The ICT-Artefact in Capability Approach: Analysing an ICT-enabled, Renewable Energy Intervention, in Rural Kenya

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ABSTRACT

This paper proposes a novel conceptualisation that holistically places the Information and Communication Technology (ICT) Artefact in Capability Approach (CA). The conceptualisation harmonises the different views about technology within CA-based frameworks in ICT4D, in order to address the inconsistencies. To demonstrate the utility of the conceptualisation, while simultaneously addressing the highest thematic research gap among post-2015 ICT4D research priorities, the study collected primary data from users of Pay-As-You-Go (PAYGO) solar kits who reside in rural Kenya. Using the conceptualisation, the study demonstrated that the ICT-artefact can holistically be placed within three of CA's concepts: under material resources as a capability input; as a new category of conversion factors (technological factors); and as a component within the structural context. The study further demonstrated how the same ICT artefact could play out in the three different conceptualisations, resulting in different development outcomes. The study finally presents the implications for policy and practice.

Keywords: ICT Artefact, ICT4D, PAYGO Solar, Kenya, Development Outcomes

INTRODUCTION

Information and Communication Technology for Development (ICT4D) is an emerging and vibrant field of practice and research, that focuses on the use and design of ICTs in efforts to further (socioeconomic) development (Burrell & Toyama, 2009; Kleine & Unwin, 2009; Stillman & Linger, 2009). ICT artefacts are critical components within ICT4D studies. They include "bundles of hardware infrastructure, software applications, informational content, and supporting resources that serve specific goals and needs in personal or organizational contexts" (Mehdi, 2018, p. 631).

Despite different conceptualisations of development within ICT4D, Capability Approach (CA) has emerged as the holistic lenses to conceptualise development. It has been used as a normative and analytical framework. Over a dozen CA-based frameworks have been developed to operationalise CA in ICT4D studies (Egessa et al., 2018b, 2020, 2021; Hatakka & Dé, 2011; Kivunike et al., 2014; Kleine, 2010, 2013; Zheng & Walsham, 2008). However, the ICT artefact, or technology (more broadly defined), is not conceptualised in a consistent way across the different frameworks. There is still no consensus in these frameworks, on how 'technology' relates to the core concepts of CA (inputs or 'resources', capabilities,

conversion factors, functionings, structural constraints and agency) (Haenssgen & Ariana, 2018, p. 99).

This paper makes a case for a re-configured analytical conceptualisation that holistically places the ICT artefact within CA. It demonstrates the utility of the novel conceptualisation using an ICT-enabled, renewable energy intervention, in rural Kenya.

The rest of the paper is organised as follows. Section two gives an introduction to on the theoretical background, including concepts of CA and Choice Framework (CF). Section three presents the proposed conceptualisation that holistically places the ICT artefact in CA. Section four describes how the innovative, ICT-enabled, renewable energy intervention works. Thereafter, the research design is described, followed by the findings and discussion. The paper then concludes by giving the implications for policy and practice.

THEORETICAL BACKGROUND

Capability Approach (CA)

CA is a normative theoretical framework for the evaluation and assessment of individual well-being and social arrangements; the design of policies; and proposals about social change. Its core idea is that social arrangements should aim to expand people's capabilities (their freedom to promote or achieve valuable beings and doings). It evaluates a person's achievements in terms of his or her actual ability to do or be, the different things a person has reason to value doing or being.

Sen (1999, p. 75) defines **functionings** as "the various things a person may value doing or being". Functionings are the valuable states (beings) and activities (doings) that make up people's well-being, such as a healthy body; being safe; being calm; working; resting; having a warm friendship; being nourished; being confident; being able to travel or taking part in political decisions. Functionings are related to resources (goods and income), but they focus on what a person is able to do or be as a result.

Capability refers to a person's or group's freedom to promote or achieve valuable functionings. Sen (1992, p. 40) posits that capability "represents various combinations of functionings (beings and doings) that the person can achieve. Capability is, thus, a set of vectors of functionings, reflecting the person's freedom to lead one type of life or another… to choose from possible livings".

In CA, the term **'resources'** is interpreted in a broader sense than the understanding of the term elsewhere in the Social Sciences. The focus is on material resources: either income and wealth or the consumption that these financial means (or unpaid production) generated. The resources and consumption could be conceptualised as capability inputs. They are means to the opportunities to be the person one wants to be, and to do what one has reason to value doing.

These resources do not all have the same power to generate capabilities. They depend on the individual's **'conversion factors'**, as well as **structural constraints**. Conversion factors either filter, amplify or modify the input characteristics. They determine the degree to which a person can transform a resource into a functioning. All conversion factors influence (enable or inhibit) how a person can be or is free to convert the characteristics of the resource into a functioning, yet the sources of these factors may differ.

Conversion factors are often categorised into three groups: personal; social; and environmental conversion factors (Crocker & Robeyns, 2009, p. 68; Robeyns, 2005, p. 99). The example of a bicycle is often used to illustrate the idea of different conversion factors.

Personal conversion factors are innate or internal to the person. They are characteristics and attributes that an individual can use, to enable them utilise resources, to realise a functioning that they have reason to

value. These factors include mental and physical conditions, metabolism, sex, reading skills or intelligence.

Social conversion factors are factors stemming from the society in which one lives in. They entail 'characteristics of social settings' such as public policies, social norms, practices that unfairly discriminate, societal hierarchies or power relations related to class, gender, race or caste.

Environmental conversion factors emerge from the physical or built environment in which a person lives. Aspects of one's geographical location are climate, pollution, likelihood of earthquakes, presence of seas and oceans. Among the aspects of the built environment are the stability of buildings, roads and bridges, and the means of transportation and communication.

The three types of conversion factors enable the acknowledgement that it is not sufficient to only know the resources that a person owns, or can use, in order to be able to assess the wellbeing that he or she has achieved or could achieve; rather, there is need to know more about the person and circumstances in which he or she is living.

Structural constraints can have a great influence on the conversion factors as well as on the capability sets directly. There is a difference between social conversion factors and structural constraints. While structural constraints affect a person's set of conversion factors including the social conversion factors that s/he faces, conversion factors only help to convert characteristics of resources into capabilities. Structural constraints affect conversion factors but can also affect a person's capability set without impacting on the conversion of resources into capabilities (Robeyns, 2017).

Figure 2.1 depicts a stylised visualisation of the core concepts of CA

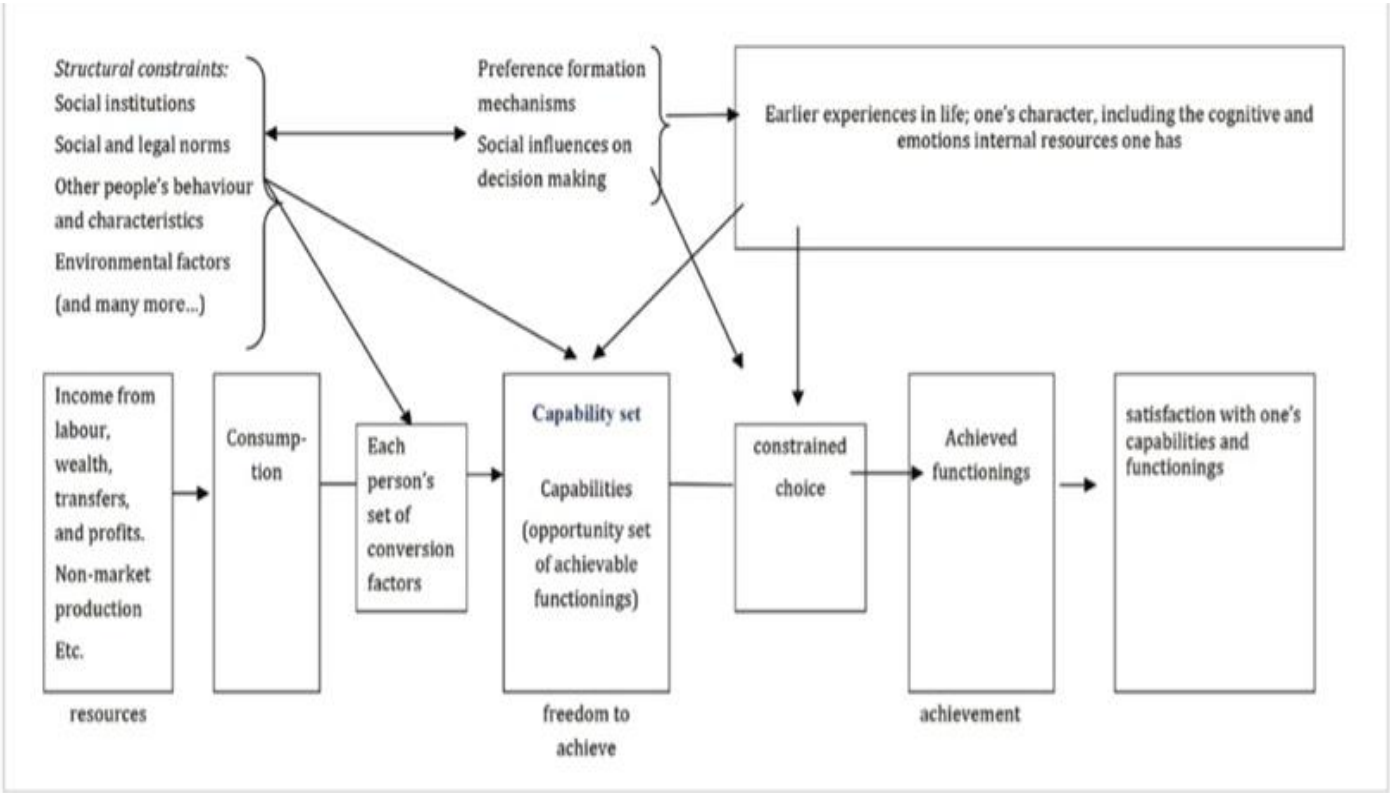

Figure 2.1: A Stylised Visualisation of the Core Concepts of CA

(Source: (Robeyns, 2017, p. 83))

Choice Framework (CF)

Due to the difficulty in finding a balance between CA's conceptual richness and its potential to be operationalised, CF is arguably the most widely used operationalisation of CA in the field of ICT4D (Sein et al., 2019; Zelezny-Green, 2018) Figure 2.2 shows the CF.

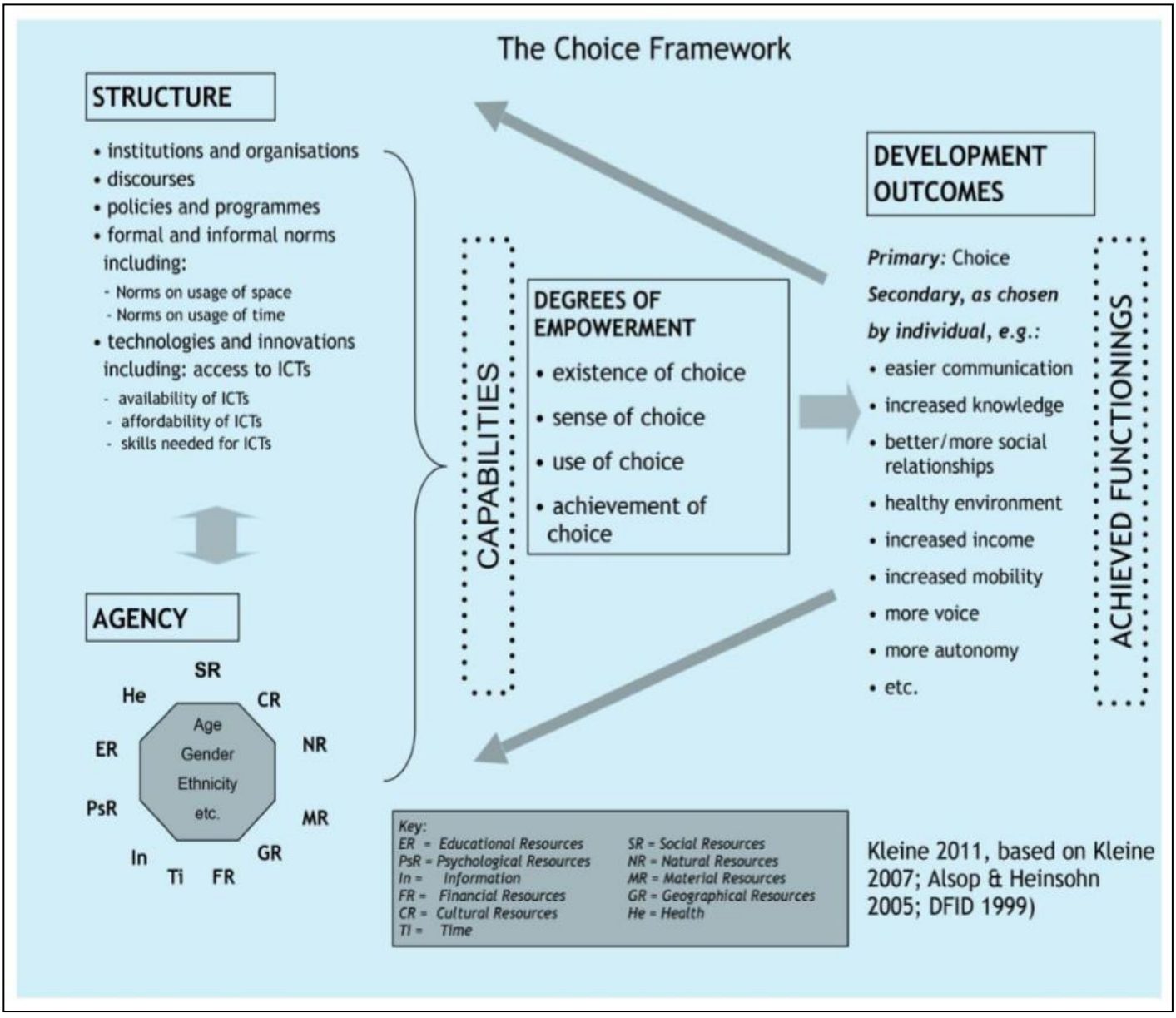

Figure 2.2: Choice Framework

(Source: Kleine (2013, p. 122) Based on Alsop & Heinsohn (2005); DFID (1999))

Informed by an in-depth research project with micro entrepreneurs' use of ICTs in Chile, Kleine (2010, 2013) draws elements from literature on Empowerment (Alsop & Heinsohn, 2005) and on Sustainable Livelihoods (DFID, 1999), to enhance the application of Sen's approach, by developing Choice Framework (CF).

The CF is read from right to left. Analysis starting from outcomes, then working backwards into the systematic relationships between agency, structure and choice, thereby analysing how the outcomes came to

be. CF places choice as the primary development outcome, while other secondary outcomes depend on the individual's choice as to what livings they value. The CF also has dimensions of choice, including: existence of choice; sense of choice; use of choice and achievement of choice.

However, CF falls short in remaining consistent with this study's reading of Sen's core concepts and terminologies.

Conceptual Framework

This paper intends to reduce the difficulty in operationalising CA within ICT4D, as well as remaining consistent with Sen's core concepts and terminologies. Therefore, it proposes having a reconfiguration and realignment of the various agency-based and structure-based capability inputs of CF into conversion factors in Robeyns (2017) stylised presentation of CA. The paper then harmonises the different conceptualisations of technology within CA-based frameworks in ICT4D. The paper further proposes the explicit and holistic addition of the ICT artefact as a component within the structural context, thus extending Haenssgen & Ariana's (2018) conceptualisation.

Kleine (2010, 2013) does not use the term 'conversion factors' in her CF. However, some of the resources in her individual-based capability inputs are described in a way that fits Sen's conceptualisation of 'conversion factors'. If the CF is adopted to evaluate the development outcomes in an ICT4D intervention, the material resources of the intervention become what is 'consumed' to generate capabilities and later functionings. The material resources are the physical objects with characteristics that enhance human capabilities directly. All the other resources in the portfolio will only play a facilitative role in the conversion process, that is, if at all they come into play. At the root of the analysis, it will boil down to a material resource that will provide the main 'generative' characteristics to achieve a functioning. The material resource could still double up in other places of the CA analysis (as this paper will later demonstrate), but at the core, it will act as the capability input.

To differentiate between resources and conversion factors, working backwards from an achieved functioning, an individual would not have achieved the functioning without the presence of the resource. However, with the absence of a conversion factor, the same individual could still have achieved the functioning, but to a different degree or intensity.

In this study's reconfiguration of the agency-based capability inputs by Kleine (2013), it is only material resources that are retained as a capability input. The rest of the resources are redistributed into the three conversion factors as described by Sen. Educational, psychological, information, health and financial resources are reconceptualised as personal conversion factors. Time, social and cultural resources are reconceptualised as social conversion factors. Lastly, geographical and natural resources are reconceptualised as environmental conversion factors. The reconfiguration and pairing up of the resources to the categories of conversion factors by Sen, is achieved by matching up their corresponding definitions.

Within CF, the structures that frame people's lives are related to the concept of structural constraints in CA. They include: institutions and organisations, discourses, policies and programs, formal and informal norms, as well as technologies and innovations. Contrary to Haenssgen & Ariana's (2018, p. 101) reading of CF's structures, and equating them to conversion factors, this study closely associates CF's structure with the structural constraints in the abstract CA. CF's structure is related, but not equivalent to conversion factors. It is more equivalent to structural constraints, as Robeyns (2005, 2017) defines it, in relation to CA.

This study conceptualises 'structural context' as an overarching construct that affects and gets affected by

almost all the other constructs. Structural context encompasses both the structure in CF and the structural constraints in CA. However, this study refrains from using the term 'constraint' because it connotes an inhibition, yet, the same construct could as well play an enhancement role to the other concepts.

Overall, this study proposes that the ICT-artefact be holistically placed within three of the constructs in the conceptual framework: under material resources as a capability input; as a new category of conversion factors (technological factors); and as a component within the structural context.

First, this paper is in agreement with Haenssgen & Ariana's (2018) argument that, in most of the operationalisations of CA, ICTs have been conceptualised as an input that enables capabilities, 'used' alongside other resources like food, to exploit its particular characteristics. Sen (Sen, 2010, p. 2) argues that the role of the mobile phone is typically 'freedom-enhancing' so that, as a resource, it is subject to conversion factors such as computer literacy and infrastructural context. The ICTs such as mobile phones have intrinsic characteristics that can expand human capabilities and therefore fulfil the same purpose as other inputs in CA. This 'generative' dimension of the ICT-artefact qualifies it for explicit inclusion as a material resource in CA analysis.

Secondly, in other operationalisations of CA, ICTs are conceptualised in a broader way. They are understood to interact with other conversion factors and influence how inputs are used. Gigler (2004, p. 9) states that 'ICTs can play an important role not only in their own right, but can act as 'agents' for the strengthening of the poor's capitals in multiple areas'. This operationalisation of CA therefore indicates the 'transformative' dimension of ICTs. Likewise, Heeks and Molla (2009, p. 34) contend that apart from being resources, ICTs can fit as conversion factors in CA. For example, technological objects can alter the characteristics (e.g nutritional content or taste) of other inputs (e.g food) by modifying them directly (e.g through a cooking stove). In a similar way, Lawson (2010) argues that other characteristics of technological objects extend human abilities, enabling them to do other things in a better way. Van den Hoven (2012) also describes the nature of technological objects as 'agentive amplifiers'.

In agreement with the arguments of Haenssgen & Ariana's (2018) on the 'transformative' dimension that technological objects possess, this study further proposes the explicit addition of another factor (technological factors), to the other three conversion factors (personal, social and environmental). This is necessitated because technological objects do not perfectly fit into any of the other factors, they neither conform to personal, social nor environmental factors.

Thirdly, taking the argument forward, since this study equated structure in CF to the 'structural context' in the conceptual framework, then technology will also have an explicit place in the 'structural context'. Kleine (2010, 2013) includes technology and innovations within elements of structure. Zheng (2009) argues that technology (especially ICT) co-evolves with values and choice processes. Zheng and Stahl (2011) suggest that technology may influence people's agency in attaining functionings. This perspective is similar to Coeckelbergh's (2011), who criticises the purely instrumental view of technology as an input for enhancing capabilities. His argument is based on the idea that humans are embedded in a socio-technological context, which forms part of their life. In CF, among the contextual structures is ICT together with its availability, affordability, and the skills required to operate it (Kleine, 2013, p. 44,49,50).

This paper's placement of ICTs within the 'structural context' is also in line with Heeks and Molla (2009, p. 34) who also argue that ICTs can act as 'choice developers' because they can change perceptions of personal needs and preferences. Figure 3.1 depicts the conceptual framework.

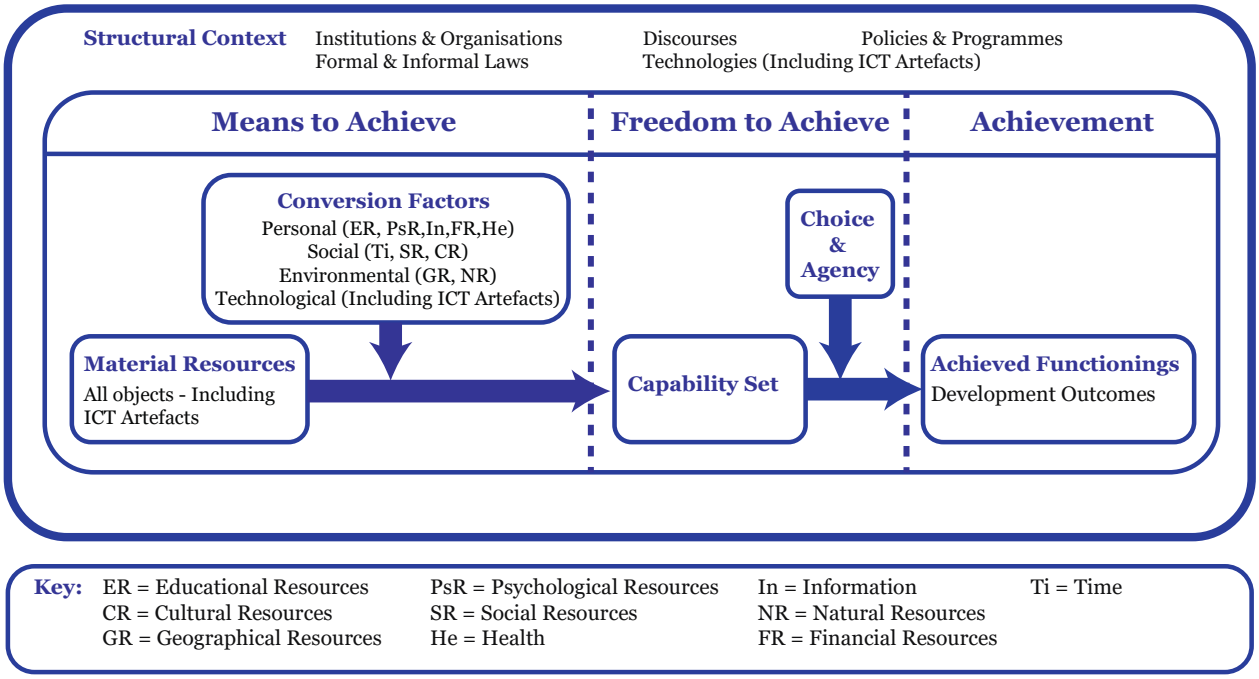

Figure 3.1: Conceptual Framework: Holistic Placement of the ICT Artefact in Capability Approach

ICT-enabled Solar Solutions

Topically, 'e-Environment and Sustainable Informatics' is considered to have the highest research gap among post-2015 ICT4D research priorities (Egessa et al., 2018a). The Sustainable Development Goals (SDGs) have included a specific target (SDG 7.1) solely for ensuring access to affordable, reliable and modern energy for all by 2030. This affirms the importance of access to modern energy services and centrality of energy in achieving many of the other SDGs (United Nations, 2015, 2017). To demonstrate the significance of the developed analytical framework, while equally addressing this topical research gap, the study collected primary data from users of Pay-As-You-Go (PAYGO) solar kits who reside in rural Kenya.

PAYGO refers to a conglomeration of technologies, payment arrangements, ownership modes and financing structures that allow the end user to pay for a solar kit in instalments. The embedded Machine-to-Machine (M2M) connectivity disables the system if a payment is overdue (G.S.M.A., 2016; M-KOPA, 2016)

The customer typically makes an initial payment of around 30 USD from a sales location for a basic Solar Home System (SHS) that consists of a Photo Voltaic (PV) panel, a battery and a control unit, two or three Light Emitting Diode (LED) bulbs, a phone charger and sometimes other appliances. The customer then makes regular payments (daily top-ups/ credits) of 0.30 – 0.50 USD per day to access the services. They are also allowed to buy credits in any amount, from a single day to 30 days or more. After the customer pays 365 credits, the system automatically switches to free use, requiring no further top ups. The customer then owns the system (BNEF & LG, 2016; G.S.M.A., 2017; M-KOPA, 2015).

The cost is normally calculated so that it is competitive with the daily expenditure on stop gap technologies, such as candles, allowing customers to save from day one. This however applies only to the most common types of SHSs. The payments are mostly made via mobile money although there are alternative ways, such as scratch cards, direct cash payments or using mobile phone credit. If the account is empty or in arrears, the SHS will not discharge power until a payment is made.

PAYGO customers under a lease-to-own model may also make use of the PAYGO activation technology to

collateralise the asset once all payment is made. This will enable them to purchase additional solar capacity, more appliances on offer like smart phones or smart television sets or even non-electrical products like water tanks or energy saving cook stoves. If another product is purchased, the system is closed and top-ups are re-introduced until the full payment is made once again (BNEF & LG, 2016; M-KOPA, 2015, 2016).

Proliferation of mobile phones in low income economies has been a major driver behind the PAYGO model. The number of people who own mobile phones far out strips those with access to other services such as grid power and banking (M-KOPA, 2015). The addressable market for PAYGO solar solutions remains largely untapped. GSMA (2017) estimates that two thirds of the 1.2 billion off grid population are covered by mobile connectivity. This presented an exciting opportunity to redesign solutions for people who are invisible to traditional service providers.

The PAYGO solar sector allows lower income customers to buy solar products on credit and pay small fees for continuous use. By mid-2017, over 1.6 million PAYGO solar units had been sold, having been an increase from 800,000 units that had been sold by 2016.

RESEARCH DESIGN

The study adopted a constructivist ontology and an interpretivist epistemology. The study used the embedded single-case design because within the single-case (PAYGO solar intervention) there are sub-units (different providing companies/brands). The population for the study were the users of ICT-enabled Solar Home Systems who reside in Junju and Sokoke County Assembly Wards in Kilifi South and Ganze sub-counties of Kilifi County, at the Coast of Kenya. Purposive sampling was used to select study participants. For the purposes of both triangulation and transferability, the study used three data collection methods: in-depth semi-structured interviews, observations and document reviews. 24 in-depth semi-structured interviews were conducted with users of 4 different PAYGO solar companies and 3 in-depth semi-structured interviews were conducted with representatives of 3 PAYGO solar companies. The interviews, which lasted between 30 minutes and 1 hour, were audio recorded. The recordings were later transcribed and translated from Swahili to English.

FINDINGS AND DISCUSSION

Just like in CF, this study begins the analysis from the right of the conceptual framework, coming to the left (Kleine, 2013). In line with Robeyns (2017), the study uses the term **'development outcomes'**, to refer to the achieved functionings, as a proxy to measure capabilities and wellbeing.

Development Outcomes Arising from PAYGO Solar Kits

For this study, development outcomes are conceptualised as valuable states (beings) and activities (doings) that make up a person's wellbeing, such as being safe, resting, and being calm. Arising from the in-depth semi-structured interviews, the research participants enumerated many states and activities that they valued and had reason to value. They also elaborated on their aspirations. From the analysis of their responses, several development outcomes emerged. This study shall however narrow down to only those development outcomes that were closely linked to the ICT artefacts that are bundled within the PAYGO solar kits. They include: **'communicating'; 'having additional study time'; 'increasing sense of security'; 'increased income'; 'making savings' and 'being entertained'**.

All the respondents valued **'communicating'** to people in a different location. This development outcome was made possible through the use of mobile phones. By implication and extension, all of them were happy with the PAYGO solar kits. The kits allowed them to keep their phones charged. Even before acquiring the

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solar kits, they kept spending cash regularly in order to keep their phones charged. This expenditure on charging their phones, despite their limited incomes, demonstrates the value that they had placed on communication via the mobile phones.

The respondents also valued **'being in a well-lit environment'** especially at night. This is demonstrated by the following excerpts from the interview transcripts.

*"What I perceive as the benefit for me is the lighting. It makes my place well lit…. I do not want this place to remain dark" –**Research Participant (RP) 10***

*"Right now, even my mother has benefitted because if she wakes up at night, she does not have to look for a matchstick in darkness so as to light the tin lamp, she just puts on the switch. She is very grateful because going to sleep and waking up is no longer challenging because I connected for her a bedside switch. She is very happy with the solar kit and really supports it." – **RP 15***

*"The solar kit is important because without it, there will be darkness yet we are used to bright light, just like during the day…"- **RP 6***

*"We installed the solar kit in our home because it was dark and we were bypassed when the government installed the 'free electricity'. Our neighbours got connected but we did not…..The solar kit provides adequate lighting, it does not have any issues" – **RP 12***

*"I acquired the solar kit because I had great need for electricity so that I could ……, have this place to be well lit at night and …" – **RP 9***

Being in a well-lit environment is a development outcome that was closely linked to **'having additional study time'**. Most respondents who valued being in a well-lit environment also demonstrated desire to have their children or siblings, study for longer at night, courtesy of the bright lighting from the solar kits. The following excerpts from the interview transcripts demonstrate this.

*"It has helped on the side of my children. Especially at night, they usually switch on the lights and put them on the table for reading. That has really helped me, – **RP 3***

*"I acquired the solar kit because when I used to get back from work, I would get reports from my children that they would like to read but there is no light….. So I decided to acquire the solar kit so that my children could have extended study time – **RP 11***

*"I installed the solar kit so that it could help my children with studies in the evenings, you know we live in quite a remote area that is not connected to the electricity grid"- **RP 17***

*"At least the children are improving their performance in school, the one who was position 20 last term has now climbed to position two, another one became position 5. At least there is some improvement because it helps them during revision"-**RP 17***

*"first and foremost, the children are very happy with it because they no longer have to use the tin lamp. It (solar bulbs) has really helped them in their studies. You cannot study using the tin lamp from outside here, there is a lot of wind, so the solar kit has come with goodness. I have sisters who are still in school and they also like the lighting because it makes them be in a well-lit area – **RP 10***

*"It even helps the children to read while at home"-**RP 2***

The respondents also valued **'increasing sense of security'**. This is also a development outcome that was

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also closely linked to being in a well-lit environment. It may be seen a subsequent development outcome. The following excerpts from the interview transcripts demonstrate this.

"My security light has made this place well-lit at night, even my neighbour who owns that shop now says that thieves cannot attack his shop because the light covers till there" ***– RP 11***

"…I keep livestock, so the light has helped because I do not want this place to remain dark. The light enhances security by making this place open" – ***RP10***

*"We placed two bulbs in each of the three houses including our mother's house which is big. We also placed one security light outside mum's house." –****RP 12***

Another main development outcome that emerged from the field visits is **'increased income'** which is also closely tied to the development outcome of **'making savings'** on expenditure. Different respondents were engaged in different economic activities. Therefore, the development outcome of '**increased income'** mattered because it was linked to the ICT artefacts that come together with the PAYGO solar kits. The ICT artefacts are either 'consumed' as a service, in exchange for cash, or they enhance an economic activity that generates cash for the owners. This development outcome is demonstrated by the following excerpts from the interview scripts.

"To say the truth, I normally earn from charging people's phones. I normally charge about 20 phones in a day. Charging one phone costs Kshs. 15, therefore I earn about Kshs. 300 per day and Ksh. 2,100 per week. Had I not installed this solar kit, I would not be earning the Ksh. 300 daily. I normally make repayments of Kshs. 800 weekly, to the solar provider. I therefore remain with the surplus" ***– RP 9***

"I also charge other people's phones at a cost of only Kshs. 10…..I have some additional income. Before possessing the solar kits, I never used to charge mobile phones for people, which I now do. For the little cash that I get, I am grateful." ***– RP 3***

"The solar kit has somehow improved my earnings because when I charge someone's phone, I get some small money. I charge phones at Kshs. 15…..Sometimes, I can charge upto ten phones because the display on the battery shows four bars. Even if the four bars get consumed and I remain with a single bar, that is enough for lighting the house at night" – ***RP 2***

"… we have placed here the TV and we charge people to enter to watch the TV. They normally start coming in at about 6.30pm and depart at about 11.00pm" – ***RP 22***

The respondents also valued **'making saving'** on their expenses. This is demonstrated by their enthusiasm that they exhibited when describing the kind of savings that they made on foregoing kerosene purchases.

"In terms of lighting the house, the solar product really helped a great deal because I stopped buying kerosene."

"Before purchasing the solar panel, I used to buy kerosene. In that regard, the solar panel helped a lot."

"Had I been using kerosene lamps and say I lacked kerosene on a particular day yet the baby cries at night, how could I help myself? That would be problematic….Had it not been for the solar panel, I would have been in huge problems during that period" – ***RP13***

. Once you pay up all the instalments, you get to fully own the solar kit. For example, I currently neither have to pay the instalments nor buy kerosene. I feel great." – ***RP 3***

"whenever you have solar lamps, you do not have to spend on kerosene" – ***RP 8***

"Before I acquired this solar kit, I could sometimes lack money to purchase kerosene and therefore remain in darkness. But right now, even with cash spent on other things, the solar kit is normally there to provide light." – ***RP 2***

Lastly, the respondents also valued **'being entertained'** or **'being relaxed'**. A number of them would do it by engaging in sporting activities while others liked watching TV. Many of the residents in the villages would pay to enter video viewing shops to watch news and movies. This is demonstrated by **RP 15** who liked going to video viewing shops at the market centres to watch news in the evenings. **RP 21** and **RP 22** operate an establishment that charges people to watch TV. Going by the number of people who flock the establishment on a daily basis, it therefore shows that the people actually value getting entertained. The following excerpts from the interview transcripts demonstrate the same.

"The solar kit is beneficial because we have placed here the TV and we charge people to enter to watch the TV. They normally start coming in at about 6.30pm and depart at about 11.00pm"- ***RP21***

"We want the television set for us to enjoy life too…..We also want to enjoy life. We want to watch soccer even if we are not die-hard fans…..You know after working the whole day, you can come back home and relax, watching soccer or any other programmes like Bongo movies. Even the children would be happy." – ***RP12***

The Holistic Place of the ICT Artefact in CA

ICT Artefact as a Material Resource

As a material resource, the ICT artefact becomes the means to the opportunities of value, which an individual may want to be or do. In order to achieve the desired outcomes, the individual has to consume the characteristics of the material resource while navigating the structural context to achieve the capability set. The transformation from the resource to a capability will be enhanced or inhibited by conversion factors. The individual will then have to draw from his agency and decision-making mechanisms in order to choose a functioning from his capability set.

From the findings of this study's field visits, the following artefacts could be conceptualised as material resources – phone charger, TV and radio.

Phone Charger as a Material Resource

The phone charger that comes bundled with the PAYGO solar kits can be conceptualised as a material resource. This conceptualisation will fit those who use it for economic purposes. Those who charge other people's phones as a service, at a cost. To the owners of the PAYGO solar kits, the accompanying phone charger will act as a material resource that will lead to the development outcome of '**increased income'**. The following are excerpts from the interview scripts demonstrating this conceptualisation

"to say the truth, I normally earn from charging people's phones. I normally charge about 20 phones in a day. Charging one phone costs Kshs. 15, therefore I earn about Kshs. 300 per day and Ksh. 2,100 per week. Had I not installed this solar kit, I would not be earning the Ksh. 300 daily. I normally make repayments of Kshs. 800 weekly, to the solar provider. I therefore remain with the surplus" – ***RP9***

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"I also charge other people's phones at a cost of only Kshs. 10… I have some additional income. Before possessing the solar kits, I never used to charge mobile phones for people, which I now do. For the little cash that I get, I am grateful." – ***RP3***

"The solar kit has somehow improved my earnings because when I charge someone's phone, I get some small money. I charge phones at Kshs. 15… Sometimes, I can charge upto ten phones because the display on the battery shows four bars. Even if the four bars get consumed and I remain with a single bar, that is enough for lighting the house at night" – ***RP2***

The same phone charger in the same conceptualisation as a material resource also resulted in the development outcome of '**increased savings'** for the following respondents.

"My parent and siblings have phones, so they just charge from my solar kit at no cost since it is from home"- ***RP1***

"My wife, siblings, mum and I, no longer spend to charge our phones or buy kerosene" – ***RP6***

"I no longer take my phone there for charging. I charge my phone using my own solar kit" – ***RP 3***

TV as a Material Resource

The TV that comes bundled together with the PAYGO solar kits can be conceptualised as a material resource, a means to achieve the different development outcomes. From the field visits, the TV artefact was able to achieve **'increased income'** for those who were enterprising and who charged a fee, so that others could watch.

*"The solar kit is beneficial because we have placed here the TV and we charge people to enter to watch the TV. They normally start coming in at about 6.30pm and depart at about 11.00pm" –***RP 22**

On the other hand, the TV artefact was also able to be conceptualised as a material resource to achieve the development outcome of **'being entertained'** or **'being educated'**

"We want the television set for us to enjoy life too… We also want to enjoy life. We want to watch soccer even if we are not die-hard fans… You know after working the whole day, you can come back home and relax, watching soccer or any other programmes like Bongo movies. Even the children would be happy." – ***RP12***

Through paying before watching TV at **RP 22's** establishment, and also by indications by **RP 15** and **RP6** relatives, it is implied that they were achieving the development outcome of **"getting entertained"**

"before I acquired this solar kit, I used to love going to video showing joints or even to bars that have a TV because I loved watching news and other programmes…but nowadays whenever I am tired from work, I just come and relax at home. The TV keeps me busy"- ***RP 15***

"nowadays my siblings do not roam around and say that they have gone to watch TV at the neighbour's place, they just watch TV from here" – ***RP6***

The TV becomes a material resource for a person who watches TV as a means to an end. Either the owner of the PAYGO kit, a member of the household with the TV bundled with the PAYGO, or a patron who has paid to watch the TV.

Radio as a Material Resource

Just like the TV, the accompanying radio in the PAYGO solar kits can also be conceptualised as a resource. It also provides a means for the users to achieve the development outcome of **'getting entertained'**

On the day of the installation, they put the music system on and danced a lot. The young ones really enjoyed themselves. But now, the music cannot play because there is no electricity. We have not paid" – ***RP 18***

Figure 6.1 depicts the phone charger, TV and radio as material resources to generate the capabilities of increased income; making savings; being entertained and being educated.

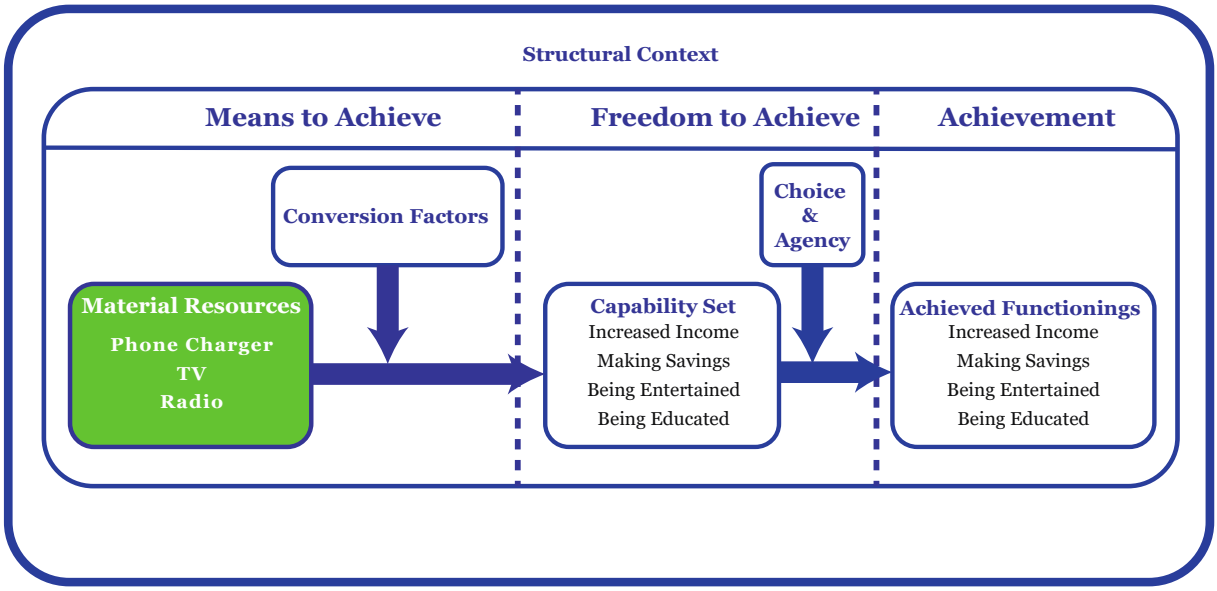

Figure 6.1: ICT Artefact as a Material Resource

This conceptualisation is in line with other scholars who have depicted in their analysis, the ICT artefact as a capability input (Haenssgen & Ariana, 2018; Ibrahim-Dasuki & Abbott, 2010; Kivunike et al., 2014; Ruhiu, 2016). They have however used different names for the ICT component: ICT intervention; commodities e.g. socio-technical interventions; ICT characteristics and technical objects.

ICT Artefact as a Conversion Factor

For this conceptualisation, the 'transformative' dimension of the ICT artefact is demonstrated. It alters the characteristics of other material resources by modifying them directly. The ICT artefact as a conversion factor either inhibits or enhances the transformation of the material resource to capabilities. The findings indicate that the phone charger, the controller & the cloud-based system (machine to machine communication device), the TV and the mobile payment service, were the ICT artefacts (within the PAYGO solar kits) that could be conceptualised as conversion factors.

Phone Charger as a Conversion Factor

For the phone charger to act as a conversion factor in the analysis, the end goal of the usage of the phone matters. If by using the phone, the individual has achieved a functioning, then, the phone will be conceptualised as a conversion factor.

This conceptualisation was demonstrated by those respondents who only charged their phones and those of

their loved ones at no pay and for personal usage.

"The solar kit has helped me charge my phone, it charges well…My parent and siblings have phones, so they just charge from my solar kit at no cost since it is from home" –**RP 1**

*I just charge phones that belong to my family members, I do not do it as a business"***- *RP 15***

"I own two mobile phones, my wife has one, my two children also have one each and my brother also has one. All of us used to take the phones for charging at a fee. The cost of charging one phone is Kshs. 20. So if you calculate the cumulative cost of charging all those phones, it comes to about Kshs. 80 or 100 per day… but now things are a lot easier. All of them charge from here and it is sufficient, it has no problems" – **RP 8**

This conceptualisation can be contrasted with the earlier conceptualisation of the phone charger as a resource. For the previous conceptualisation, the phone charging service has to be used as an income generating venture.

PAYGO Controller and Mobile Payment Service as a Conversion Factor

The modalities of how the controller works was mostly invisible to the interviewees. However, from the interviews with the providers of the PAYGO solar kits and from document reviews, it was apparent that the whole working of the PAYGO model was pegged on how the controller works. It was the core enabler and inhibitor of the usage of the PAYGO solar kits.

Though this conceptualisation seemed invisible to most respondents, it was quite apparent to **RP 15** because he encountered problems with his PAYGO solar kit. The problems were able to be sorted remotely via the controller. This enabled him to continue with the use of the other material resources provided by the PAYGO solar kit such as lighting bulbs and watching TV.

"It was on a Saturday afternoon when the lights went on and off, just like it happens when power fluctuations occur. That forced me to call their customer care, they said that since it was computerized, they could troubleshoot and repair it remotely. They found out that it was the controller that had a problem but since it was on a weekend, they promised to come the following Monday. When they came, they replaced the controller and things went back to normal." – ***RP15***

*"**SOLA4** is different from the other providers, starting with the repayment amount and duration, the amount of light emitted, and the appliances that come with the solar kit. Their wiring is of high standard if you compare it to **SOLA1**. Their panels are also larger and their service is of high standards. They keep visiting you time and again to know whether you are experiencing any challenges. If you encounter any challenge with the kit, say the lights just go off and you do not know what the problem is, they can check your kit from their end, make the necessary repairs remotely and you will find that you get back your electricity"***- *RP9***

Unlike the controller as an artefact, the mobile payment as an ICT artefact was visible to the respondents. They all knew that they had to make regular payments or else, their electricity would get disconnected. They knew that it was the mobile payment that enabled their getting electricity in order for them to pursue their different development outcomes.

TV as a Conversion Factor

The TV artefact in the PAYGO appliances can also be conceptualised as a conversion factor. Just like the phone charger, for a TV to be the conceptualised as a conversion factor, the development outcome matters. There has to be another capability input (material resource) that gets transformed into a capability. The TV has to influence the conversion process from a resource to a capability. The presence of the TV should either

increase or reduce the attainment of the development outcome.

The TV was conceptualised as a conversion factor when it was used to enhance attainment of other development outcomes. For the case of **RP 22** who owned a traditional bar, the TV was used to attract patrons. The TV used to be left on, till the patrons were done with partaking their palm wine.

Though other respondents who owned traditional bars did not get the TV with their PAYGO solar kits, they indicated similar intentions. They believed that being in possession of a TV would have attracted more customers to their bars so that they could get **'increased income'** from the sale of palm wine.

Figure 6.2 depicts the phone charger, PAYGO controller, mobile payment service and TV as conversion factors for the capabilities of communicating; additional study time; increased security; increased income; being entertained; being relaxed and increasing saving.

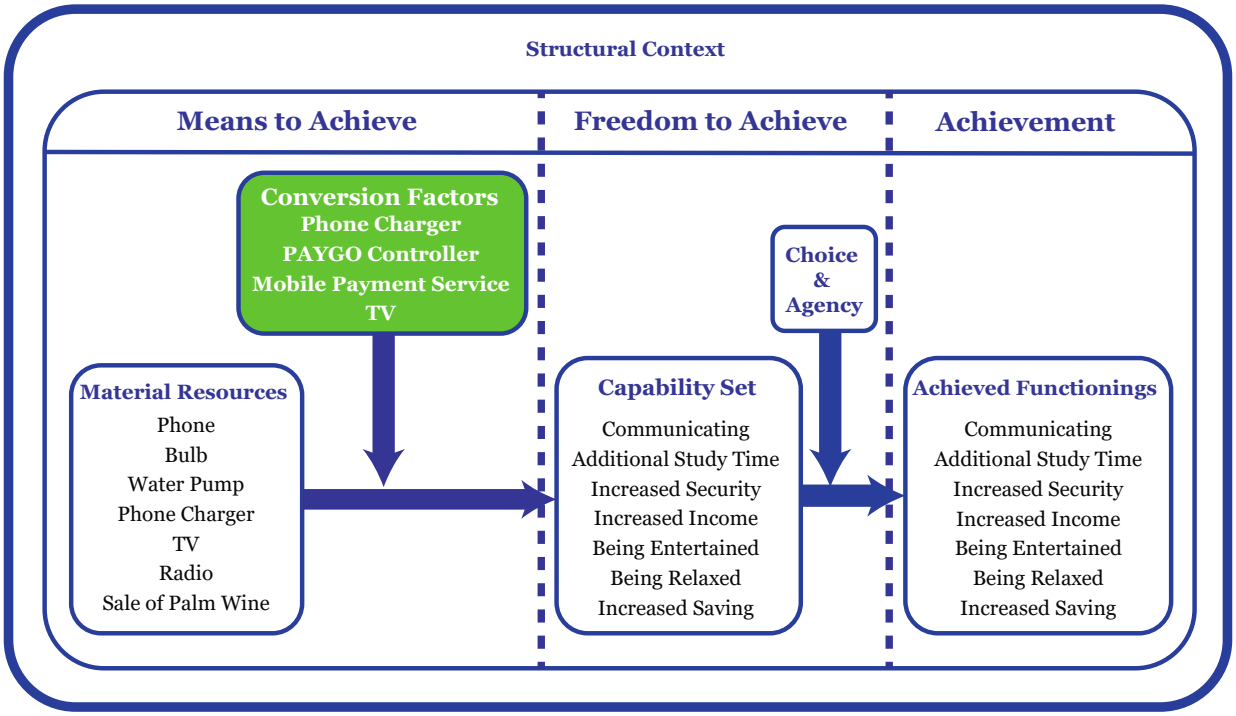

Figure 6.2: ICT Artefact as a Conversion Factor

From the conceptual framework, the ICT artefact can be broadly conceptualised as a conversion factor. This is as an addition to the three traditional conversion factors (personal, social and environmental) (Haenssgen & Ariana, 2018). Conversion factors influence how other material resources are used as means to development outcomes (functionings). In this way, the ICT artefact as a conversion factor is understood to interact with other conversion factors. This conceptualisation is in line with other scholars who have alluded to such a conceptualisation (Gigler, 2004; Heeks & Molla, 2009; Zheng, 2009).

ICT Artefact as a Structural Context Component

Components in the structural context can have great influence on the conversion factors as well as on the capability sets directly. This is unlike conversion factors which only help to convert characteristics of resources into capabilities. The ICT artefact conceptualised in this way should also have the ability to influence other conversion factors in the conversion process.

The findings indicate that the phone charger, TV and PAYGO controller could be conceptualised as

structural context components.

Phone Charger as a Structural Context Component

This is the third conceptualisation of the same ICT artefact, in the same PAYGO solar kit, but intended to achieve different development outcomes. At first, the phone charger was conceptualised as a material resource when it was used to provide phone charging services as an economic activity. This is when the development outcome expected is **'increased income'**. The characteristics of the phone charger get combined with the geographical resources as a constraining factor (being off-grid), get transformed to **'increased income'** as a capability for the owner of the charger. This is demonstrated in section 6.2.1.1.

Subsequently, the phone charger was also conceptualised as a conversion factor when the charging of the phone was for personal use. It was also similarly conceptualised for charging phones belonging to loved ones at no cost. In such cases, the phone is the one that is conceptualised as a material resource while the charger influences its transformation to a valued capability.

In contrast, the third conceptualisation of the phone charger is that of a structural context component. This conceptualisation is used when the phone gets to be conceptualised as a conversion factor.

When the phone influences the conversion of other material resources into development outcomes, by the phone charger influencing the working of the phone, then it will ultimately be influencing a conversion factor and therefore fall within our definition of what constitutes a structural context component.

In a case where an individual uses his/her phone to conduct or facilitate economic activities, then, the phone charger will influence the usage of the phone. From the field visits, **RP1** and **RP6** depend quite a bit on their mobile phones for their livelihood. **RP1** is a middleman for selling cattle. He normally gets contacted via phone, whenever there are cattle to be sold. **RP 6** normally taps palm wine from the palm trees and sells it to the traditional bars. He mostly contacts his clients via the mobile phone, to get orders. He also uses his phone to contact buyers of bananas when they are on season.

"The solar kit has been beneficial in my work by enabling me to charge my phone. Before I acquired the kit, there were time I was not reachable via the mobile phone for about six hours daily because of lack of charge. I used to lose lots of work. But since I acquired it, I normally charge my mobile phone at night. When I leave the house in the morning, my phone is usually charged and this ensures that I am reachable via phone. In my line of duty, I have to be contacted before I head for work." **–RP1**

"In terms of my work, the solar kit has helped me charge my phones so that I can communicate with my clients, those I supply palm wine and even those I supply bananas when they get ready" –**RP6**

In such cases, the phone charger can be conceptualised as a structural context component because it either enhances or inhibits the usage of the mobile phones and in these two cases, the mobile phones are acting as conversion factors in getting to the capability of **"increased income".**

TV as a Structural Context Component

This is similarly a third conceptualisation of the TV within the conceptual framework. The TV will be conceptualised as a structural context component when it alters perceptions and changes preferences. The findings demonstrate that the TV can alter behaviour and change preferences. In this conceptualisation, the TV does not come between the material resource and capabilities but influences the choice and agency that occurs between the capabilities and functionings. This demonstrates the alteration in preference formation.

"I am now grateful because I keep myself busy. Initially, I used to mostly visit friends to catch up so as to

pass time. I could get bored while at home. But right now, you may come here and you you think there is no one at home because I normally just lock myself indoors…The TV has helped me because it has kept me away from many other vices because I just get busy by myself here, no one comes here. You know, as ladies we have the tendency to gossip and the word goes round and comes back to haunt you. I feel that the TV has been one way that greatly helped me keep away from the gossip because it keeps me busy. When I finish my daily chores and my husband is not in, I just lock myself indoors and watch TV. When I get tired, I sleep. It has helped me a lot because I do not roam a lot and therefore it has kept me away from a lot." – ***RP14***

"I enjoy watching 'Bongo' movies and gospel music. I love 'Bongo' movies because they are educative. I get to learn about marriage. Most of them act about challenges encountered in marriages. So you may be watch and relate because the actors could be facing the same challenges that you are facing and they overcome. So it motivates you to confront your challenges so that you can also overcome"- ***RP14***

Figure 6.3 depicts the TV, PAYGO controller, phone charger and mobile payment service as components of the structural context.

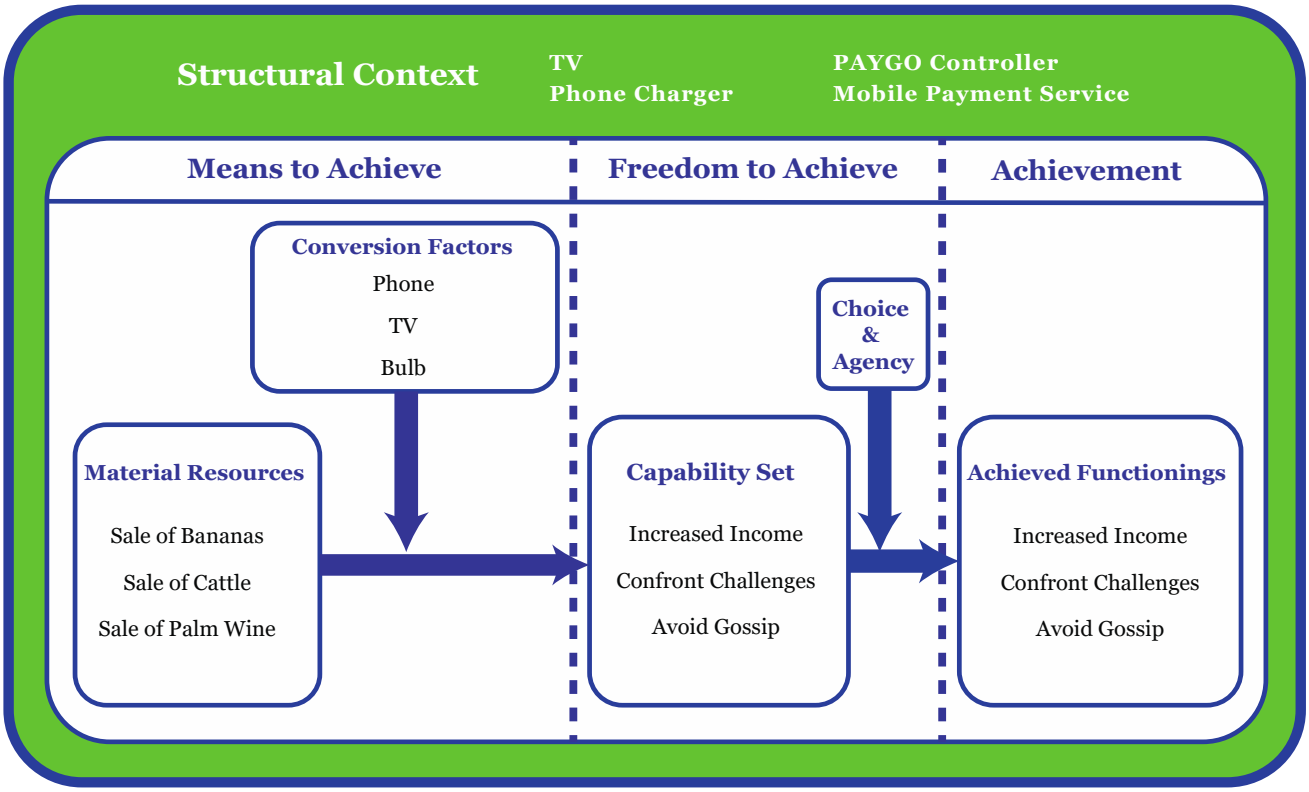

Figure 6.3: ICT Artefact as a Structural Context Component

In the conceptual framework, the structural context is an overarching concept that affects and gets affected by almost all the other concepts in the framework. This is in line with Heeks and Molla's (2009) argument.

CONCLUSION AND RECOMMENDATIONS

Being attentive to the different conceptualisations of the ICT artefact as demonstrated by the study can be of help to practitioners and providers of ICT4D interventions. The providers of the ICT artefacts will be able to consider how the artefacts play out in the development journey of their customers. This will enable them to put in place mechanisms that will enhance the related constructs to help achieve the valued development outcomes.

Additionally, the different conceptualisations demonstrated by the study can be of help to policy makers, especially those seeking to create social policies that enhance people's capabilities. Having the bigger picture of all the conceptualisations of the ICT artefact will give guidance on what policies to make for greater impact.

For further research, the study recommends the use of other research designs such as multiple case studies. Employment of ethnography could also help bring out aspects about the respondents that this cross-sectional study could not.

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