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# Methodological Approach for Identifying Mechanisms in ICT4D: A Critical Realism Perspective

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**Abstract.** The ontological questions ‘What is ICT?’ and ‘What is development?’ are described and documented in literature. Similarly, methodological approaches for understanding how ICT leads to development or for measuring the impact of ICT are described. However, explaining ‘why’ ICT works or not in the contexts of developing countries needs further investigation. We propose a critical realism based methodological approach for answering the above mentioned ‘why’-question. The core of a critical realism based approach is to identify the underlying mechanism(s) that may explain a phenomenon of why ICT leads to development. We demonstrate the proposed methodology through applying it on a case in an ICT4D context from Nepal.

**Keywords:** ICT4D, Development, Critical Realism, Methodology, Mechanisms.

## Introduction

Over the years development has been viewed from different perspectives [1] depending on class, culture, historic context, politics, relationship to power and technology [1]. Along with changing perspectives on development the understanding of the role of technology in development has changed [1]. In their literature review Thapa and Sæbø [2] identified six research gaps for understanding the link between ICT and D [2 p. 11]. Most of the research gaps relate to a lack of understanding the link while some also relate to scope and context. However, no identifications or suggestions of research gaps was found for explaining why deploying ICT leads to development.

Scholars in ICT4D advocate for human oriented approach [4,5,6], particularly Sen’s [3] idea of capability approach (CA) [7, 8]. According to Sen [3] development should be seen as the freedom for people to live the lives that they value and have a reason to value. Sen [3] argues that poverty should be viewed as capability deprivation, not only as an economic factor. This is an encouraging trend, since Sen’s CA is seen as a suitable and appropriate lens for investigating how ICT may foster development [9]. However, a major challenge remains on explaining why development happens when pairing ICT and CA [10].

adfa, p. 1, 2011.

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Information and communication technology is developed in an accelerating speed and has come to be regarded as more than a just tool. Through a more holistic understanding of ICT, it can act as an enabler of capability enhancement [6]. Especially the emergence of Internet allowed “the small and new to compete on equal terms with the large and the well-established, and permit leapfrogging to an ‘information economy’” [11]. With their “Desperately seeking ‘IT’ in IT Research” Orlikowski & Iacono [12] opened new strands of research on IT artifact that has benefitted many researchers in their quest for understanding IT artifacts. Using the conceptualization of IT suggested by Orlikowski & Iacono [12], Sein & Harindranath [6] focused on understanding the role of ICT in national development. They conceptualized ICT artifacts from five different views described as follows:

In the Nominal view of ICT, ICT is not distinguished from any other objects of study. In the Tools view ICT is conceptualized as a technical entity as means to achieve some objective like substitute ICT for manual labor to increase productivity. ICT may further ease communication and be an instrument for changing relationships thus supporting development activities. In the Computational view the conceptualization of ICT focuses solely on the technology as such, the machine itself and its algorithms. In the Proxy view ICT is conceptualized as a surrogate for other concepts. “We interpret this view as ‘what ICT represent’...as a knowledge enabler” [6 p. 19]. In the Ensemble view ICT is conceptualized as going beyond the technology i.e. beyond the Computational view and into a view of ICT as part of the actual use of ICT in a social and development oriented context. “In this view, the social and contextual aspects determine how ICT is conceived” [6 p. 19].

ICT used in development will supposedly have some “impacts” compared to not using ICT. However, “How does ICT actually lead to development?” is a challenging question to answer [6 p. 19]. In their quest for answering this how-question Sein & Harindranath [6] suggests that new technology impact society through three effects (referring a framework proposed by Malone & Rockart [13], adopted by Sein & Ahmad [14]).

The first-order or primary effect is that old technology is substituted by new. Primary effects may not in itself indicate development, but are essential for higher-order effects to take place. The second-order or secondary effect leads to an increase in phenomenon enabled by using the new technology. The third-order or tertiary effect is that new technology-related businesses are established and societal change may take place. Based on the three conceptualizations (i.e. ICT use, ICT views, and ICT impacts) Sein & Harindranath [6] propose an integrated framework for studying ICT in development (p. 20) suggesting that ICT view and ICT use influences ICT impacts that in turn influence human development. However, they do not suggest any causal mechanism that can explain why ICT leads to these different impacts.

Kleine’s [8] question “ICT4WHAT?” and the Choice framework to operationalize the capability approach to development give some direction for answering the why-question. The Choice framework of Kleine [8 p. 680] suggests that Structure and Agency influences each other and these two elements influences the degree, primarily as choice (including choice in ICTs), secondarily as easier communication, increasing knowledge, greener environment, increased income, increased mobility, more personal

time, more voice, more autonomy, etc. The development outcomes then in turn influences Structure and Agency thus having a possible strengthening of these two elements leading to a greater degree of empowerment that in turn leads to more development outcomes in a positive spiral movement.

However, the question about the ‘causal mechanism’ by which agency interacts with ICT, and that enhance the individual capabilities still remain unanswered. We fully acknowledge the existing research; however, at the same time, argue that the existing research limits their methodological application to describing the phenomena. The causal explanation to the ‘why’ question still needs further investigation. To complement this research strand, we propose a methodology that is derived from the philosophy of critical realism. In the following sub sections, we discuss critical realism and methodology. We then present an exemplary case that is used to illustrate the methodology before we conclude the paper.

## **Critical Realism and Methodology**

This section describes critical realism in brief, and, subsequently the proposed methodology.

### **Critical Realism**

Seeking to answer our research question searching for mechanisms that may explain why ICT works for “D” we will discuss underlying philosophies used for researching information systems. “Historically, most IS research and systems development, particularly in the US, has been underpinned by a positivist (more generally empiricist) philosophy” [15 p. 87]. Initially, the ICT4D domain followed a similar tradition [16]. The challenge with the empiricist philosophic view on researching ICT4D is threefold: i) perceptions of reality was mainly based on observations i.e. the reality is what you see and perceive, ii) the observations made of the actual events did not provide opportunities for proving underlying mechanisms, i.e. what cause the event, and iii) that universal laws could be derived from a set of particular observations, i.e. same cause-and-effect works in various situations [17]. However, it is difficult to ascribe universal laws to the success/failure of ICT4D. The nature of ICT4D research is highly contextual [18]. For example, positivist models and frameworks that claims that ICT deployment in particular ways will lead to development and does not consider the socio-political contexts in which they are deployed [19].

Other philosophical underpinnings in IS research, as interpretivism or conventionalism [15], according to the Kuhnian view, “highlights the constructed, conventional nature of scientific theorizing, and truth is that which is accepted by a scientific community rather than correspondence to some external reality” [15 p. 90]. The challenge with these approaches is that truth is contextual and based on the perceiver’s perspective. A majority of the recent ICT4D research follows interpretive tradition, however the interpretive approaches are more interested in understanding context rather than explaining

the phenomena. The interpretive tradition reject the idea of discerning causality through interpretive case study. To find the middle way of universal law vs mere understanding critical realists argue that the world is socially constructed but not entirely so. Sometimes we, as researchers, can transcend interpretation and explain the situations we research [20]. We therefore suggest turning to Critical Realism that we describe in the following.

Roy Bhaskar developed a general philosophy of science that he labeled transcendental realism and a special philosophy of the human sciences that he called critical naturalism. The two terms were combined by other authors to form the umbrella term critical realism [21]. The main idea behind Bhasker's critical realism is a stratification of reality in three domains: the real, the actual and the empirical [22].

According to critical realism, the real domain consists of structures of objects, both physical and social, with capacities for behavior through mechanisms [20]. The mechanisms may trigger events in the actual domain and the events may be observed empirically. Thus, structures are not deterministic, but have the potential to enable and constrain events through inherent mechanisms [20]. Therefore, from a critical realism perspective, understanding the societal effects/outcomes associated with introducing new structures (e.g. new ICT systems in ICT4D context) and how they occur can be viewed as understanding the generative mechanism associated with those structures [23]. However, critical realism does not aim to uncover general laws that predict outcomes, but to identify the underlying mechanism that have generated the phenomena of interest and could do so again. We therefore argue that critical realism is a methodology we can apply for seeking to answer our research question.

## **A Proposed Methodology**

The layered ontology structures, mechanisms and events "is the key to the critical realist methodology" [24 p. 3]. Critical realism as a methodology (cf. Figure 1) seeks to describe mechanisms and structures theoretically for hypothesize how the events observed or experiences may be explained [24]. The researcher in a critical realist research design will therefore systematically analyze the interplay between the three layers: structures, mechanisms and events. "The methodical question is; how do we identify mechanisms, since they are not observable?" [24 p. 3].

Mechanisms are central in critical realist methodology, therefore, what are mechanisms? This question may be answered from different perspectives. Mechanisms are the casual powers that causes the events that we may observe [22, 24]. Mechanisms may also be called generative mechanisms [24]. For example, we may observe developers of information systems for ICT4D and buyer/users of the information systems agree on functions of such information system. However, the underlying mechanisms in the negotiations, the communication or the power differences prior to the signing of the contract may not be observable. Some other perspectives on mechanisms are "...a causal structure that can trigger events" [24 p. 3], being a causal relationship between objects [25], contingent causality [26], or causation [27 referred in 20] meaning that the same mechanism may produce different outcome in different situations and contexts

depending on structures and conditions (other mechanisms) [27 referred in 20]. Mechanisms may therefore not be used for prediction, but may be useful for explaining why a given outcome was produced in a given context in an actual situation with actual structures and conditions.

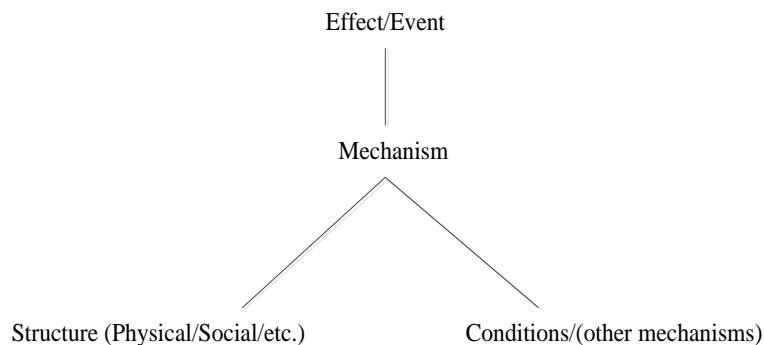
The challenges in identifying mechanisms in a critical realism methodology are many in that there are no direct and stable links between structures, mechanisms and events. However, the idea is to identify the mechanisms, not the empirical data. "The mechanisms are associated with the nature of the object of study, not with the attributes of the data" [24 p. 5]. These mechanisms can be uncovered through retrodution, a process of working backward from the empirical events, searching for the underlying mechanisms that could logically have produced the events. The retrodution may include interviews asking the question "what produces change?" [20 p. 123]. Through an iterative process, we may improve our understanding of the mechanisms that produce the change.

In addition to the real-actual-empirical stratification and the temporal separation of structure and action, structures themselves can be stratified. The structures may consist of various components. Rather than being a simple aggregation of parts, they combine into 'assemblages', whose causal properties emerge from the interactions between parts and are not just an additive combination of the properties of the components. Since the relations between parts matter the mechanisms that arise from these nested structures are a complex web of interpenetrating effects that can lead to evolution of new structures and mechanisms [15].

Critical realist methodology must have a research question of the form "What caused the events associated with the phenomenon to occur?" [20 p. 123]. Bygstad & Munkvold [24] suggests six steps in a stepwise framework for critical realist data analysis. The first step is describing the events observed [24]. A description may include a decision to start a project that may give internet connection to a remote village. Often such descriptions will include many different observations that are connected to the decision. The second step is to identify the entities/objects that characterize the phenomenon being studied [20] and collect data about these entities. The key components are for example persons, organizations and systems, i.e. the real objects of the case, forming networks with causal power. Then follows the third step, interpreting the data [20] also called theoretical re-description (abduction) [24]. Preparing for step four, retrodution, we need, in step three to abstract the case, searching for different theoretical perspectives and different explanations [24]. Theories for use in the abduction step of the process may be theories for ICT4D that may help us to increase the theoretical understanding of the case giving a deeper understanding of the events in the case. The fourth step, the key epistemological process, retrodution, "is a meta-process the outcome of which is the identification of mechanisms that explain what caused the events to occur" [20 p. 124]. According to Bygstad & Munkvold [24] this step is the most crucial. They have therefore divided the step in to two sub-steps, the interplay of objects and looking for micro-macro mechanisms [24 p. 6]. In the ICT4D field the interplay between objects will often be between social and technical objects. Since ICT4D may include cross cultural activities using technology that is developed in one culture for

development in other cultures the interplay between the objects are important to identify. Bygstad & Munkvold [24] exemplify the micro-macro mechanisms as follows: the micro-macro mechanisms explain the emergent behavior, that is the interaction of different objects that produce some outcome at a macro level, and the macro-micro mechanisms that can explain how the wholes enables and constrains the various parts [24, 19]. In step five the results of the retroduction process, the mechanisms are then analyzed [24] to find what mechanisms may explain the outcomes. We may analyze the outcomes using forward chaining to understand intentions, or backward chaining to understand results [24]. For instance, studying ICT4D we may find some cases where the intended goals were reached, we should look for the mechanisms that led to the success. The results from Step five then prepare for the sixth and last step in the process, deciding if the explanations found are “good” or not [20]. The different explanations, i.e. mechanisms that caused the events may then be ranked and argued for as the last part of step six.

In the following section, we illustrate how this stepwise framework may be used in searching for underlying mechanisms that can explain ICT4D phenomena in the Nepal Wireless Networking Project (NWNP). The case relates to 10 villages and to Kathmandu, the capital of Nepal. The case description is an excerpt of around 60 interviews conducted in the period of 2009 to 2011.



**Fig. 1.** Critical realist view of mechanisms (adopted from Sayer [27 p. 15])

## **An Exemplary Case**

NWNP was initiated by educationist and social activist Mahabir Pun (team leader of the project). He wanted, initially, to solve the communication problem in a village called Nangi located 2000 meter above sea level. There was no transportation facilities leading to the village and the villagers had to walk 8 or 9 hours just to post their letter. It was a huge problem for the villagers because most of the people from this village had jobs in foreign countries, like India, Middle East, and UK. Letter from their relatives living abroad could take 2-3 months to reach the village. As late as 1997, the village

had no telephone or Internet connection to the outside world. Realizing the pressing need of the Nangi people, Pun started to search for the possibilities of using ICT in solving this problem. In 2001, Pun wrote an email to the British Broadcasting Corporation (BBC) asking for ideas to connect this remote village to the outside world through the Internet. After the BBC broadcasted his email, the response was overwhelming. Within a year, volunteers from Europe and the United States began to pour into Nangi and helped him in setting up a wireless connection between Nangi and other neighboring villages using desktop and laptop computers, internet telephony equipment, network cameras, and TV dish antennas mounted in trees. Gradually, the story of NWNP spread across Nepal and to the outside world leading to Mr. Pun's social network expanding across Nepal and to other parts of the world. Volunteers from several countries started donating computers, parts, Wi-Fi equipment and their time to the related mountain villages in Nepal. The project initially started for solving the villagers' communication problem, but opened new possibilities for education, healthcare and income generating activities. For example, NWNP collaborated with OLE, for education, Kathmandu Model Hospital, for telemedicine services and Thamel.com, for e-commerce opportunities.

Since 2003, this project has been in full-fledged operation. Despite difficult circumstances, as lack of government support, lack of funding, lack of technical knowledge, and an unstable political system like the civil war between the government and the Maoists when the project started, the project succeeded in providing Internet services to villages in the Myagdi district. Currently, the NWNP has assisted in setting up networks in around 200 villages providing various services in education, healthcare, and income generating activities in the mountain regions.

## **Illustration of The Proposed Methodology**

In this section, we describe how the methodology based on critical realism can be used to identify the mechanisms and structures that lead to development or capability enhancement in the NWNP case and provide a discussion of the literature related to the analysis of the steps.

### **Step 1: Description of events**

Since the purpose of this ICT4D research is to find out why ICT leads to some sort of capability development we needed to identify events that are related to enhancement of capabilities (freedom of choice) in the case we have described. We identified four events/effects of NWNP in the mountain region: communication through VOIP, telemedicine, online education, and online business activities. The identification of the events was done through discussing with key interviewee such as Mr. Pun, Dr. Dhital, Mr. Karmacharya, teachers, district officers and community people. Furthermore, one of the authors did field visits observing what happened in different situations and everyday activities related to the case.



## **Step 2: Identification of entities**

The process in step 2 revealed how various technologies, PCs, software, antennas, batteries etc, actors, internal from the village, from neighboring villages, from Kathmandu, and international actors, social structures formed by the actors mention and in addition some key social groups like ‘mothers group’ known locally as ‘aama samoh’, interacted and formed the ‘assemblage’. The links to external stakeholders included actors such as Kathmandu model hospital, OLE, and thamel.com were also identified. As stated, “Entities only attain meaning if they are embedded in a theoretical framework... entities can be tangible or intangible, social or physical, dormant or active” [20 p. 125]. In the next step, we therefore relate the entities to relevant theoretical framework.

## **Step 3: Theoretical re-description (abduction)**

The abstraction and generalization of the events identified in Step 1 were performed over a 2-year’s period being the data for identifying the entities in step 2. In step 2 we identified that the entities in the case interacted and formed an ‘assemblage’. The assemblage includes enrolled network partners and local communities, and installation of internet connection. The process of forming assemblage can be theorized and explained with the ANT’s (Actor-Network Theory) translation moments of problematization, inter-essement, enrolment, and mobilization [28]. The translation moments describe the key strategy factor of NWNP [28]. The results of this strategy led to a gradual establishment of NWNP’ main infrastructural hub for telemedicine and distance education services. The popularity of the project after Pun received the Magsaysay award led to enrolling an increasing number of national and international partners to provide resources to extend NWNP services.

In the beginning of our theoretical re-description, we interpreted the enrolling of key actors and the mobilizing of them as a means of enhancing capabilities. However, later we found that people first form trust and norms in the network, thereafter they take collective actions as essential elements in the network in the formed assemblage.

ANT could therefore be used to describe the process of the formation of assemblage. However, to understand why and how people form trust and norm in the network, and why they take collective action, we furthered the theorizing process by introducing social capital theory [9] in step 3. The emergence of trust and norms in the network can be described more precisely in terms of mechanisms, which produce the outcomes described. Social capital explains why and how the participation of the actors in the NWNP case in turn lead to collective action [9]. The core element of social capital exercised in networks of social relations are characterized by norms of trust and reciprocity [29, 30]. By combining the perspectives from Actor-Network Theory and social capital theory, we can provide an explanatory lens to understand why and how different actors interacts and build social capitals in the above mentioned assemblage. A major focus of these theories in this particular context is to try to explore the processes whereby relatively stable networks of aligned interests are created and maintained successfully, or alternatively to understand why such networks fail to establish themselves [31]. ANT suggests that successful social networks of aligned interests are created

through the enrolment of actors and translation of their interest so that they are willing to participate in particular ways of thinking and acting that will maintain the network.

#### Step 4: Retroduction: Identification of candidate mechanisms

Based on the description and analysis in steps 3 three interconnected mechanisms were identified as candidates for mechanisms. They were identified through applying ANT and social capital theories described in Step 3. The mechanisms can be described in this particular case as follows: i) ICT provide possibilities to enhance capabilities, but the possibilities provided by ICT need to be perceived by actors or mediators informed by ANT. Then ii) to actualize these perceived possibilities, we need collective action. The source to collective action is social capital, informed by social capital theory. Furthermore, iii) if the collective action is taken and the possibilities are actualized then it can enhance individual capabilities, informed by social capital theories. In summary, the first mechanism explains the roles of focal actor(s) in identifying the social problems and the possibilities of ICT that can solve the problems, thereafter enroll other actors who can facilitate in actualizing the ICT possibilities. The second mechanism explains the role of social capital in building trust and norms among the actors. The third mechanism explains the mobilization of actors-network through collective action. To make it more representational we coined the three interconnected term as ‘Actor-Network in Action’ mechanism (Ref Figure 2).

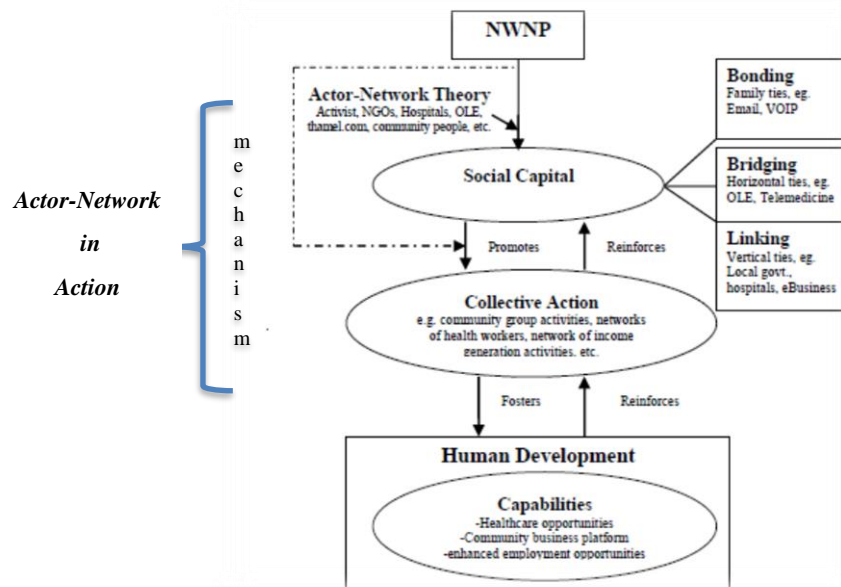


Fig. 2. Identifying Mechanism in ICT4D (Figure adapted from Thapa [32])

## **Step 5/6: Selection of mechanism and ranking of the selected mechanisms**

Step 4 results in multiple interconnected mechanisms as candidates for explaining why events occur arising the question of selecting mechanisms. What mechanism is best or the most acceptable mechanism in the given situation [20]. Easton [20] suggested the idea of, "... judgmental rationality. It means that we can publicly discuss our claim about reality as we think is, and marshal better or worse arguments on behalf of those claims" [20 p. 124].

The results of a critical realism based methodological analysis shows that the three interconnected mechanisms 'Actor-Network in Action' explain the process by which ICT enhance the capabilities leading to D in the NWNP case (cf. Figure 2).

## **Conclusion**

In this paper we started with defining ICT and Development, then related the two. We identified that when relating ICT to Development, the main focus of existing studies is on HOW questions, such as how does ICT leads to development, or how to measure the impact of ICT. However, explaining underlying mechanism like 'WHY' ICT leads to development remained unanswered and was therefore a matter of further enquiry. Therefore, to contribute to this knowledge gap we proposed a methodology based on critical realism. We also argued that critical realism reconcile the realism stand with the interpretivism stand by taking the middle ground of realist ontology and relative epistemology.

The proposed methodology was illustrated using a case from Nepal, the Nepal wireless networking project. We presented the case analysis using a step-by-step approach in identifying the mechanism 'actor-network in action' as an explanation of why ICT succeeded to create various opportunities in this case, for instance, because there was a goal oriented actor, who build trust in the vertical and horizontal network of various actors. The network finally took collective action to realize the affordances of ICT.

The methodology however is not without caveat. For instance, the critical realist still cannot claim that the mechanism identified is the best one. However, as we mentioned earlier, in a given situation the retroduction process can identify the best possible explanation that is consistent with the data. It may be questioned if results from using the methodology may be generalized per se. However, as for generalizability, Easton [20] suggests four supportive reasons that can be helpful in theory development: first, identification of the entities, structures and their relation, second, understanding of affordances and constraints of various tangible and intangible structures, third, identification of contingent relations among entities and structures, and finally, provide evidence through judgmental rationality. These are some avenues for further research.

Another avenue for further research is the relationships between the micro-macro mechanisms, morphogenesis, explaining the emergent behavior that produce an outcome at a macro level, and the macro-micro mechanisms, explaining how the whole enables and constrains the various parts [24]. Implicitly we touched upon these two sub-steps in step 4, but these sub-steps need more elaboration.

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