Putting critical realism to use in ICT4D research: Reflections on practice

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Abstract

This paper presents my reflections on adopting critical realist (CR) assumptions in information and communication technologies for development (ICT4D) research over the last decade. Critical realism, and its notion of generative mechanisms as contingent causality, offers one potential way to frame and engage in research that is compatible with the contextual nature of developing ICT4D theory. However, CR can be difficult to understand and operationalize. This paper provides practical insights on how to engage in ICT4D research underpinned by the CR philosophy of science. As such, the bulk of this paper presents insights and implications of accepting CR assumptions in the research process, looking at different elements of research (eg, including forming research questions, theory building, engaging in research). I use examples in ICT4D research to illustrate these implications.

KEYWORDS

causality, context, critical realism, generative mechanism, ICT4D, research, theory building

1 | INTRODUCTION

This paper presents reflections and lessons from my experience of adopting critical realist (CR) assumptions in information and communication technologies for development (ICT4D) research for more than a decade. I first discovered critical realism during my PhD (2003-2007), when I adopted it as the philosophy of science that underpinned my research (see Smith, 2007, particularly chapters 2-4, 2010a, 2010b, 2011). The underlying CR assumptions have since deeply informed my work as a program officer at Canada’s International Development Research Centre (IDRC), where I have funded and supported many ICT4D-focused research projects from 2008 until the writing of this article.

In my experience, CR assumptions are appropriate, applicable, and highly useful for ICT4D research. In particular, this paper hones in on the CR ontological account of causality as a generative mechanism and its compatibility with the building, testing, and refinement of both context-sensitive and generalizable theory. This is important because the ICT4D field has struggled to engage with context (Avgerou & Walsham, 2000; Prakash & Dei, 2007) while building theories of ICT-related social change (eg, Avgerou, 2017; Sahay & Walsham, 1995).

The intent of this paper is to offer useful insights on how to engage in ICT4D research underpinned by the CR philosophy of science. One noted challenge to adopting CR in ICT4D research, however, is that CR as a research paradigm is difficult to operationalize, and perhaps even more difficult to understand (Heeks & Wall, 2017). Indeed, I found the learning curve to be steep when engaging with CR in research—but ultimately very rewarding. I hope this paper helps researchers to adopt CR assumptions in their work more quickly and successfully.

The paper proceeds as follows. It begins with discussion of a key CR concept: the generative mechanism and how it is reflected in ICT4D research. Then, the paper covers a series of approaches, implications, and lessons taken from engaging in ICT4D research informed by the concept

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of generative mechanisms. This section includes a range of topics, from generating research questions (RQs), to building and refining theory, to the importance of variation in that process. The following section then examines a few challenges to putting critical realism into practice. Finally, this paper concludes with an overview of the main implications for ICT4D research.

2  |  GENERATIVE MECHANISMS

One key to understanding the implications discussed in this paper is grasping the CR idea of a generative mechanism. Note that while there are other important CR assumptions to understand, I have come to view the generative mechanism as the core idea of CR. Bhaskar, the progenitor of critical realism himself, has called the generative mechanism the "lynchpin" of critical realism (Bhaskar, 2002; Groff, 2004, p. 138; Sayer, 2000). The generative mechanism is the root of a majority of the implications for research discussed below.

I first encountered generative mechanisms while in a bit of a social science philosophical crisis. I was stuck between two mutually unsatisfying alternatives: (1) causality as immutable, following universal laws (eg, if x then y); and (2) causality as inextricably complex and context dependent. First, immutable laws do not appear to hold in the social world. For example, it is never a question of if mobile phones reduce poverty, or if computers in classrooms improve student test scores—life is more complex. Rather, the question is how, to what extent, for whom, and in what contexts do mobiles reduce poverty? While these nuances get lost in newspaper articles, they are of utmost importance for research—particularly for research that seeks to be actionable. Second, for the opposite reason, I found the view of causality as inextricably complex and context dependent to be flawed, since it only allows for description without generalization. In other words, while there may be actionable information in a particular context, is there really no possibility for ideas to travel to other contexts? For me, neither of these two alternatives was acceptable on its own.2 Generative mechanisms were an alternative conception of causality; that is, they were a middle way out of the impasse, providing a means for researchers to both respect complexity while still attempting to draw generalizable inferences.

2.1  |  Contingent causality

A generative mechanism3 is "nothing other than the way of acting of a thing" (Bhaskar, 1998, p. 38). This “thing” is really an "ensemble of structures, powers and relations," and it is this "ensemble that has a tendency to do x" (Fleetwood, 2001, ital mine). This notion of tendency is highly useful because it (1) allows for the actual structure of things to have causal influence (ie, they tend to act in a particular way), while (2) moving away from a deterministic conceptualization of causality. In other words, causes can exist, but they do not have to produce empirical regularities (ie, behave in a law-like manner) (Lawson, 1989).4 Rather, these tendencies may produce semi-regularities, which are "partial event regularities" that can be useful for identifying the mechanisms themselves (Zachariadis, Scott, & Barrett, 2013, p. 6).

Another way to think about generative mechanisms is as a form of contingent causality (Pawson & Tilley, 1997: 69). A mechanism is only ever triggered (or not) in a context of other mechanisms. The resulting outcomes are a function of the mechanism being actualized and modulated by the relevant contextual mechanisms. Critically, this means that generative mechanism-based explanations must include some element of the context. As we will see, when making an explanation, we are looking to identify the necessary mechanisms (ie, the mechanism being triggered in the context) and the contextual mechanisms (ie, the mechanisms in the context that interact with the necessary mechanism).

One tricky thing to understand about mechanisms is that they appear to be two things at once. They are both a latent causal power that emerges from a thing and the acting of the thing when that mechanism is triggered. Thus, a mechanism is both potential and the realization of that potential. This, we will see, has implications when it comes to theory building and drawing inferences from research, in particular because what something can do is unobservable while what it does is potentially observable. Importantly, and as stated above, what a mechanism actually does is also a function of context.

2.2  |  Generative mechanisms in ICT4D

Applying this thinking to ICTs, we can say that any ICT will have a set of causal powers that emerge from its constituent structure. However, what that ICT mechanism is depends upon how you scope it (ie, where you draw boundaries around the technology). The key to scoping is to distinguish between the necessary components of the structure from which the causal power emerges (ie, the necessary mechanisms) and the contextual mechanisms. I have found that in research the lines between necessary and contextual mechanisms can quickly blur if you are not sure what mechanism you are looking at or for.

Therefore, scoping can be a bit tricky—and the key challenge is to draw boundaries around the structure from which the generative mechanism of interest emerges. A bit of philosophy of technology is helpful here. We draw from Arthur (2009), who takes a position that is useful from a CR perspective. Arthur argues that technologies are things that take advantage of a phenomenon to create an effect. For example, an internal combustion engine harnesses the combustible properties of fuel to produce a direct force on a piston. Once these technologies are understood, they can easily combine with other technologies for more sophisticated outcomes—such as all of the technologies that come together to form a car with a new set of causal powers that the individual parts did not have (eg, driving, carrying large loads over distance).

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2 Of course, my understanding at the time was an oversimplification of the existing philosophies of science.

3 Note from here on I will interchange the term "mechanism" with "generative mechanism."

4 Note that this is not to say that a generative mechanism is a form of probabilistic causality, although probabilities might be useful for identifying causal mechanisms.
ICTs, like a mobile phone or mobile phone network, are also combinations of many other technologies that, when combined, have specific causal powers (generative mechanisms). For example, a mobile phone doesn't have the causal power to make a call unless it is connected to a mobile network. Once we combine these technologies—each of which are combinations of many other technologies—then the causal power of making a call emerges. In this case, the person placing the call is the source of a contextual mechanism, which triggers the causal power of calling that exists due to the interconnected structure of the mobile phone and the network.

Importantly, the causal powers of mobiles also extend beyond our common interpretation of a mobile—that is, what we assume a mobile will be used for. For example, a mobile phone can also operate as a paperweight, burst into flames, and excrete toxic material. These are also generative mechanisms inherent in the mobile itself.

Another example helps to illustrate how a mechanism emerging from an ICT may interact with contextual mechanisms. We might expect a One-Laptop-Per-Child intervention to have many contingent effects depending upon the context, as the presence of the laptops triggers a range of mechanisms. Children may explore the mathematics software (Mechanism1). One child may find the content interesting (Contextual Mechanism1), while another may find it boring (Contextual Mechanism2). Concerned teachers and parents may restrict the use of the laptops at home (Contextual Mechanism3). Teachers may show preference towards boys using the technology (Contextual Mechanism4), and so on. One could imagine many such interacting mechanisms, all potentially occurring at the same time. Each of these mechanisms will contribute to the aggregate effect of the intervention and the ideas and opportunities it introduces.5

One upshot of this perspective is a slight change of thinking on the relationship between technology and context. ICT4D is not the study of ICTs in developing country contexts. ICT4D is the study of the interaction of ICTs with the developing country context. Or, in CR language, it is the study of the interaction of mechanisms emerging from ICT artefacts with mechanisms in developing country contexts. This is what contingent causality really means—you can never separate the activation of a mechanism and the outcome it generates from the context it is in.

One practical way of working with generative mechanisms comes from the realist evaluation literature, where explanation is the uncovering of context + mechanism = outcome configurations (Dalkin, Greenhalgh, Jones, Cunningham, & Lhussier, 2015).

“Context-mechanism-outcome pattern configurations (CMOCs) comprise models indicating how programmes activate mechanisms amongst whom and in what conditions, to bring about alterations in behavioural or event or state regularities” (Pawson & Tilley, 2009, p. 160).

Note that the notion of a generative mechanism is roughly compatible, in my experience, with the notion of a social mechanism (eg, Bunge, 1997; Hedström & Swedberg, 1998), which is receiving some attention in information systems and ICT4D (eg, Avgerou, 2013, 2017). The compatibility with the social mechanism literature is not surprising, as they both stem from realist philosophies of science. While there is some difference in terminology and description, and while generative mechanisms can be both natural and social, both are forms of causality that do not imply law-like regularities (Weinert, 2014) given their contextual sensitivities (Avgerou, 2013). Indeed, I have found the social mechanism literature extremely useful for deepening my understanding of how to apply generative mechanisms within ICT4D research.

3 | RESEARCH IMPLICATIONS

This section spells out some of the most influential approaches, implications, and lessons taken from engaging in research undergirded by CR assumptions. In particular, these implications flow from accepting the assumption that causality is explained by the existence of generative mechanisms. This section focuses on key stages in the process of explanation, revolving around theory based on generative mechanisms. It roughly follows one potential research arc, from the generation of RQs and theory, to testing and refining that theory through a focus on extracting a variation of context-mechanism-outcome combinations in different contexts.

3.1 | Developing research questions

When I work with researchers, I rarely mention critical realism or explain my underlying philosophical assumptions—despite the profound impacts it has had on the way I conceptualize the activity of research. For me, rather than talk philosophy, my typical entry point is through RQs. Indeed, if there is one thing that people take away from this paper, I hope it is how CR influences the construction of a RQ.

For the research I have done and have supported, there are generally two elements to asking RQs.

First, is that any RQ must include all three elements of the process of generative mechanism causation: context (contextual mechanisms) [C], mechanism [M], and outcome [O] (ie, CMO configuration). The goal of including all three components in a RQ is to orient the researcher to look for the contingent nature of causality. So, for example, the core question of my PhD thesis was: How [M], for whom [C], and in what circumstances [C] do e-services [M] impact on citizens’ trust in government [O]? Or, a research network on open educational resources (OER) asked: In what ways, and under what circumstances [C] can the adoption of OER [M] address the increasing demand for accessible, relevant, high-quality and

5The literature also talks of the symbolic impact of ICTs (see, eg, Rye, 2009). These impacts emerge from the mechanism of interpretation and sense-making by an individual or social group, rather than a mechanism emerging from the ICT artefact itself. In other words, the introduction of ICTs into a context becomes a contextual mechanism that influences the triggering of individual or social mechanisms.
affordable post-secondary education [O] in the Global South? If one is interested in magnitude of the outcome, it is common to add “to what extent” to the RQs as well.6

Second, is that there will be various levels of RQs, from the more abstract to the more concrete. Typically, the highly abstract questions are those that set the contours of a field, such as, “What are the impacts of mobile phones on human development?” Framed in a CR way, that question would be, “How, for whom, and in what contexts do mobile phones generate human development impacts?” However, this level of RQ is unanswerable. There are simply too many possible variations of mechanisms (how), contexts (for whom and in what contexts), and outcomes. Thus, more concrete, and ultimately empirically testable questions are required, such as, “How, for whom, and in what contexts do mobile phones improve the livelihoods of sex workers in Bangladesh?” As we see in the following section, these questions correspond to different levels of theory, from highly abstract to middle range to case specific.

3.2 Theory building

Theory can work at different levels of abstraction, from highly abstract to highly concrete. In any knowledge quest, there must be something to explain and a corresponding level of theory that is the explanation. And, as discussed, explanation in CR requires unearthing causal mechanisms and their interplay with different contexts. In other words, this theory must also include the three elements context, mechanism, and outcomes (CMOs). Building theory happens through the generation, testing, and refinement of increasingly concrete CMO theories. The argument put forth here is that it is working across the different levels of CMO theories—from abstract to concrete—that is relevant for ICT4D theory building.

At the most abstract are high-level theories—the overarching questions—that typically drive a discipline. For example, in ICT4D, a general theory may be that the diffusion of mobile phones contributes to poverty reduction, or that “computers in classrooms don’t improve test scores” (see Coughlan, 2015). Or, in my PhD research, the abstract theory I was interested in was that a government offering e-services will build citizens’ trust in that government. A key feature of this type of theory is that it doesn’t include context and is therefore ultimately untestable. Rather, we have abstract notions that, continuing with our examples, mobiles can reduce poverty, or that e-services tend to build trust. These are simply starting points for research.

At the other end of the spectrum are case-specific theories. These are highly concrete, empirically testable and refinable propositions. In CR, these are specific hypotheses as to how a given mechanism [M] interacts with the context [C] resulting in an outcome [O] (ie, CMO configuration7). For example, if an e-service results in user benefits in terms of time and cost savings, it will tend to build trust.

Lying between the abstract and the very concrete case level theories are “middle range theories” (MRTs) (Merton, 1949). This level of theory serves a dual role. First, it acts as a series of connecting bridges between the abstract theories and the case-specific theories. Thus, for every abstract theory, there will probably be several MRTs, and for every MRT, there will probably be one or more case-specific theories. Second, MRTs work at the level that begins to make generalization to other contexts possible. See Table 1 for a set of examples.

The MRT plays a critical role connecting the levels of theory, making cumulative theory building possible (Danemark, Ekstrom, Jokobsen, & Karlsson, 2003; Pawson & Tilley, 1997). The connections allow the different levels to inform each other during theory building, testing, and refinement processes (see Figure 1). Findings at the individual case-specific level inform the building, refinement, and testing of CMO configurations at the MRT level. MRTs can also help inform the development of case study specific hypotheses. CMOs established at the MRT level provide insight into the more abstract questions of the ICT4D field. Finally, CMOs from other research can be integrated into existing middle range and case-specific theories. We will discuss this integration process more below.

The type of theorizing promoted here will necessarily be multidisciplinary. ICTs are always enacted by people who interpret and act on the ideas and resources they offer, all while they are constrained and enabled by their positions in social structures. This means that there are a variety of potential mechanisms that can shape the effects of the ICTs—from social structures acting on individuals, to individual psychological and social-psychological mechanisms. So, for example, the MRTs in the research on trust and e-government drew from a wide range of disciplines including psychology (eg, cognitive dissonance), sociology (eg, trust), political science (eg, accountability), and public administration (eg, public value).

3.3 Theorizing mechanisms

I have found it useful to think of mechanisms in terms of the active voice, often using “-ing” words. If mechanisms are simply “the ways of acting of a thing” (also “causal power”), then mechanisms are not “things,” but rather they are the doing of the thing. As we illustrate more below, the active voice (“-ing” words) is a helpful tool for theorizing.

For example, Jetzek, Avital, and Bjørn-Andersen (2013) identified four archetypical generative mechanisms of open government data: efficiency, innovation, transparency, and participation. Digging deeper, you can see that these are all “-ing” terms: efficiency (“better utilizing current resources”), innovation (“creating new products and services”), increasing transparency, and participation (“participating and collaborating with government”). Similarly, the 2016 World Development Report entitled Digital Dividends starts from the theoretical basis that the internet promotes inclusion, efficiency, and innovation (World Bank, 2016). All of these are expressions of fairly abstract generative mechanisms that emerge from the underlying structures of open data or the internet.

6Note that “for whom” and “in what contexts” are both elements of the context. I find it useful to differentiate between the two—particularly in development—because it alerts researchers to look at differential uses/outcomes by people.

7Though noting—see below—that both case-specific and middle range theories consist of CMO configurations.
However, just thinking in terms of the active voice (“‐ing” words) is incomplete. As discussed above, a mechanism is both the latent causal power and the resulting action when that causal power is triggered. Thus, focusing on doings of mechanisms only looks at the observable outcomes. This is, thus, an incomplete understanding. As described above, a more complete theory of a mechanism includes three elements: (1) the structure of the thing and how that shapes its causal powers \[M\]; (2) how the causal power is (or is not) activated by the context \[C\]; and (3) the observable outcome \[O\]. Each of these elements is always deeply interconnected.

Amartya Sen’s Human Capabilities Approach (CA) provides a good example. Capabilities and their associated functionings can be thought of as generative mechanisms (Martins, 2006; Smith & Seward, 2009). Capabilities are mechanisms that emerge from the combination of an individual and the opportunities, constraints, and resources that their position in society provides them. When triggered, capabilities result in particular functionings.

ICTs introduce mechanisms that can expand individuals’ capabilities, provided the right contextual mechanisms (eg, conversion factors in CA parlance) exist. A person (eg, with sufficient skills, other family members with a mobile, subscription on a mobile phone network) with a mobile phone has a particular set of capabilities (eg, communicate with family, provide a return number when applying for a job) that he/she may or may not realize at different times. From a CR perspective, a CMO might look as follows: (1) a mechanism \[M\]—in this case, the ability to make a phone call—emerges from a mobile and the mobile network structure that is triggered by (2) the context \[C\], consisting of a person with the necessary skills and ownership of the mobile (with sufficient calling credits and in range of mobile towers), that (3) determines the nature of the outcome \[O\], which is an observable phone call to a business associate. This maps to the capability language where one must have the necessary conversion factors (personal, social, and environmental) \[C\] to take the resource (in this case, the mobile phone) \[M\] and turn it into a functioning \[O\].

The latent nature of capabilities as causal powers that may or may not be realized has made operationalizing the capability approach difficult (Comim, 2001). The problem is: how do you measure capabilities if you can only observe functionings? From a CR perspective, this problem exists
for all research, as the world consists of unobservable causal powers that you can only observe through their activation. To deal with this, CR researchers employ retroduction, a form of transcendental inference. This is an inference from observable events to underlying unobservable structures (Danermark et al., 2003, p. 96) (see Figure 2). Retroduction is thus a key element of the research process, particularly when one is testing and refining theory, or generating new explanations (i.e., theories) from empirical observation. Thus, to go back to our mobile calling example above, by observing an individual talking with a business associate over the phone, you can then infer the existence of a structure with the causal powers to make that call, as well as the contextual mechanisms that made the call possible at that point in time.

### 3.4 Theory integration

A key component of developing theory is the ability to integrate other theory and research findings. What I have found to be a powerful benefit of CR is that it allows the integration of theory and research findings from different underlying philosophical assumptions. This happens through interpreting the theory and findings in light of CR ontological assumptions that provide a way to bridge what were previously thought to be incompatible perspectives (Befani, 2005; Ron, 2002). This bridge is the notion of a generative mechanism that incorporates the positivist notion of causality as empirical regularities and the interpretivist rejection of cause and effect (Smith, 2006).

From a CR perspective, both the positivist and interpretivist notions of causality only paint a partial picture because they only describe what is at the level of the empirical (i.e., what is observed). The CR notion of a generative mechanism, as a latent, unobservable causal power existing at the level of the real provides a concept that subsumes other research explanations (Mingers, 2004). Hence, one can take positivist and interpretivist research findings and reinterpret them through the process of retroduction, turning the findings into generative mechanisms and CMO configurations (George & Bennett, 2005; Smith, 2007, 2010a).

A corollary to the ability to reinterpret research from other research traditions is that it makes CR compatible with any methodology, from randomized control trials (RCTs) (Bonell, Warren, Fletcher, & Viner, 2016; Porter, McConnell, & Reid, 2017) to grounded theory (Lee, 2012; Oliver, 2011). In other words, any research result is the expression of some part of a generative mechanism, its interaction with a context, and the resultant outcomes. As always, however, whether or not a method is useful is a function of the desired type of explanation.

There are at least two situations where this reinterpretation process is useful. The first is integrating research findings from different philosophical perspectives, as discussed above. So, for example, one might try to extract the generative mechanisms from an RCT and combine them with generative mechanisms from qualitative case studies done with interpretivist assumptions.

Unfortunately, in my experience, integrating findings from different philosophical traditions is often challenging. Given that most research is satisfied with empirical regularities, most research also then does not describe the context, mechanisms, and their interaction in sufficient detail to make strong retroductive inferences. Single case studies, particularly those that take a more interpretivist approach, often skirt around potential causal mechanisms and struggle systematically to rule out alternative explanations. Or, they highlight important individual-based mechanisms (e.g., interpretations, ideas) that are important, but miss out on other potential causal factors. Conversely, more positivist research tends to gloss over the contextual variation that is so important to explanation from a CR perspective. Note, this is a common challenge to social science research and evaluation, and not just to ICT4D (Pawson & Tilley, 1997, see chapter 1).

A second means of interpretation based on mechanisms emerges from “competing” MRTs. If one subscribes to causality as regularities, then when a regularity doesn’t exist, neither does the cause. Thus, a causal theory must either be true or false. If there are two potential competing explanations, then only one can hold true. However, from a CR perspective, these theories might both represent some truth in the world, but their contingency and potential interaction make their outcomes indeterminate. For example, from a CR perspective, it is not a contradiction to say that ICTs can contribute to both alleviating and exacerbating poverty; to both the democratization of knowledge and to monopolizing its production; and/or to both increased feelings of connectedness and to feelings of alienation. All of these contradictory tendencies might be co-active in any particular context.

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8There are also probabilistic notions of causality, but these are also focused at the level of the observable. They also don’t make explicit the elements of context that make the tendency probabilistic. I’m going to avoid discussions of quantum mechanics here because ICT4D research doesn’t work at that level.
Another example from the trust literature helps to make this clear. There is a debate within the trust literature as to whether or not trust is a function of rational individual decision making, or more a function of values-based, moral reasoning (Smith, 2007). CR would argue that these conceptions are not competing, but rather, they are potentially co-active mechanisms. In other words, the theories “point to different causal components that may lead to trustworthy behavior (‘it is in my interest to do so and I think it is the honorable thing to do’) and to trusting behavior (‘I think she will do it because it is in her interest and I think she is a virtuous person’)” (Smith, 2010b, pp. 48–49).

One final point on theory integration: theory integration as provided by CR can be a means for uncovering the common denominator required for comparative research. This common denominator comes from a focus on mechanisms expressed as processes (i.e., “-ing” words) rather than static objects (e.g., ICTs).

For example, there is wide-ranging literature on the application of “openness” across many domains, such as open government, open education, open source software, and even open development (Pomerantz & Peek, 2016; Smith & Reilly, 2013). The multitude and diversity of applications, domains of application, and interpretations of meanings make comparisons challenging. One approach to making comparison possible is to conceptualize openness as a set of specific practices (Smith & Seward, 2017). For example, it might seem challenging to do comparative work across a case of a researcher opening up their research data, an academic making a textbook openly accessible, and a government making budgetary data public. All have very different actors, objectives, and potential outcomes. However, one common denominator across these examples is the practice of sharing knowledge resources. Sharing can be thought of as a generative mechanism that emerges from a technological structure (e.g., online sharing platform and availability of knowledge resources) that is then activated by the context (e.g., by a new policy, or directive, or just by an individual) (Smith & Seward, 2017). From a research perspective, we can now learn about the practice of digital sharing and refine our theory of sharing.

An added benefit of a focus on practices is that it provides a bridge between ICT artefacts and outcome. Further, since practices in CR are mechanisms that must be understood in interaction with the context, these practices ultimately connect ICT artefacts to context and outcomes.

### 3.5 Testing and refining theory

A key part of contributing to the literature is taking existing theory and refining it through empirical enquiry. CR provides a means to doing so through both deductive and inductive approaches. In my experience, both the deductive and inductive approaches go hand in hand in the building, testing, and refining of theory. Here, I focus on engaging in case study research.

One logical consequence of the tight connection between levels of theory, and between theory and RQs, is that theory development is typically necessary before engaging in research. Theory building is required to develop the MRT and case-specific theories, and thus also RQs. In my experience, the better developed a theory is beforehand and the more refined the RQs, the easier it is to gather highly salient data that directly refines the original theory when engaging in research. This approach is deductive. You are formulating testable and refinable hypotheses before engaging in research, and then analyzing the results with respect to those hypotheses.

In practice, there are challenges to developing case-specific theory and RQs. If unfamiliar with the context, it will be difficult to develop the case-specific theory. In these instances, some pilot research is required to feed back into the early stage generation of theory and associated RQs. This should result in the refinement of the case-specific hypotheses, as well as the inductive generation of new ones. Commonly, this refinement means realizing that some of the case-specific hypotheses are not relevant in the particular context you are examining. Note that finding a hypothesis irrelevant in a particular context is both significant and interesting as it raises further questions about why that mechanism doesn’t exist or doesn’t get activated.

The result of this process will potentially be a large list of case-specific hypotheses and RQs, much like those spelled out in Table 1 above. For my PhD research, I had over 15 such case-specific hypotheses. The research component involves testing and refining these hypotheses. This involves refining CMO combinations, which can then inform MRT. An important part of this process is to actively try to disprove potentially competing mechanisms.

### 3.6 A focus on variation

Testing and refining CMO combinations is only possible through observing variation. Information about when things work differently or not at all in different contexts is incredibly valuable—indeed, it is exactly what to look for. This has other interesting implications.

When engaging in case studies, the desire for variation implies a preference for comparative research designs rather than single case designs—where possible. Looking at a similar mechanism interacting with different contexts gives you just the information that a CR explanation requires. Again, ICT4D research is research on the interaction of ICTs with a context. This is also why theory integration is so important and valuable. It provides more cases of variation of the same mechanism interacting with different contexts.

This focus on variation is in contrast to research methodologies such as RCTs that rely on the fidelity of an implementation and on extracting an average effect size. From a CR perspective, the move to an average effect size conceals the interaction with differing contexts, which is both a goal of explanation and critical to move the intervention to new contexts. This is not to argue that the results are not useful, but simply that the information on variation is lost and would need to be uncovered for a more complete understanding.
When it comes to RCTs, we are particularly interested in interventions that have “large effects” (Smith & Smith, 2009). This implies that the intervention is sufficiently robust such that the mechanisms it introduces can effectively override a wide diversity of contexts. In contrast, an on-average small but positive effect size will gloss over the wide diversity of effects in different contexts (which can run from large negative to large positive effects). Furthermore, given the difficulties to do RCTs without introducing some sort of bias (Ginsburg & Smith, 2016), we should be wary of the robustness of an intervention that only demonstrates a small effect. Indeed, from a CR perspective, it is tantamount to guaranteeing failure in many locales if one moves to scale an intervention based on a small effect size result.

In contrast to fidelity, adaptation is often the other side of large effects. At the design and implementation stage, it is essential to learn how to make an intervention work in that particular context. This involves having a good understanding of the “core” generative mechanisms that you hope will bring about the desired change. For example, the introduction of ICTs in a classroom will typically require teacher professional development mechanisms to make it successful. These together would be the core generative mechanisms of the intervention. However, an intervention typically comes with a range of other mechanisms that enable the core mechanisms to successfully generate the intended outcomes. For example, the organization of access to the ICTs by teachers and students may be different in different contexts due to electricity constraints. However, the result is that these contextual adaptations maintain the integrity of the core intervention, thus maintaining the large effect. Understanding the difference between the core intervention mechanism and those that support the core mechanism helps to enable the identification of sources of failure; that is, is it a poor or incorrect theory of change, or an implementation failure? There are new emerging methodologies, such as those within implementation science, that offer rigorous approaches to both designing and moving implementations to new contexts, and that make a similar distinction (see, for example, LeMahieu, Bryk, Grunow, & Gomez, 2017).

### 4 | CHALLENGES PUTTING CR INTO PRACTICE

Critical realism has been critiqued for being time-consuming and resource-intensive to operationalize (Reed, 2009). This strikes me as an odd critique. If we agree the social world is complex, and that we are operating in an open system: why would anyone think that research, particularly social science research, should be easy? Indeed, if it appears that ICT4D research is simple, you are probably doing it wrong (or the research is, at least, incomplete). That said, critical realism is difficult to operationalize, for a few reasons apart from the fundamental realities of the social world.

The first challenge to applying CR is that it is new, difficult to understand, and not often applied. CR is replete with neologisms (eg, generative mechanisms) that take a while to understand. This understanding is made more difficult because the key ideas often run counter to how many think about research. Furthermore, the relatively novel nature of CR means there isn’t a long history of established work to draw on. For example, there is no existing set of ICT4D-related mechanisms to which researchers can turn. For those interested in advancing a CR approach to ICT4D research, building that repertoire of mechanisms should be the first item on the agenda.

Perhaps, the most difficult element of employing a CR philosophy is attempting to deal with highly complex social situations in an analytical manner. It is easy to speak of CMO combinations, but it is much harder to try to sort them out—especially when there could be many. This is just the reality of the situation. Abstracting from concrete case-specific theories up to MRTs is very helpful here, as is scoping research by starting with some ideas of case-specific theories you are testing and refining.

### TABLE 2

| Activity                          | Implications/Approaches                                                                 |
|----------------------------------|-----------------------------------------------------------------------------------------|
| Research questions and theory building | Research questions and explanation should always include some combination of how, to what extent (M), for whom and in what contexts (C) a particular outcome (O) occurs. The purpose of the research determines the appropriate level of theoretical abstraction and how thoroughly one needs to build out contingent causal chains. Theorize as much as possible upfront. Theory should be developed at different levels, with clear connections between the levels. Build on existing theory, taking advantage of theory integration enabled by reinterpreting research from different philosophical perspectives in light of CR assumptions. Research questions should correlate directly with theory. |
| Theorizing mechanisms            | Think of mechanisms as processes, employing the active voice (eg, with “-ing” verbs). Theorizing should have this process at the center and build out in three directions: (1) specifying the underlying structural components of the mechanism; (2) understanding how this mechanism interacts with mechanisms in the context; and (3) describing what the resultant outcome is. Be clear to distinguish the mechanism under study from mechanisms in the context. In ICT4D, this will often require a careful scrutiny of the underlying structure (often combinations of technological structures) from which the mechanism emerges. This scrutiny might change with different mechanisms. |
| Testing and refining theory      | Engage with multidisciplinary teams if possible. Engage in comparative work where possible and pay close attention to variation. Use this variation to test and refine rather than verify and falsify. Actively look for competing explanations (mechanisms). While this is good practice in general, it is particularly critical when using a single case study research design. Abstract from case-specific tested and refined theory to middle range theory to enable generalization. |
Another challenge is that the multidisciplinary nature of theorizing requires a researcher to read widely and typically outside of their area of expertise. It is challenging to be sufficiently steeped in a wide variety of fields such that you can potentially infer causal mechanisms from them. It is hard enough to follow one’s own focus discipline! In many ways, CR-inspired research calls for more generalists rather than specialists. In lieu of that, multidisciplinary teams are useful.

5 | CONCLUSION

To adopt CR assumptions is to adopt a worldview. Once you become fully “infected” with the ideas, it becomes (at least, for me) very difficult to interpret the world otherwise. From a research perspective, this has meant that these assumptions have permeated all that I do. More concretely, the influence has shaped the way I think about explanation, which then has a ripple effect on what I am looking for in research and how I might go about it. This paper is an attempt to present some of these effects, alongside ways of operationalizing the CR assumptions that I have found useful over the years.

By way of summary, see Table 2 for some key implications and approaches discussed above.

One caveat: there are many other implications to be drawn from CR assumptions. The sample of implications I have highlighted here is biased by the nature of my work in the ICT4D field. The bulk of my experience comes while at Canada’s International Development Research Centre, meaning that this paper is highly influenced by working with research for development projects (ie, research with a focus on having policy or practice implications). As such, use of the research findings is of critical importance, as the major focus is on producing research results that feed into change processes. Typically, but certainly not exclusively, this involves research where (1) the focus of explanation of ICT and social change processes is on causal components, often with testable propositions, and (2) the resultant explanations should be generalizable to different contexts.

That said, the CR approach is compatible with research with other aims or uses. For example, in areas where there is not a lot of existing theory, it might be necessary to engage in inductive theory building without the prior theoretical work. While CR pushes researchers to think about causal explanation, purely descriptive research can also be useful—particularly as a precursor to follow-up studies that attempt to explain what has been observed. So, despite the biased sampling of the implications given above, I believe a majority of them are still relevant for a wide range of different ICT4D research purposes.

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