires an understanding of the drivers of behavior and decision-making at the local level, and how these relate to the wider social-ecological systems within which households operate. To address these complexities, social-ecological systems analysis focuses on the social group in order to influence behavior and feedbacks (Fabinyi et al., 2014). Although studies of social-ecological systems and complex adaptive systems recognize the importance of studying actors within a system, as well as the system itself, they have been critiqued for homogenizing social complexity by assuming that people’s interests, expectations and experiences are the same (Fabinyi et al., 2014), and for downplaying experience-based behavior and the importance of cultural context and meaning (Cote & Nightingale, 2012).

To illustrate a behavior change process, we draw on concepts from resilience and ecology research (Holling, Schindler, Walker, & Roughgarden, 1995) of an ecosystem shift between ‘stable states’, driven by a shift in state variables that alters the landscape and causes the system to move into a new state (Beisner, Haydon, & Cuddington, 2003). Applying this concept to explain a behavior change process, the ball (Fig. 1) represents an actor, or an actor type, that, due to changes in state variables, (e.g. behavioral drivers and behavior change techniques) transitions from one behavior, to another, constituting a new stable state.

2.2. Behavioral insights for low-income settings

‘Behavioral insights’ is the collective term for empirically grounded knowledge based on cognitive psychology, behavioral sciences and the social sciences about how people behave and make choices. Behavioral insights are applied to better understand, and predict, human decision-making (Anderson & Stamoulis, 2006; Team, 2017). Insights from behavioral research tell us that
individuals typically make decisions based only in part on economic rationales, acting to the best of their knowledge and influenced by norms or emotional responses (Kahneman, 2013). Several underpinning principles have been shown to be important for explaining decision-making and choice. These include thinking automatically (Kahneman, 2013), the use of mental models, and thinking socially (World Bank, 2014, 2014). The application of behavioral insights in the field of public policy has gained significant traction over the past few years, both nationally and in international organizations. A study by Lourenço, Almeida, and Troussard (2016), commissioned by the EU, identified over 200 examples in 32 countries of public policy initiatives related to behavioral perspectives.

There is a growing body of literature on the influence of behavioral insights in the context of development interventions in low-income settings, e.g. for programs focusing on agriculture (Dufo et al., 2011; Liu & Huang, 2013; Verschoor, D’Exelle, & Perez-Viana, 2016), improving the quality of education (Benhassine, Devoto, Dufo, Dupas, & Pouliquen, 2015), encouraging individual saving (Karlan, McConnell, Mullainathan, & Zinman, 2016), providing access to electricity (Lee, Miguel, & Wolfram, 2016) and improving health outcomes (Hallsworth, Snijders, Burd, Prestt, Judah, & Huf, 2016). Although widening the geographical coverage of studies, they have been criticized for being too narrowly focused and difficult to generalize beyond specific cases, and thus difficult to scale up (Datta & Mullainathan, 2014; Tantia, 2017).

Datta and Mullainathan (2014) propose an approach for applying behavioral insights to the design of development interventions and suggest three stages in the process where behavioral insights can be influential: in defining the problem, in diagnosing the problem, and in designing the intervention. Datta and Mullainathan’s model of behavioral design has been further developed to include the stage “scale” and possible iterative loops between the first three stages (Tantia, 2017). See Fig. 2.

The authors of the behavioral design framework recognize the opportunity to closely link behavioral insights and intervention design and highlight the need to embed innovation in the process by designing interventions with an iterative experimentation process (Datta & Mullainathan, 2014). This enables researchers and practitioners to identify unintended consequences, generate better solutions and diagnoses, and develop diagnostic techniques relevant for other contexts. An iterative experimental approach requires being willing to develop an intervention without necessarily isolating the causal effect of a single cognitive process or pathway, but rather focusing on a set of interconnected design innovations. A key strength of such an approach lies in the thorough testing that takes place at each point in the process allowing for mistakes, for example, misdiagnosed problems to be corrected along the way.

Behavioral design has been applied extensively to identify and address reasons why public programs are not performing as expected, the most advanced study being the Behavioral Interventions to Advance Self Sufficiency (BIAS) project which tested the effect of behavioral nudges in 15 randomized control trials in eight different locations in the United States (Richburg-Hayes, Anzelone, Dechausay, & Landers, 2017). The study found that the nudges applied had a statistically significant impact on at least one primary outcome of interest, leading the authors to conclude that Behavioural interventions hold promise as a tool for delivering effective public programmes (Richburg-Hayes et al., 2017). The behavioral design approach used in the BIAS project is similar to the United Kingdom Medical Research Council’s framework for developing and evaluating complex interventions to tackle health problems, (Craig et al., 2008) in that the design and implementation process is iterative.

A number of models have been developed that aim to explain behavior change related to the longer-term uptake of development interventions. Notable are Mosler’s RANAS framework for behavior change in the water and sanitation sector (Mosler, 2012), the Behaviour Centered Design Framework (Aunger & Curtis, 2016), USAID’s Designing for Behaviour Change Framework (USAID, 2017a) and Michie et al.’s Behaviour Change Wheel, a synthesis of 19 frameworks of behaviour change, drawn from a wide range of domains. Although each of these frameworks provides a useful guide for practitioners seeking to develop behavior-based interventions in low income settings, they do not fully address the complexity of implementing interventions in terms of how behavioural determinants change over time, the motivations of different types of users of a service or system or the variety of actors involved beyond the individual and household scale, all of which have consequences for how sustainable and scalable an intervention is over the long term.
2.3. Service design

Service design has a legacy in design and service research (Patrício et al., 2018) and emerged around the turn of the millennium (Segelström, 2013; Wetter Edman, Göteborgs universitet, & Konstnärliga fakultetskansliet, 2011). As a design practice, service design is a creative, human-centered and iterative approach to service innovation (Wetter-Edman et al., 2014), gaining ground as a systematic method for creating systems and services that are useful, efficient, effective and desirable to the user (Penin, 2017; Stickdorn & Schneider, 2012). Service design is a qualitative approach to understanding people's needs, wider context, motivations and behaviors, which aims to co-create improved services or systems that better meet their needs (Edvardsson et al., 2012; Manzini, 2015; Pfannstiel & Rasche, 2017). Service design may be seen both as a set of tools and techniques as well as an approach to service innovation and shows promise as a methodology to address challenges within the public sector (Malmberg, 2017) and for addressing wicked problems in social systems (Banathy, 1996; Jones, 2014).

A central tenet in service design research is the principle of co-creation, where actors in service systems engage in a creative process to define problems and explore solutions. In recent years, service design has been increasingly applied in low-income settings to improve public services to better meet the needs of users and deliver positive social impact through so-called design labs, or public policy labs (Bason, 2017; Escobar, 2017).

3. Generic description of the methodological framework

Our conceptual framework draws on the Behaviour Change Wheel framework, developed by Michie et al. (2011). In this framework, capability, opportunity, and motivation interact to generate behaviour in a system known as COM-B (Michie et al., 2011). These components can be linked to more fine-grained behavior-change techniques (BCTs), which are active components of an intervention designed to change behavior (Michie et al., 2013). Michie et al. have systematically generated and applied collections or “taxonomies” of BCTs and from there, developed a “cross behaviour” taxonomy which includes 93 distinct BCTs (Michie et al., 2015). To enhance usability and accuracy of the taxonomy, the identified BCTs were organized into 16 groups (Michie et al., 2015).

Michie et al. (2011) demonstrate the connection between capability, opportunity and motivation, key behavioral mechanisms and BCTs, and the interventions and policies that could be introduced to target or change these mechanisms. However, as Michie et al. highlight, “there is a general recognition that context is key to the effective design and implementation of interventions, but it remains under-theorized and under-investigated”. And although the Behavioral Change Wheel links behavioral mechanisms to decision-making, it does not account for the need to coordinate and sequence BCTs within a process of developing and implementing an intervention. Failure to coordinate BCTs within a change process can result in a “scattershot” approach to intervention design whereby knowledge about behavioral drivers is applied at the wrong point in the process, where synergies between BCTs are missed or, where BCTs come into conflict with one another. This is shown in Fig. 3 where BCTs are depicted as scattered puzzle pieces.

By using service design, it is possible to identify, at the individual level, behavioral drivers, their underlying mechanisms, BCTs and behavioral archetypes, and to relate these to a specific change process in a coordinated way. This is illustrated in Fig. 4 where the puzzle pieces, representing BCTs, are joined up. The service design...
approach strengthens Datta and Mullainathan’s behavioral design process by demonstrating how behavioral change mechanisms and BCTs could be sequenced over time to support sustained behavior change in the context of a development intervention.

Our conceptual framework for intervention design (depicted in Fig. 5) follows six consecutive stages. Whereas the behavioral diagnosis and design model recommends the iteration between the first three stages (define, diagnose and design) (Barrows, Dabney, Hayes, & Rosenberg, 2018), our framework suggests that iterations should be made between each stage.

Stage one – Problem co-definition – is a formal and thorough effort to gather evidence to support the initial underlying assumptions of an intervention. This is done in close collaboration with key actors and stakeholders, including the intervention funder(s),
target beneficiaries and sector experts. This stage can also involve a review of the existing literature on the context of the intervention.

Stage two – experience-based problem diagnosis – verifies the problem identified in stage one from the perspective of the beneficiary (e.g. individual, household, farmer) to identify the underlying causes. User journey mapping is conducted and key behavioral drivers at the individual level are identified in different phases of the journey (see supplementary material for a detailed account of user journey mapping). This stage also merges iterative intervention design with the actual journey of the target actors through an intervention, allowing pivotal ‘behavioral moments’ to be identified, highlighting, for example, where an intervention could be derailed due to a disconnect with the users’ needs or motivations, or the emergence of previously undetected opportunities to support the intervention. Unlike behavioral mapping which pinpoints discrete behavioral action points in a process and seeks to understand ‘sub-optimal behavior’ (Barrows et al., 2018; Richburg-Hayes et al., 2017), the objective of user-centered mapping is to understand the user’s behavior and decision making in relation to the wider system, beyond a given intervention process.

Stage three – System mapping – involves creating a detailed map of the entire system, including the socio-economic, ecological, structural and institutional dimensions of the setting, using the target beneficiary’s experience or ‘journey’ as the starting point. Though similar to process mapping whereby steps in a programmes’ process are analyzed from the perspective of the programme clients (users) and staff (Richburg-Hayes et al., 2017), actor mapping seeks to widen the scope and includes the roles of all key actors and processes in the intervention, as well as actors not directly engaged in the intervention but who have influence over or interests in it. The resulting system map from stage two is “verified” with stakeholders in a workshop setting to ensure accuracy. See supplementary material for a detailed description of system mapping.

Stage four – rapid prototyping – uses the insights gathered in the previous three stages to develop rapid prototypes (quick sketches) of an intervention which are then piloted in a subset of the target population to verify the insights gathered so far and to reduce design flaws in the intervention. These rapid prototypes are informed by the BCTs and behavioral mechanisms, in turn based on the behavioral drivers identified in stage two. Rapid prototyping can be used in parallel with experience-based problem diagnosis, to generate rough ideas about the design of the intervention which can be quickly tested during interviews with users.

Stage five – design and testing – tests a fully designed intervention in a subset of the population and makes changes based on the results.

Stage six – upscaling – scales up the intervention beyond the initial population, possibly in a new location. This stage entails returning to stage 1 and following the cycle again in order to verify assumptions about a new location and new actors. The second stage should be straightforward because it builds on previously collected and verified data. However, care is taken to identify critical elements that might need to be re-designed for the intervention to be transferrable to a new location.

Ideally, all the above steps would be followed early in the process of designing an intervention. However, as illustrated by the three case studies described below, the conceptual framework can also be applied at any stage in the intervention process to identify and correct flaws in design.

4. Application of the conceptual framework

The conceptual framework was developed iteratively through a series of case studies on behavior change in relation to the uptake of new technologies. We present findings from three case studies: uptake of clean cookstoves in peri-urban Nairobi, Kenya, and urban Lusaka, Zambia; uptake of off-grid electricity services by households in Zambia; and uptake of pre- and post-harvest technologies among mango farmers in Kenya. The case studies follow the development of the interventions with a focus on improving an existing intervention, rather than informing the design of a new one. Each case study has contributed differently to the development of the conceptual framework, as Table 1 illustrates.

4.1. Identifying user archetypes and opportunities for behavior change techniques: Case study on adoption of advanced biomass cookstoves in Kenya and Zambia

Approximately 80% of households in sub-Saharan Africa do not have access to clean energy for cooking (International Energy Agency, 2018, 2018). Although advanced cookstoves have been promoted for decades by governments, NGOs and the private sector in different parts of the world, the level of adoption still falls far short of what is needed to achieve substantial benefits (Barnes, 2014). We used case studies from Kenya and Zambia to examine what drives households to adopt clean stoves for most or all of their cooking needs. The study aimed to better understand the drivers of behavior related to adoption of clean cookstoves by households in Kiambu, Kenya and Lusaka, Zambia. In each case we studied cookstove users’ experience of purchasing and using an advanced biomass cookstove. The main research question asked what support is needed, and at which point in the actor journey is it needed, to achieve lasting behavior change? Results and conclusions from this case study are further described in Jürisoo, Lambe, and Osborne (2018).

4.1.1. Methods

The primary methods to collect data were open-ended interviews using trigger material, rough pen-and-paper sketches used to discuss prototypes of possible changes to the intervention, and user journey mapping. For selecting interviewees, our main crite-

Table 1

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<th>Case study</th>
<th>Stages of the framework applied</th>
<th>Key contribution to framework development</th>
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experience-based problem diagnosis  
experience-based problem diagnosis  
Rapid prototyping  
experience-based problem diagnosis | User journey mapping  
Identifying BCTs at different phases in the journey  
Sequencing of BCTs  
Identifying archetypes  
Targeted solutions for identified archetypes  
Linking archetypes to BCTs |
| Kenya mango farmers (2017)   | experience-based problem diagnosis  
System mapping  
Rapid prototyping | User journey mapping  
System map/value chain map  
Targeted solutions for specific actors |
| Zambia mini/grids (2017)     | experience-based problem diagnosis | User journey mapping, over time |
rion was cookstove users who had purchased an advanced cookstove. In both locations, we made use of existing partnerships to facilitate interviewee selection and access to households that had purchased advanced cookstoves. In Kenya we conducted 19 interviews and in Lusaka we conducted 17.

We gathered data to map a composite user journey, broken into phases of “before”, “during” and “after” using the stove. The “before” phase refers to the stages of hearing about the stove and deciding to purchase it; the “during” phase refers to the period of starting to use the stove and establishing a new cooking practice; the “after” phase refers to the period when the user starts looking for a new technology to replace and/or complement the stove. The user journey phases were developed during the Kenyan study and further tested and validated in the Zambian case.

4.1.2. Key results and discussion

The composite user journey is presented in Fig. 6. The red dots illustrate key components of the behavioral change process under study: becoming aware of advanced stoves, buying a stove, and making it the household’s main or only cooking device. The blue dots represent points during the user journey where, if conditions are unfavorable, the opportunity to induce a change in cooking practices can be lost. These can also be viewed as points in the decision-making landscape where a specific type of support is vital for achieving a long-lasting change in behavior.

A key finding of the case studies was that for the cookstove interventions to be successful (i.e. advanced cookstoves are adopted by households), BCTs, need to be identified and carefully sequenced throughout the user journey. There is a tendency for cookstove programs to focus their efforts on the “before” phase of the user journey, on the provision of marketing and technical information to support potential users to acquire a new cookstove. We found, in both studies, that acquiring the new stove is only the first step. What the user experiences when getting started with the new technology, in the “during” phase, and how well the technology meets their expectations, is critical. See supplementary material for a table summarizing the BCTs identified in the “during” and “after” phases of the user journey.

Thus, the identified BCT grouping ‘continuous social support’, to help users overcome technical problems, remind households about how to use and maintain the stove, and build confidence using the new technology, is imperative at the start of the “during” phase. However, this BCT grouping will be less useful if it is not available to the actors early on; they may already have experienced disappointment that the intervention is not fulfilling their expectations.

In addition, the study identified that the BCT groupings ‘change in physical environment’ (i.e. increasing fuel availability) ‘reward and threat’ (i.e. financial incentives) and ‘shaping knowledge’ (i.e. information access) are also crucial at different stages along the journey. For more detail see supplementary material and (Jürisso et al., 2018).

Beyond sequencing of BCTs, the user journey mapping also helped in identifying three distinct types of cookstove user, loosely defined by their main motivation for purchasing the stove. We also observed that each type requires specific support at different points in the adoption process. Those who were motivated to purchase a stove by saving money tend to take several weeks before the value of the stove is realized. These users seem aware of the fact that change takes time and are willing to continue to use the stove even where problems were encountered early on. In terms of support, these users need accurate technical information on stove use, how to optimize use so as not to waste fuel, and how to avoid accidents with the stove.

The user group motivated by convenience needs a relatively immediate improvement for the value of the stove to be realized, otherwise they tend to become disillusioned. This group requires continuous support from the start, ideally from a trusted source. Users attracted to the aesthetic appeal of the stove reported purchasing the stove to increase their social status or to be perceived as modern and aspirational. We found that for this group of users the “newness” tended to decrease over time and the immediate rewards in terms of less smoke and fuel saved do not necessarily motivate long-term use. Compared to other types of users, this group did not appear to need as much support in the early phase as those motivated by convenience or by saving money.
4.2. User mapping to understand the wider context: case study on solar PV mini-grids for household electricity provision in rural Zambia

More than half of the population of sub-Saharan Africa – 590 million people – do not have access to electricity (International Energy Agency, 2018). Renewable energy mini-grids are expected to play a major role in the pursuit of universal access to modern energy services, particularly in areas where grid extension is technically or financially unviable (IRENA, 2013; Szabó, Bódis, Huld, & Moner-Girona, 2011). Out of the roughly 315 million rural Africans that the IEA envisions will gain electricity access by 2040, about 45% would be served by mini-grids (International Energy Agency, 2014). However, little is known about the socioeconomic determinants in Africa of uptake of electricity from renewable energy mini-grid systems. This case study explored the behavioral and socio-cultural factors that support and constrain the adoption of electricity services provided by a solar mini-grid project in rural Zambia.

The case study location is Mpanta, Zambia. Mpanta is a rural community of 2673 people, situated on the shores of Lake Bangweulu in Luapula Province in northern Zambia (Rural Electrification Authority. (2016), 2016). In November 2013, a 60 kW solar mini grid in Mpanta was commissioned by the Rural Electrification Authority to provide essential electricity services for lighting (including street lighting) and light load appliances (such as televisions, radios, fridges and mobile phones) to 450 users comprising of households, a school and staff houses, a rural health center, harbor facilities, small businesses and churches.

After commissioning of the mini-grid in 2013, users were initially connected for free. Each user was required to pay a monthly fixed tariff based upon their user category (i.e. residential, commercial and social services) and, if a residential user, the number of rooms in their house. Following this initial free connection period, a 50 ZMW (5 USD) connection fee and 15 ZMW (1.5 USD) wiring fee were introduced. Meanwhile, to encourage community participation and ownership of the project, mini-grid operation, plant maintenance and revenue collection was handed over to a local Multi-Purpose Cooperative Society (hereafter Kafita Cooperative).

4.2.1. Methods

User journey mapping was used to map and explore users’ needs, expectations and experiences “before”, “during” and “after” connecting to the solar mini-grid. The user journey mapping was conducted based on 28 semi-structured interviews with users and non-users of the solar mini-grid services. Interviewees included 21 households (12 still connected, 4 disconnected and 5 never connected), 5 businesses (4 still connected, 1 disconnected) and 2 institutions (both still connected). Data saturation was reached after 28 interviews, thus determining the sample size.

For data analysis, user and non-user interview responses were coded in a spreadsheet based on user category (households, businesses and institutions) and connection status (connected, disconnected and not connected). Responses were then analyzed to generate insights on the varied emotional and physical experiences associated with connecting to the mini-grid and using its services and the different contextual factors shaping adoption or non-adoption of mini-grid electricity services. For more detailed results and conclusions see (Muhoza & Johnson, 2018).

4.2.2. Key results and discussion

Key results from the Zambia case relate to the importance of embedding local context and the needs and motivations of the users of services in the design of an intervention. Mapping the experiences of individual users over time highlighted inconsistencies in the delivery of the intervention which can result in disappointment and reduced overall effect of the scheme.

The user journey map in Fig. 7 visualizes the experience of users and non-users before, during and after connecting to the Mpanta solar mini-grid. These three stages in the user journey correspond to: becoming aware of the mini-grid service, getting connected to it, and continued or discontinued use of electricity. Fig. 5 highlights touch points associated with the various phases in the user journey.

The case study found that information about the intervention was not coherently provided to all users, in the same way. For example, some were informed that the electricity provided would be free of charge while others were aware of the actual costs. Some were told that they would be able to use the electricity for cooking and other uses that would require heavy loads, even though the system was not designed for heavy loads. Others had a clear understanding of the capacity of the system.

The experience of becoming connected to the mini-grid also varied greatly depending on when households joined the scheme. Those who participated in the scheme early on, and benefited from free connections, were first visited by an agent from the Rural Electrification Agency who brought the application form to their home for completion, and then by an engineer who would install the necessary wiring to connect the household to the distribution network and provide free light bulbs. Those who joined the scheme later had to visit the Kafita Cooperative offices in person and apply and pay the connection fees, which were often prohibitive for low-income households.

Many users (47%) were disconnected because they defaulted on their payments. The user journey mapping provided insightful information about why so many were disconnected. The community relies on small-scale fishing as the main source of income, but during December to March every year a ban is imposed to allow fish stocks to replenish. During this time, household incomes tend to decrease, leaving many users unable to afford the fixed tariff. Thus, if a similar mapping had been conducted while designing the business model for the mini-grid, economic incentives would, preferably, have been directed to cover costs during this period, and attract and retain users.

4.3. Situating individual behavior within the wider system: case study on technologies for reducing post-harvest losses in small scale mango harvesting in Kenya

Agriculture is the most important provider of livelihoods in Kenya, with more than 75% of the population depending on the sector for food and income (USAID, 2017b). Mango is an important food and cash crop, with a six-fold production increase between 2000 and 2014. However, more than 25% of the crop is currently lost during and after harvesting due to pests, inadequate on-farm storage and a lack of direct access to markets among small-scale farmers to sell their produce (Financial Sector Deepening (FSD), 2015). To reduce losses, development interventions have been introduced to small-scale farmers to reduce losses and improve incomes by producing higher-quality fruits, to process the mangoes (into more durable and/or higher-value products), and to improve fruit storage. However, uptake of technologies is generally low, particularly among more marginalized groups, including female-led households.

The study focused on two sites: Tana River County in eastern Kenya, and Meru County in the center of the country. With 76.9% of the population living below the poverty line, Tana River County is among the poorest in Kenya (CRA, 2011). Approximately 40% of households in Tana River County are engaged in small-scale farming (MOPHS & IMC, 2010). The poverty rate in Meru County is 28.3% which is well below the national poverty rate of 47.2%.
High-input, rain-fed agriculture complemented by irrigation is the main source of livelihood in the county, contributing about 80% to the average household income (MoALF, 2016). The study intended to investigate how to improve the development and implementation of technologies, aiming to reduce losses among smallholder mango farmers.

4.3.1. Methods

In this case study, the intervention aimed to help small-scale farmers to reduce loss of their mangoes by marketing improved harvest and post-harvest technologies. The primary actors were assumed to be smallholder farmers, and technologies were already developed and introduced to farmers at different locations in Kenya. However, we applied user journey mapping to help identify not only what could be improved in terms of technology design, but also the underlying factors behind the low uptake of technologies. In addition, we conducted participatory observations, open-ended interviews with a range of stakeholders and two field workshops, in total 206 interactions with stakeholders in the two locations. Periodically, we presented our evolving analysis to farmers and other stakeholders for their feedback. We also mapped the mango value chain within which the new technologies and services would be provided, to understand the roles of, and relationships between, different actors and the links between them at multiple scales. These insights were consolidated in a system map and a corresponding narrative for mango farmers in Hola and Meru.

4.3.2. Key results and discussion

The case study demonstrated the need to account for the interests and incentives of a wide system of actors when designing an intervention. In terms of reducing losses in Kenyan mango production, we found that the underlying problem that the intervention sought to address had been misdiagnosed, and as a consequence, interventions were not developed and introduced to the right actors. As illustrated in Fig. 6, the user journey of a farmer could follow a number of different scenarios: the farmer could indeed be harvesting the fruits, and thus be the target beneficiary of interventions aiming to reduce pre-harvest and post-harvest losses. However, many farmers did not harvest the fruits but either hired harvesters, or sold fruits to a broker, who used their own harvesters. In these cases, the technologies were introduced to the wrong group of actors. The systems mapping identified an array of actors, interacting in various ways. Besides farmers and end-buyers (such as retailers or mango-processing companies) there were three other key actors (or key roles) in the value chain: harvesters, brokers and farmer organizations (see Fig. 8 below). Without mapping the entire system, the importance of these other actors and their connection to the farmers would not have been identified.

The pre-harvest and post-harvest interventions had been developed with the objective of enhancing the quality of the produce and thus improving farmers’ incomes. However, the study found that farmers did not have access to the market, or buyers, that would give them increased return for better quality fruits. Furthermore, since harvesting was carried out by hired labour, reduced damage to fruit during the harvest was out of the farmers’ control, which meant that technologies to reduce such losses were of little use to the farmers.

5. General discussion

In this section we discuss the conceptual framework considering the case study findings, with a focus on overarching parameters...
that should be considered when designing robust and implementable interventions in a low-income context.

5.1. Behaviour change occurs (and is reinforced) within separate but interconnected phases of the actor journey

Depending on the type of behavior change required, users engage with varying intensity in different parts of the user journey. For adoption of an intervention, such as a cookstove, a significant change in behavior is required in the sense that it involves active engagement in several of the phases of the user journey. The case study on adoption of improved cookstoves in Kenya and Zambia demonstrates that developing a new habit with a new technology requires a user to stay motivated over a long period of time. In addition, users need to learn how to use a new technology early in the process, which requires changing several behaviors at once, e.g., cooking food more quickly, not leaving the stove unattended or not using the traditional stove, and maintaining the behavior change until new habits are formed.

With high-effort behavior change, such as technology adoption, supportive actions may be needed over a long period, as the change in behavior is not immediate, nor a one-time action. Breaking down the experience of adopting a new technology into constituent phases provides a simple way to identify when, in the journey, the user needs support to develop a new habit and what type of support is needed.

As proposed in this study, key behavioral drivers, BCTs and behavioral mechanisms must be identified and sequenced into the decision-making landscape, for interventions to be successful and scalable. Based on our case study findings, we suggest that designing interventions requires active engagement on the part of the implementer or service provider to iteratively develop the service or intervention in collaboration with the users, particularly when the intervention in question seeks to introduce a new technology or displace an old one.

In the cookstove and mini-grid cases, we found that the extent to which user expectations set in the “before” phase of an intervention are met in the “during” phase is central to success. In the cookstove case, individuals and households were provided with information about the functioning of advanced cookstoves by way of marketing and promotion – often related to the high efficiency of the stoves and the potential to save significantly on fuel purchase. Indeed, the potential to save fuel was the most commonly cited reason for purchasing an advanced cookstove. Where users encountered problems getting started with the stoves, and fuel savings were not quickly realized, the result was often disappointment and, in some cases, reduced or discontinued use of the new stove.

In the mini-grid case there is a clear pattern of unmet expectations among service users. Following connection to the mini-grid, households reported being disappointed that they were unable to use the electricity for cooking or productive uses and for some users the connection fee was higher than expected.

Although awareness raising and promotion of new services and technologies is necessary, implementers and service providers need to strike a careful balance between communicating the benefits of the new service or technology and ensuring a clear understanding on the part of their users of the costs and limitations. The careful management of expectations in the “before” phase, based on a clear understanding of the factors motivating users to adopt a new technology or service, is a prerequisite for adoption and sustained use of the technologies and services in the “during” phase.

In the case of Kenyan mango farmers, the technologies themselves were not necessarily malfunctioning; the problem was that they did not target the challenges or bottlenecks that users faced, nor were the behavioral components that needed to change sequenced in the decision-making landscape of the system. The study showed that to achieve the objectives of the intervention, farmers must be provided with the appropriate incentives. Farmers need assurance that adopting a technology to improve the quality of their produce would generate a higher income, otherwise the traditional harvesting methods, which are less costly both in terms of time and capital, will remain more attractive.

5.2. Identifying where BCTs or groups of BCTs could be applied

The Kenya and Zambia cases identified behavioral drivers of improved cookstove uptake, and the BCTs that could support the process of behavior change. In a recent review, the BCT “shaping knowledge” was identified as the active ingredient in 85% of cookstove interventions globally and “social support” in 64% (Goodwin et al., 2015). These findings suggest that designers of improved cookstove interventions have confidence in the effect of these BCTs. The BCTs “Shaping knowledge” and “social support” are often applied together with “reward and threat” (most often in the form of a financial incentive) to encourage uptake of improved cookstoves.

However, our conceptual framework extends the work of Goodwin et al. (2015) by not only identifying key BCTs but also...
illustrating where in the behavior change process they are most relevant. For example, in the case of cookstove adoption, our studies identify that “shaping knowledge” (information and demonstration), “reward and threat” (in the form of financial incentives) and the “impact of peers” (friends and social groups) are important BCts in the “before” stage of cookstove adoption, while “social support” (user support to overcome problems using the stove) and “reward and threat” (ongoing financial incentives, e.g. subsidized fuel) are more important in the “during” phase.

5.3. The importance of user archetypes

The Kenya and Zambia case studies demonstrate that the conceptual framework can be useful for identifying categories of users, and the type of support that they require in different stages in intervention. For example, we identified three main cookstove user archetypes, defined by their key motivation for purchasing and using an improved cookstove: those who were motivated by saving money, those who sought convenience and those who appreciated the aesthetic appeal of the new cookstove. The user journeys for each archetype revealed positive and negative experiences in different phases of the actor journey and, thus, very different needs in their journey toward adopting the cookstoves.

The mango case study demonstrates the importance of understanding the roles, motivations and incentives of all key actors in the system when designing an intervention aimed at improving system outcomes for individual actors. It also highlights the need to work closely with the target users of a technology in the early stages of intervention design, both in co-identifying the problem and co-designing the intervention.

5.4. Connecting interventions to the wider social-ecological context

Users in our case studies are not behaving and making decisions in isolation; rather they are embedded in multi-level systems with other actors and ongoing processes. All three case studies highlight the importance of situating an intervention or change process within a broader societal context or social system. The mini grids case study in Zambia makes shows that it is important to acknowledge that development interventions operate within a social-ecological system. Despite economic incentives (e.g. low fixed tariffs) users were unable to afford the cost of the electricity service. The business model had failed to recognize that the intervention was introduced in a community highly dependent on seasonal incomes. This could easily have been acknowledged and designed for, if actors had been consulted early in the design process and implementation plan. In order to improve actors’ ability to pay on a regular basis, there is a need to diversify actors’ sources of income. In the mango case study, interventions were introduced that sought to change behavior and decisions in relation to agricultural management. However, the targeted value-chain was not thoroughly mapped to identify interconnected actor scenarios. Pre-and post-harvest technologies were introduced to farmers who in many cases were not involved in pre and post-harvesting of mangoes. In addition, farmers were assumed to be primarily mango farmers, yet mangoes were seldom their primary source of income. If the development and delivery of technologies had been an iterative and collaborative process involving all relevant stakeholders, it is likely that relevant actor groups and the most appropriate BCts for targeting them would have been identified early on.

5.5. Limitations and future research

The conceptual framework has been applied in only three cases, all located in either Kenya or Zambia, which may limit the generalizability of the findings to other contexts. In addition, the framework has so far only been tested in cases focusing on the uptake of new technologies, and not yet applied in cases where the focus is change of practice. However, the case studies focused on technologies that are relevant far beyond the geographic scope of the case studies, and on communities of smallholder farmers and households that share characteristics with millions of people in sub-Saharan Africa and South and Southeast Asia. Furthermore, for all case studies described here, the “real world” interventions in focus were already in the early implementation phase at the time we conducted fieldwork, which meant that we did not have the opportunity to study other phases, for example “upsaling”. Thus, our insights about the usefulness of the conceptual framework are based on the study of a limited number of stages of the intervention development process and the approach would benefit from further development and testing.

There is a growing number of studies that apply behavioural diagnosis and design approaches to intervention design, and some studies have conducted rigorous testing of the behavioural design approach (e.g. (Richburg-Hayes et al., 2017). In addition, there are studies looking at sustained change in behaviour, for example (Allcott & Rogers, 2014; Ashraf, Bandiera, & Jack, 2014; Hussam et al., 2016). Our proposed framework seeks to contribute to the field by addressing behavior change in complex systems where multiple behaviors need to change at different points in time during an intervention process, and where actions may be needed by a range of actors at different parts of the system.

6. Conclusions

Behavioral science-based approaches to designing and testing development interventions have come a long way in terms of identifying key cognitive processes and behavioral levers to trigger behavior change in low income settings. However, these approaches do not fully account for the complexity and interdependence within social-ecological systems, or for the fact that change processes, once triggered, play out over time and are experienced differently by different people or archetypes in a system.

The conceptual framework proposed in this paper seeks to merge the methodological approach of service design with behavioral insights to better address complexity in social-ecological systems. Service design offers both a process for carefully finding solutions, and a methodology for basing such solutions on a knowledge base that is as widely and inclusively informed as possible. The user journey component of the framework allows us to visualize the experiences and perceptions of users of a given technology or service throughout a change process and ensures that important behavioral drivers and social processes are captured at every phase of the journey. The systems mapping component situates the lived experiences of users within complex social-ecological systems and highlights connections between users and other potentially important actors and processes at different levels of society.

In the case studies presented here we examined the factors affecting a sustained shift in behaviors over time. These are situations where a change in behavior on the part of individuals and households is required every day, and where behavior may be influenced by multiple factors operating at different levels – cognitive, psychological, social and structural – and where feedback loops may occur. We show how the proposed framework can be used to pinpoint when in a in a temporal continuum a behavior change technique or group of behavior change techniques and behavioral determinant is relevant, at what point in the change process they matter, and based on this how those that steer interventions can intervene to support lasting behavior change. As such, the framework could help development practitioners and donors to plan and allocate constrained funding to focus on phase process
that is likely to need more attention and resources. Our aim beyond this article is to is to apply the framework in additional “real world” case studies, cases that focus on changing practices and to update and refine the framework accordingly. We are seeking opportunities for applying the framework in all phases of intervention design, from Problem co-definition to scaling and replicating.

Declaration of Competing Interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.worlddev.2019.104703.

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