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The place of technology in the Capability Approach

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ABSTRACT

Increasing scholarly attention has focussed on how to integrate technology within the Capability Approach (CA), yet without a consistent solution. Some describe technology as a special kind of capability input, but others consider the concept of technology to be fundamentally different from that of an ordinary input. We aim to contribute to the theoretical development of the CA by offering a consistent justification for the explicit inclusion of technology in this framework. We propose that technical objects have a 'generative' and a 'transformative' dimension through which they enable capabilities directly and affect other inputs in the attainment of valued capabilities. The objects acquire the transformative dimension from the broader technological context, which we propose as a new class of conversion factors. Using the example of mobile phones and their role in healthcare access, we demonstrate that our proposal helps to frame the analysis of the development impact of technology.

Abbreviations: CA: Capability Approach; ICT: Information and communication technologies; IT: Information technology; SMS: Short message service

KEYWORDS

Capability approach; technology; mobile phones; health; India; China

1. Introduction

The Capability Approach (CA) was designed as a normative framework to evaluate the quality of human life and the process of development (Robeyns, 2006, p. 352).[1] It places emphasis on people as ends rather than means of development, where development is understood as an expansion of humans' ability and freedom to live the life they value (Stewart & Deneulin, 2002, p. 64). The CA not only offers a perspective on how we should evaluate 'development', but it has also been applied more widely within development studies to analyse the impact of development processes and interventions on people's lives.

Researchers have recently begun incorporating the notion of 'technology' in the CA (Andersson & Hatakka, 2013, p. 288; Heeks & Molla, 2009, pp. 33–40; Oosterlaken & van den Hoven, 2012, p. 7). Normative analyses of technology investigate for instance how technology-related development processes would be deemed valuable from an individual perspective (Birdsall, 2011; Johnstone, 2007). Variations of the CA have also been applied to exploratory analysis that study, for example, the link between technology, human development, and economic growth (Ranis & Zhao, 2013, pp. 468, 469).

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However, there is no harmonised underlying notion of how technology should be conceptualised within the CA (Andersson, Grönlund, & Wicander, 2012, p. 1). Our aim is to provide a justification for the explicit inclusion of technology and thereby contribute to the theoretical development of the CA.[2]

To this end, we review the prevailing notions of technology in the Capability Approach literature and reconcile the various perspectives through reflections on the concepts of technical objects and technological conversion factors, drawing on the disciplines of cultural anthropology and sociology. We propose that technical objects do not only have a 'generative dimension' that makes them an input like other objects in the CA. Technical objects also have a 'transformative dimension' through which other inputs are affected in the attainment of valued capabilities. In this transformative capacity, technical objects behave like other conversion factors. The objects acquire transformative properties from the broader socio-technological context, which we propose as a class of conversion factors alongside the commonly identified individual, social, and environmental conversion factors. The technological context and, by extension, technical objects interact with these conversion factors, introducing additional interpersonal and inter-group variation in the conversion of inputs into valued capabilities.

Our paper fills an important conceptual gap in the Capability Approach and adds to the recent contribution by Oosterlaken (2011), who discusses the notion of technology in the Capability Approach with a focus on the inter-relationship between technical objects, individuals, and social structures. By locating technology and technical objects within the CA, we are not trying to add another operationalised framework (e.g. Gigler, 2004, 2011; Kleine, 2010, 2011, 2013; Miroro & Adera, 2014). Instead, our aim is to contribute to harmonising existing approaches through a discussion of the notion of technology at a fundamental and abstract level within the language of the Capability Approach. Our work at this abstract level thereby does not invalidate but helps to support the justification and interpretation of the concept of 'technology' in existing frameworks based on the CA.

We believe that our contribution can aid framing the analysis of the development impact of technology. The example of mobile technologies and their role in healthcare access in rural India and China will be used to illustrate the multiple roles that technology plays in human development. The illustration demonstrates that the technology-enabled CA does not merely highlight the contributions of technology to people's capability sets, but also, for example, that interpersonal variation in technology use can accentuate inequities.

2. Existing notions of technology in the Capability Approach

In development studies and beyond, the Capability Approach has been used widely both as a normative and as an analytical framework to conceptualise and explore human development. CA applications to technology in general, and to information and communication technologies (ICTs) in particular, have also become increasingly widespread. Yet, there is no consensus in the capability literature on how 'technology' relates to the main elements of the basic CA (i.e. inputs or 'resources', capabilities, conversion factors, functionings, and agency, as summarised in Figure 1).

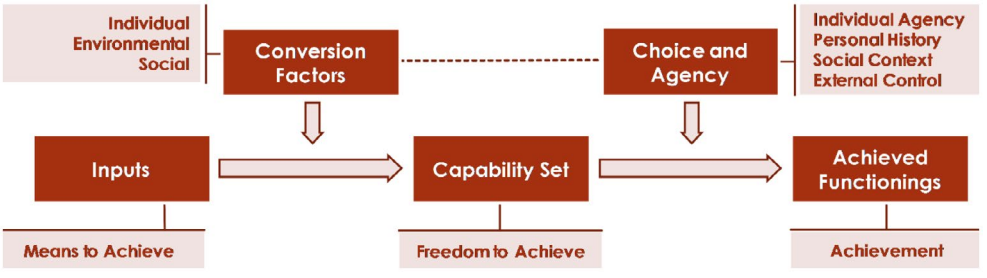

Figure 1. The basic framework. Source: Authors, adapted from Robeyns (2005, p. 98).

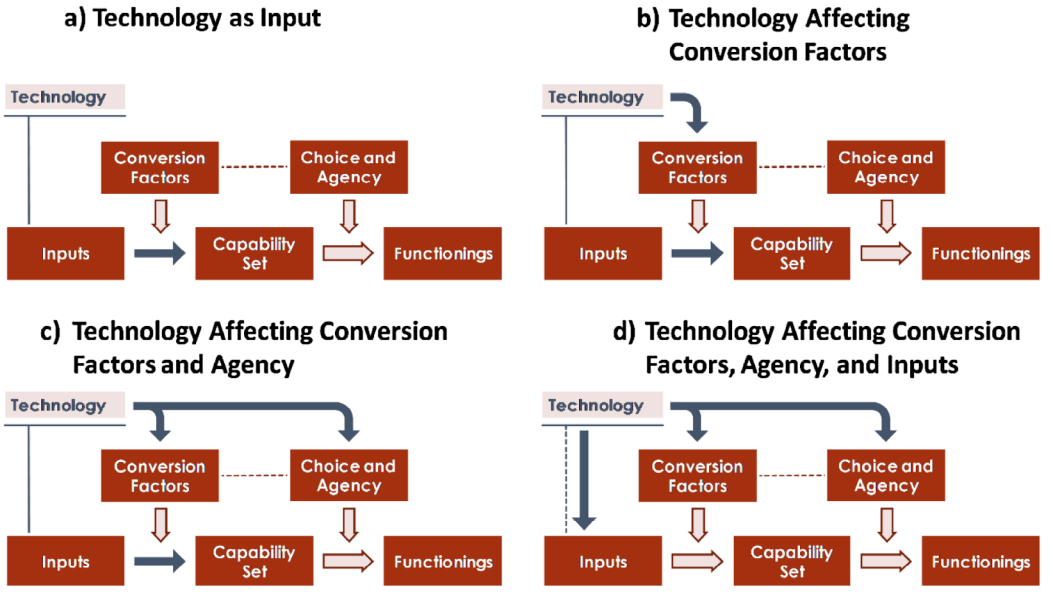

Figure 2. Conceptions of technology in the Capability Approach literature. Source: Authors, adapted from Robeyns (2005, p. 98).

This section reviews a selection of approaches, drawing on theoretical arguments as well as operationalised frameworks, both of which we translate back into the most abstract version of Sen's Capability Approach for our analysis (see e.g. Robeyns, 2005, p. 98).[3] We start with the conceptualisation of technology as an input, from where we proceed with more complex notions, all of which are depicted in Figure 2, Panels a to d. The review will highlight challenges related to either too narrow or conceptually conflicting notions of technology in the CA. In the next section, we develop our own notion of technology in the CA from the bottom up, drawing on the literature from the disciplines of cultural anthropology, sociology, and philosophy of technology.

According to the CA, capabilities are generated by inputs, or, more precisely, the characteristics of inputs, such as nutrition arising from the intake of the nutrients that are inherent in various foodstuffs (Sen, 1981, pp. 24–26). The transition from input (or an input's characteristic) to capabilities is subject to conversion factors that filter, amplify, or modify the inputs' characteristics. Capabilities are the basis for the achievement of functionings subject to people's agency and choice, from which they may derive utility value (because the CA was developed as an explicit critique to utilitarian approaches to development, we refrain from applying the concept in the remainder of this paper; Alkire, 2005; Stewart & Deneulin, 2002).[4]

The most common conception of technology in the CA is that technology is an input that enables capabilities, 'used' alongside other resources like food to exploit its particular characteristics (see Figure 2, Panel a). Sen (2010, p. 2) argues for example that the role of the mobile phone is typically 'freedom-enhancing', so that – as a resource – it is subject to conversion factors like computer literacy and the infrastructural context. Oosterlaken (2011, p. 426) explains that 'cars and bicycles expand people's abilities "to move freely from place to place"'. According to this depiction, technology is different from other inputs because it advances different capability sets such as mobility or cognitive processes (Alkire, 2005, p. 4; May, Waema, & Bjåstad, 2014, p. 17; Oosterlaken, 2009, p. 94; Robeyns, 2005, p. 99). At the same time, mobile phones, cars, and bikes are defined to have intrinsic characteristics that can expand human capabilities and therefore fulfil fundamentally the same purpose as other inputs in the CA.

A broader conception of technology includes interactions between technology inputs and conversion factors (Figure 2, Panel b). Johnstone (2012, pp. 85, 86) refers to this as systemic effects on individuals' capability sets that emanate from the socio-technological environment. This suggests that

systemic effects of technology influence our environment and its conversion factors, rather than the other way round (Johnstone, 2007, pp. 79, 80). For instance, the global spread of the Internet may affect forms of expression to such an extent as to deprive humans of social diversity. At the same time, the author states that, 'technological artefacts are, after all, resources' and supports this point by arguing that technologies are merely 'tools' for realising 'cognitive functionings' such as calculation or communication (Johnstone, 2007, p. 80). In a similar vein, Oosterlaken criticises the assumption that technology is 'value neutral' and suggests that the attributes of technology depend on the values embodied in and surrounding them (Oosterlaken, 2009, pp. 95–99). In the context of ICT, she notes that online social networking practices can shape how individuals evaluate capabilities such as affiliation and social inclusion, for instance by creating peer pressure to sign up to these networks (Oosterlaken, 2013b, p. 219). However, her conceptualisation can also be translated into the concept of inputs: 'Resources – including technical artefacts – may contribute to the expansion of one's capabilities, but there may also be all sorts of "conversion factors" in place that prevent this' (Oosterlaken & van den Hoven, 2011, p. 65). While both authors' definitions therefore reflect the concept of inputs, this position introduces a potential bidirectional relationship between conversion factors and technology inputs.

Other authors' frameworks go more explicitly beyond the instrumental nature of technology as a capability input. Zheng (2009, p. 77) and Zheng and Stahl (2011, p. 78) argue that technology (especially ICT) coevolves with values and choice processes (Figure 2, Panel c). Zheng and Stahl (2011) suggest that technology may influence people's agency in attaining functionings. This perspective is similar to Coeckelbergh (2011, p. 86), 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. Specifically, he argues that, 'Technology is not a mere "condition" for human being in the sense of a means that can be used to achieve human ends; rather, human existence is already a human-technological existence' (Coeckelbergh, 2011, p. 86). Despite these augmentations of the CA, it remains unclear to what extent technology is fundamentally different from other 'inputs' that are influenced by values, that may affect other conversion factors, and/or that have a bearing on individuals' decision-making (we discuss this point further in the next section).

Within the fundamental CA framework, the preceding definitions of technology can be characterised as capability inputs. Operationalisations of the CA in the context of ICT and development depict a broader conception (Gigler, 2004; Kleine, 2013; Miroro & Adera, 2014).[5] Kleine (2010, 2011, 2013) emphasises the relationship between ICT and choice processes. In her framework, informational resources are one amongst eleven interrelated resource types (Kleine, 2013, p. 47). The resources – corresponding to 'inputs' – enable individual action that is mediated by 'structures [or "conversion factors"] that aid or constrain this individual agency' (Kleine, 2013, p. 48). Among the contextual structures is ICT together with its availability, affordability, and the skills required to operate it (Kleine, 2013, pp. 44, 49, 50). Translated back into the abstract CA, this could be understood as technology interacting with other conversion factors and influencing how inputs are used (Figure 2, Panel d). Similar to this depiction of technology as a contextual element, Gigler (2004, p. 9) states that 'ICTs can play an important role not only in their own right, but can act as an "agent" for the strengthening of the poor's capitals in multiple areas'. These operationalisations of the CA therefore indicate the transformative nature of (information and communication) technology.

Overall, the ways in which technology is analysed across these frameworks suggests that it deserves special attention in the CA. Should this attention derive from technology being a special kind of input, or because the idea of 'technology' is fundamentally different from the idea of 'inputs'? Until now, 'technology as a special input to expand human capabilities' has been the starting point for most technology-augmented capability frameworks. Translated into the abstract version of Sen's CA in Figure 2, the conceptualisation of technology as an input like any other may be justifiable on definitional grounds, but it could encourage the neglect of the relationship between technical objects and other inputs and conversion factors that the more complex notions above plausibly convey. Conversely, the more complex notions go beyond the traditional definition of inputs and extend into other categories

in the CA. If we agree that technical objects behave in the same way as conversion factors, can we reconcile this conception with their common depiction as inputs within the abstract categories of the Capability Approach?[6]

3. Technical objects and technological conversion factors

In order to harmonise the varying perspectives in the abstract version of the CA, it is useful to revisit the question whether technology is indeed fundamentally different from the conceptual definition of 'inputs'. Some CA scholars state that technology, be it an isolated technical object or the sum of all technical artefacts, interacts or coevolves with the larger social context (Oosterlaken, 2011, p. 429). The sociologist Ling (2012) makes a similar case by reviewing the history of clocks, cars, and cell phones, arguing that these objects have become embedded into our social fabric and now constitute part of the structures within which we learn to act and behave. This mirrors arguments about the bi-directional relationship between structural (societal) constraints and individual behaviour in general, in the context of technology in particular (Giddens, 1984; Kleine, 2013; Wajcman, 2004). Yet, the idea of coevolution between humans and objects is not unique to technology.

Some anthropologists, such as Miller (2010), would go as far as claiming that all forms of 'stuff' (i.e. material objects) share this feature. His explanation of the coevolution of the material and social world is worth quoting at length:

> Objects don't shout at you like teachers, or throw chalk at you as mine did, but they help you gently to learn how to act appropriately. This theory also gives shape and form to the idea that *objects make people*. Before we can make things, we are ourselves grown up and matured in the light of things that come down to us from previous generations. We walk around the rice terraces or road systems, the housing and gardens that are effectively ancestral. These unconsciously direct our footsteps, and are the landscapes of our imagination, as well as the cultural environment to which we adapt. (Miller, 2010, p. 53, our emphasis)

Miller (2010) expresses how *all* objects (material and immaterial, e.g. laws) influence our interaction with the world. If this applies to all objects around us (and the structural influence of objects on people may have gendered dimensions as in the case of technology as described by Wajcman, 2004), it is not clear whether technology should receive any fundamentally different treatment in the CA. Along this line of reasoning, we could argue that either technology should be defined as an input alongside others, or that all inputs should have their relationships to conversion factors and human agency re-defined.

Other arguments in favour of a special place of technology face similar complications. For example, if it is argued that technology enhances cognitive functions such as calculation and reasoning (Johnstone, 2007, p. 79), then how do we judge evidence that links the intake of calories and nutrients to the ability to carry out physical and cognitive tasks (Dasgupta, 1997, pp. 11–15; Falkingham et al., 2010; Hoyland, Dye, & Lawton, 2009)? Lawson (2010, pp. 216, 217), who discusses the nature of technical vs. other objects, states that technical objects are distinct because they are not consumed in the process of enabling such functions, unlike food in the preceding example.[7] He also argues that 'toys' are not technical objects despite their durable nature because the toys' contribution to human ability persists in their absence as they help develop 'hand to eye co-ordination […] along with an understanding of how objects function, break, etc' (Lawson, 2010, p. 217). While the argument is sensible, a technical object within the CA cannot be distinguished from other 'inputs' in this way because toys also enable transient states of 'being entertained' that could fall under the definition of 'capability' (capabilities extend beyond human ability). Therefore, although we could distinguish technical objects from other 'inputs' within the CA, they would fulfil broadly the same purpose of expanding human capabilities directly.

Is technology, then, yet another input? We argue that its linkage to the social context renders technology strikingly inseparable from other inputs. In addition, it is plausible that technology *as a physical object* carries characteristics that enhance human capabilities directly, just like any other input. Stirrat (1989, p. 109) reports the case of Sri Lankan fishermen who acquire TV sets despite being disconnected from the power grid, and water tanks that never store water. The technically defunct TV sets

arguably fulfilled valued capabilities of 'identifying with a desired social group' or served as a 'work of art' that represents the purchaser's labour and aspirations (Gell, 1986, pp. 114, 115; Stirrat, 1989, p. 109). While the symbolic and aesthetic characteristics of technical objects are undeniable (Fortunati, 2005, pp. 156, 157), technology considered only in this generative capacity (i.e. the object as bearer of characteristics) behaves fundamentally in the same way as other inputs in the CA.

We may be reluctant to concede that the satisfaction of aesthetic desires is the main feature of technical objects. Instead, they are distinct from other physical objects because they modify the characteristics of *other* inputs. The argument that technology extends human abilities suggests that it enables humans to do other things better (Lawson, 2010, pp. 216, 217). A similar argument is made by Van den Hoven (2012, p. 35), who describes the nature of technical objects as 'agentive amplifiers' as follows:

> [Technical artefacts and devices] may help us to get enough oxygen where we wouldn't otherwise be able to breath (respiratory disease, altitude, under water, pollution, etc.), to get nutrients (cooking, logistics, processing) out of the organic environment, to move around (vehicle, artificial limb), to communicate (phone, computer). (Van den Hoven, 2012, p. 35)

These arguments – which liken technical objects to conversion factors – suggest that technical objects alter the characteristics (e.g. nutritional content) of other inputs (e.g. food) by modifying them directly (e.g. through a cooking stove) or through their combination (e.g. through a recipe). We argue that this modification of other inputs is what sets technical objects apart from other 'input objects' within the CA: technical objects do not only have a 'generative' dimension as bearer of characteristics like other objects, but they also have a 'transformative' dimension that influences the characteristics of other objects. In this transformative dimension, technical objects fulfil functions that are otherwise the domain of conversion factors, namely moderating the translation of other inputs into valued capabilities. This transformative dimension defines objects as technical artefacts in our framework.

If we accept that technical items have a dual nature that generates characteristics and modifies the characteristics of other inputs, it leaves open the question how an object acquires transformative qualities. We maintain that these qualities are not intrinsic to the object but assigned to it within the socio-technological context.[8]

That the context defines the technology has been shown in cases where existing technologies are being re-interpreted and re-configured. Rogers (2003, p. 244) cites the case of Punjabi farmers who acquired tractors for agricultural work – yet because the local technological knowledge only related to the use of bullocks, the maintenance of tractors reflected the care they gave to their animals. Consequently, they covered tractor hoods with blankets to keep them warm during winter at the risk of overheating and machine breakdown. In a similar vein, Lansing (1987, p. 339) reports the case of a complex yet effective irrigation systems using a network of 'water temples' in Bali, which was not even recognised ('indeed invisible') as an irrigation technology by Western agricultural consultants. In short, what counts as technical object and how it relates to other inputs depends on the specific socio-technological context (Pfaffenberger, 1992, p. 497).

In line with Lemonnier (1986, p. 154), we therefore argue that technical objects are the vehicles of a larger socio-technological system of techniques that '[brings] into play materials, sequences of action, "tools" (including the human body), and a particular knowledge. This latter is at the same time know-how, manual skills, procedures, but also […] a set of cultural representations of "reality"'. Such 'representations of reality' can for instance include the reproduction of gender- or class-based power relationships through technology design and usage (Wajcman, 2004). Technical objects acquire their transformative properties from the socio-technological environment, and their role is defined in relation to it. We therefore agree with the notion that a technical object is different from an ordinary input, because they are used on behalf or as extensions of the human body in the translation of other inputs' characteristics into valued capabilities. This may involve a transient extension of bodily and cognitive human ability as the aforementioned authors, Johnstone (2007, p. 80) and Lawson (2010), argued. However, for the distinction of other 'inputs' within the CA, the transformative dimension is decisive.[9]

The socio-technological context not only comprises local technological knowledge to define technical objects beyond their symbolic meaning (i.e., the knowledge of production methods for particular goods). In his theory of innovation diffusion, Rogers (2003, pp. 229–233, 240–244) suggests that this context further pertains to 'complementary assets' that enable the successful use of a new technology (e.g. electricity grids or mobile network infrastructure), but also alternative ways of solving problems (thereby defining the 'relative advantage' of a technology). This points at the importance of technology as a class of conversion factors in the CA.

An approach to technological conversion factors that considers the larger socio-technological system to include the complete set of problem-solving knowledge in a given society (see Heeks & Molla, 2009, p. 34 for an early version of this conceptualisation) conforms with the view 'that human existence is already a human-technological existence' described by Coeckelbergh (2011, p. 86). Along the same lines, Johnstone (2012, p. 86) maintains that 'the use of technology in society as a whole can also affect our capabilities independently of our own use', for example as we are enabled to 'eat a varied diet all year round because of high-tech agriculture and refrigerated transport'. In other words, at any point in time, humans will have an array of tools and techniques at their disposal, which will influence the conversion of given inputs in different ways.

An analysis that focuses solely on individual, social, and environmental conversion factors would therefore fall short of acknowledging important inter-personal and inter-societal variation in the access to local knowledge and problem-solving techniques (or social structures reproduced through the technology). In addition, such an analysis may neglect important interactions between these conversion factors. Take the case of health information that enables the capability of 'being knowledgeable about preventive health'. While information (e.g. in the form of written advice on healthy living) may be readily available from newspapers at the nearby library, access to an Internet-enabled computer can 'amplify' the conversion of the information into the capability of being informed. The influence of the technological context depends on individual conversion factors, as a lack of technical literacy or impaired eyesight may restrict the use of personal computers for this purpose, leaving disadvantaged social groups worse off. Conversely, if the individual is mobility-impaired (e.g. a wheelchair user), disabilities may be mitigated through interactions between individual and technological conversion factors. Grunfeld (2011, p. 62) adopts a similar notion in her argument that interactions between individual characteristics and available technology can spark a 'virtuous spiral'. According to our model, this would be an interaction purely on the level of conversion factors. This indicates that technology as a conversion factor is in a dialectical relationship with other conversion factors.

Defined in this way, it is possible to reconcile the different perspectives presented in the previous section within Sen's abstract CA. All objects serve as inputs if they carry characteristics required for attaining valued capabilities. What makes technical objects special from a capability perspective is their transformative nature, thereby modifying the characteristics of other inputs in the same way that conversion factors do. Technical objects like phones or roads can have these two natures at the

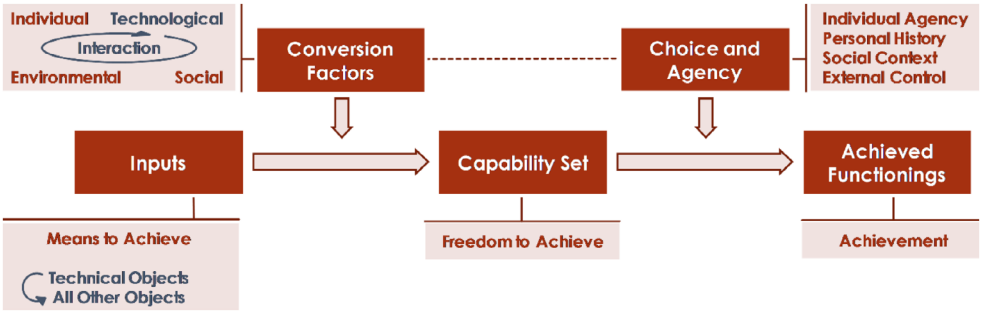

Figure 3. A technology-augmented Capability Approach. Source: Authors, adapted from Robeyns (2005, p. 98).
Note: Elements in blue are additions to the original depiction.

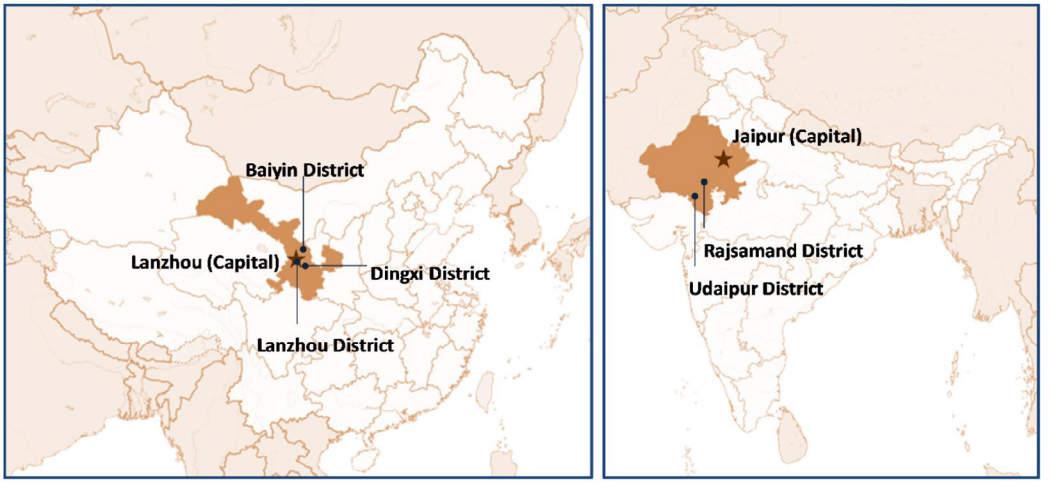

Figure 4. Rural fieldwork locations in Gansu (left) and Rajasthan (right). Source: Authors, adapted from Wikimedia Commons (2013); map copyright by Joowwww (Rajasthan) and TUBS (Gansu).

same time. The technological environment defines technical objects (and the structures that shape their use) and comprises the complete set of technological knowledge in a society. Technology as a class of conversion factors influences the translation of inputs into valued capabilities and interacts with other conversion factors. The incorporation of technical objects and technological conversion factors is illustrated in Figure 3.

4. An application to mobile technologies and health

The technology-augmented Capability Approach reconciles the various definitions of technology in the capability literature and makes the role and position of technical objects and technological conversion factors more explicit. We demonstrate in this section how our framework can aid the analysis of technology in human development. We use a qualitative case study of mobile phones and healthcare in rural India and China. In this context of poor and remote rural communities with challenging healthcare access, mobile phones and phone-based services could be seen as logical solutions to improve service access (Ling & Xiao, 2012; Qiang, Yamamichi, Hausman, Miller, & Altman, 2012, pp. 40–49; Walsham, 2010, p. 3). Our analysis using the technology-augmented CA goes beyond simplistic pro-technology arguments: it draws attention to the context-specific nature and actual use of technology; interpersonal variation in the creation of 'technology-enabled' capabilities; alternative means of attaining valued capabilities; and the beneficial and potentially detrimental outcomes of technology diffusion.

4.1. Guiding questions and case study context10The qualitative research and the interview protocol were ethics approved by the University of Oxford (SSD/CUREC1A/13-199)

Before examining the case study, it is useful to derive an analytical strategy from the technology-augmented Capability Approach. In this exercise, we focus our attention on the role of inputs and conversion factors in generating health-related capabilities, which we exemplify with 'receiving dignified and trustworthy care during illness'. Relevant inputs in this context include the actors in the health system and their healthcare solutions, for example medicines, equipment, and health information (Ariana & Naveed, 2009, p. 235). Our example will focus on the ways in which mobile phones as technical objects can influence care-seeking processes to enable this capability. If trustworthy care is indeed a valued capability in the population, mobile phones as technical objects may have intrinsic characteristics that enable this capability, but phone use may also influence the characteristics of other healthcare inputs.

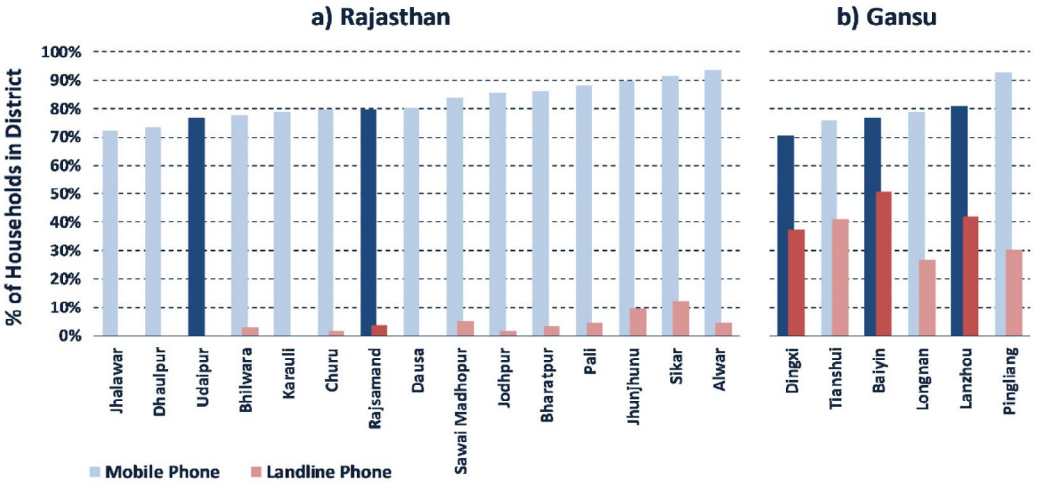

Figure 5. Rural household mobile and landline phone ownership in field sites, 2011–2012. Source: Authors, based on Desai, Vanneman, and National Council of Applied Economic Research (2016); Liu and Ariana (2012).
Notes: Household data at time of research design development. Rajasthan data from 2011–2012, based on 1859 households. Gansu data from 2011, based on 582 households. Rajasthan data representative and weighted using household weights; data available for 15 out of 33 districts. Gansu data available for 6 out of 14 prefectures, data on county level, no sampling weights.

For the purposes of this illustration, we derive three guiding questions from the technology-augmented Capability Approach. First, which inputs are available to enable the health-related capability of 'receiving dignified and trustworthy care that alleviates morbidity'? Second, what is the role of the mobile phone as a technical object in enabling and influencing this capability? Third, what are the equity patterns of the health-related capability that result from the interaction between the technological context and other conversion factors?

Other analyses (not pursued in this paper) could go further and examine the relationship of healthcare-related to other human capabilities as a function of mobile phone use (e.g. enabling access to healthcare while maintaining social interaction and doing business, thereby contributing to widening or truncating capability vectors). Similarly, interactions between the social and technological context point to structural constraints that individuals may experience in their technology use, for instance by defining gender norms and power relationships around the operation of phones (Dodson, Sterling, & Bennett, 2013; Jeffrey & Doron, 2013; Wajcman, 2004). This could be the focus of gender-specific analyses of technology and development.

Our case example is based on qualitative data from rural Rajasthan, collected from September to December 2013. The data collection involved semi-structured interviews and focus group discussions with 89 villagers in each country, and interviews with 36 local and regional health and telecommunication experts in Rajasthan and 17 in Gansu (administrative barriers affected access in Gansu). This study explored the relationship between people's mobile phone use and their healthcare access behaviour (see Haenssgen, 2014; for a more detailed description). As shown in Figure 4, our field sites within Rajasthan and Gansu are rural areas of Udaipur and Rajsamand (Rajasthan) and of Baiyin, Lanzhou, and Dingxi (Gansu). Survey data indicates average or below-average household mobile phone ownership in the selected districts (see Figure 5). The selected field sites fall into hilly and mountainous areas with sparse rural settlements that tended to be more difficult to access. Healthcare providers were sparse and concentrated in distant urban centres.

4.2. Mobile phones and rural healthcare: application of the augmented framework

In order to receive care, rural dwellers in the field sites have a range of treatment options with varying degrees of accessibility, availability, affordability, and quality. These 'inputs' include local and limitedly

trained health promoters, nurses, and village doctors; pharmacists; faith and traditional healers; private doctors who do not always have received medical training; primary health facilities staffed with one or few doctors; larger, regional hospitals; and also family members and other social contacts.

Availability of these providers in close proximity can make mobile phone use unnecessary. In both field sites, residents in centrally located, affluent, and well-accessible villages stated that 'there is no need to call' because hospitals and doctors can be reached easily (Rajasthan, man, 18, phone owner). For example, a 70-year-old man in Gansu, though owning a mobile phone, reported that, 'The doctor lives close to the village, and we just go there directly or let him come here, it's near, and I don't need a phone'.

In practice, mobile phones did influence the healthcare-seeking process for some respondents, but not directly through their intrinsic characteristics (as generative objects, mobile phones fulfilled symbolic purposes e.g. as part of people's 'uniform' and by reproducing social identity through region-specific ringtones). Rather, mobile phones emerged as transformative objects that modify other inputs like available government doctors or informal caregivers. This transformation of the existing care-seeking process can be exemplified by statements like,

> Firstly, I seek consultation and inform [the village doctor] about the illness and the situation, the duration of the disease, and the effect of the medicine taken already, but then I almost always ask him to come here for diagnosis. (Gansu, man, 50, phone owner)

> If our neighbour's mother feels uncomfortable and it is not convenient for her to call, I'll call her children [who live further away], to tell them that their mother feels unwell and that they'd better go home to look after her. (Gansu, woman, 46, phone owner)

The examples demonstrate that mobile phones can facilitate consultations and health advice. This could help overcome spatial marginalisation that otherwise limits healthcare access: poor and remotely located respondents would first and sometimes only rely on medicines for the treatment of illnesses, or otherwise (in the case of financial shortages) simply '*get some sleep*' (Gansu, man, 58; woman, 51 [joint response], phone sharers). Everything else being equal, mobile phone use could at least mitigate healthcare access problems.

Mobile phone use does not only facilitate but it can also change the interaction and the nature of information exchanged between patient and caregiver. Echoing the reports of Mechael (2006, p. 170) in Egypt, a village doctor in Gansu maintained that having to answer patients' phone calls can be 'inconvenient and a burden because he has to rush to people's homes when they call him' (Gansu, village doctor at village clinic, interview notes). Doctors in both field sites also commented on the callers' tone, indicating that older callers especially would be 'tactful' whereas younger callers 'are not very polite and treat our work as granted' (Gansu, village doctor at village clinic). Moreover, most of the doctors interviewed stated that, although phones are useful to complement their services, they do not replace face-to-face consultation in the area of curative and preventive health advice (e.g. recommendations based on a full medical diagnosis involving oral history as well as vital signs). A private doctor in Rajasthan had even started advising callers rather to come to his clinic for consultation, after having realised during home calls that the 'disease is different from what I expected, then I can't come again and again to bring the medicine' (Rajasthan, private doctor at clinic). These examples suggest that healthcare providers' ability to deliver trustworthy and dignified consultation may be altered where mobile phones intervene in the process.

While we have established that mobile phone use can modify other inputs for 'dignified and trustworthy care', mobile phones themselves are subject to individual, social, and technological conversion factors. An example of individual conversion factors interacting with mobile phone use was provided by an older woman in Rajasthan. Aged 60 years, she received a mobile phone from her daughter and agreed that it is helpful. She talks with her daughter twice a month, yet she 'just know[s] how to pick a call and how to disconnect' (Rajasthan, woman, 60, phone owner). During a recent illness episode, she only talked on the phone with her daughter about possible routes for treating her paralysis – she does not call doctors or nurses directly. Instead, she argued that, 'I directly go to the doctor, I don't know how to call and I never call for a doctor' (Rajasthan, woman, 60, phone owner). Some of her doctors live near her village, but for others she has to travel to the nearest urban area. Her narrow use

of the available mobile phone functions – driven by limited technical expertise – constrains the ability of the mobile phone to affect other health-related inputs.

Social factors, too, can influence the usability of mobile phones for care seeking. For example, social structures and norms can shape communication patterns: men were often described as talking to 'friends and colleagues', whereas women's communication took place in narrower social networks involving 'relatives', especially their spouse and their mother's family. An otherwise phone-sceptical woman in fact justified giving a mobile phone to her mother-in-law by saying: 'I have bought a phone for my mother-in-law, so I can inform her if I am late or not coming home, because it's not allowed to talk to the father-in-law' (Rajasthan, woman, 30, phone). The social context and prevailing social structures can therefore influence the modifying role of the mobile phone for healthcare (and potentially other functions such as personal finance, administrative services, or education).

Technological conversion factors, though perhaps obvious, also influence the role of mobile phones in the process of care seeking. For example, residents in the Rajasthani village of Challi reported that people from a neighbouring village would borrow their phones because the other village is not covered by a mobile signal – often to call ambulances, birth attendants, or veterinarians. A widely available and in principle 'accessible' technical object like the mobile phone can thus be underutilised due to insufficient complementary technologies.[11] Where such technological challenges are encountered, the health-related use of mobile phones is likely to be diminished.

Overall, these patterns indicate that mobile phones could potentially facilitate the translation of other inputs into health-related capabilities, but the modification of inputs can also come with a change in their characteristics that alters the nature of health-related capabilities. Our qualitative analysis also suggests that those individuals who might require improved access to care might be those for whom contextual conversion factors reduce the usability of the mobile phone. If this conclusion holds, then the increasing spread of mobile phones in rural Rajasthan and Gansu might have heterogeneous effects on the nature of care that people seek and receive with potentially unforeseen consequences for healthcare equity. Based on this simple illustration, we could hypothesise that mobile phones are less effective than commonly expected in alleviating healthcare access challenges that stem from social and economic marginalisation. The technology-augmented CA therefore helps to frame analysis of the impact of technology on capabilities.

5. Conclusion

The aim of this paper was to contribute to harmonising the existing concepts of technology in the Capability Approach. Through a fundamental discussion of the notion of technology within the language of the CA, we introduced the categories of technical objects and technological conversion factors as additional elements that had hitherto been disregarded. We applied our framework to the case of mobile technologies and healthcare, where it helped to draw attention to technical objects in relation to other inputs, to the socio-technological environment, and to other conversion factors in the generation of valued capabilities. We believe that our conceptualisation helps to add a theoretical justification for analysing technology within the language of Sen's CA, and that the technology-augmented Capability Approach can be a useful tool in framing and developing important research questions on the social implications of technology.

Notes

1. Two main strands of the CA exist. Amartya Sen's version focuses on human development, whereas the strand developed by Martha Nussbaum places more emphasis on social justice and human dignity. We chose to rely on Sen's version due to its greater flexibility and versatility.
2. We focus in this paper solely on the categorisation of technology and refrain from entering various adjacent debates on the CA covered elsewhere. For example, authors have highlighted the potentially problematic social agreement on capabilities (Stewart & Deneulin, 2002), the role of external capabilities (Foster & Handy, 2008), and the methodological individualism in the CA (Robeyns, 2005). Extensive debate has also surrounded the

appreciation of structure-versus-agency arguments in the CA (Giddens, 1984; Miller, 2010), described and discussed extensively in Kleine (2013).

3. This exercise comes with its own challenges. Our starting point is the CA as an analytical rather than a normative framework to guide exploratory qualitative enquiry of human-technology interaction (rather than to e.g. prescribe courses of action, Martins, 2007, p. 42). Our aim is not to interpret the intentions of other authors to incorporate technology into their frameworks, but to harmonise these existing notions of technology as they arise in the many variations of the CA, using Sen's original framework as the most abstract level for our analysis. Note further that this review is not exhaustive but only intends to highlight the distinct stances that exist in the literature. Besides, we focus on the context of technology deployment, diffusion, and use. Other starting points like technology design are not explicitly addressed here. See Oosterlaken (2013a, pp. 51, 52) for a more comprehensive review of the literature on technology and the CA.
4. We could argue among similar lines that technology may *produce* utility value within its generative dimension, and that it *modifies* (increase or decrease) other inputs' utility value within its transformative dimension.
5. The frameworks draw on the sustainable livelihoods approach (Bebbington, 1999; DFID, 1999). Gigler (2004) and Kleine (2013) also draw on the empowerment literature, with the latter building on the empowerment framework by Alsop and Heinsohn (2005).
6. Recall that our objective here is not to detect inconsistencies in other authors' writing, but rather to translate and map different stances into the most abstract version of the CA. Inconsistency according to Sen's abstract version of the CA is not synonymous with an inconsistent argument in the original writing.
7. He argues that the effects of technical activities are transient rather than permanent, thereby distinguishing them from food. Our previous argument undermines this point, as food 'inputs' yield transient effects on human cognition, or at least rectify the adverse effects of acute malnutrition.
8. This does not exclude the possibility that the 'affordances' of a technical object influence the way in which humans engage it.
9. Although our use of the term 'technical object' suggests a physical manifestation, there is nothing in this definition that would exclude non-physical technologies such as recipes, management techniques, or services.
11. Surveys have shown that the vast majority of individuals in both sites can access, though not necessarily use, mobile devices (Haenssgen, 2015).

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