**Article:**
Karanasios, S and Allen, D (2013) ICT for development in the context of the closure of Chernobyl nuclear power plant: an activity theory perspective. Information Systems Journal, 23 (4). 287 - 306. ISSN 1350-1917

https://doi.org/10.1111/isj.12011

# ICT for Development in the Context of the Closure of Chernobyl Nuclear Power Plant: an Activity Theory Perspective

**Stan Karanasios**
AIMTech Research Group, Leeds University Business School, Maurice Keyworth Building, University of Leeds, Leeds LS2 9JT, UK, email: s.karanasios@leeds.ac.uk

**David Allen**
AIMTech Research Group, Leeds University Business School, Maurice Keyworth Building, University of Leeds, Leeds LS2 9JT, UK, email: da2@lubs.leeds.ac.uk

**Citation:** Karanasios, S., & Allen, D. (2013). ICT for development in the context of the closure of Chernobyl nuclear power plant: an activity theory perspective. *Information Systems Journal, 23*(4), 287-306. doi: 10.1111/isj.12011

**Abstract**

This paper provides an analysis of a broadband implementation in the town of Slavutych, Ukraine. Slavutych was purposefully built 50km from Chernobyl shortly after the Chernobyl Nuclear Power Plant (ChNPP) disaster in 1986 to house personnel of ChNPP and their families evacuated from the city of Prip'yat. Drawing on activity theory and in particular the notion of activity systems we demonstrate how an activity system approach can be used to frame Information and Communication Technology for Development (ICTD) intervention. We highlight the tools used to mediate the activity, the activity motivation and the relevant stakeholders and examine the role of "contradictions". Using the notion of connected activities we also provide some theoretical basis for understanding the emergence of activities and conceptualising the impact of development projects, arguing that the outcome of an activity leads to/is consumed by other related activities. This paper contributes to scholarship in the field of ICTD using an empirical case in a complex setting and furthers theoretical development by advancing an activity system perspective for understanding and theorising ICTD interventions.

**Keywords:** activity theory, information and communication technologies (ICTs), development informatics, impact, broadband.

## 1 INTRODUCTION

There is a general consensus that information communication technologies (ICT) can play some role in invigorating economic growth and improving livelihoods in emerging and developing countries; contingent upon on a number of social, political, environmental and economic factors. Over the last decade a growing corpus of research has illuminated our understanding of how ICT facilitate activities in health, business, the environment and governance (Miscione, 2007, Rajão & Hayes, 2009, Datta, 2011, Karanasios & Burgess, 2008, Karanasios, 2012), amongst other areas. These activities are best underpinned by broadband (Qiang et al., 2009). However, penetration levels in some developing countries remain as low as 4.4 subscriptions per 100 people compared to 24.6 in developed countries (ITU, 2010).

The reasons for the "broadband divide" echo that of the broader digital divide, which is well visited in the academic literature. The reasons include a mixture of interrelated factors such as inadequate physical infrastructure, the high costs and other political, economic and technological imperatives. In order to address the broadband gulf there has been academic, government and development agency interest in the implementation of new or significant overhauling of existing telecommunication infrastructure. The implications of the implementation of telecommunications infrastructure offering high-speed internet connection to citizens, government and business in a town setting is a relatively unexplored domain, as most academic research focuses on the micro (individual users or businesses) or national level. Nonetheless, for last-mile and outer-urban areas across many countries, new telecommunications infrastructure or significant overhauling of existing infrastructure is required in order to provide efficacious connectivity. Therefore, intervention in the form of multi-nationals, donors, international agencies and local business, which all may have incongruent motivations, is often required to develop the infrastructure, leading to complex networks of relationships (Sayed & Westrup, 2003).

Some authors provide guiding principles for augmenting the success of ICTD interventions. Heeks (2010) suggests that successful ICTD implementations should address three key domains (i) ensuring that designs are sufficiently aligned to local realities (ii) open governance which involves multiple stakeholders, and (iii) ensuring sustainability from an economic and socio-political perspective. Mallalieu and Rocke (2007) articulate two underlying attributes (i) interventions must be driven by national or provincial developmental objectives, and (ii) these developmental objectives should be achieved through the

parallel engagement of many sectors. These principles suggest that ICT interventions should be designed to fit the cultural-historical context in which they will be utilised and shaped.

In this paper we focus on an investigation of a recent broadband town information network (TIN) implemented in Slavutych, Ukraine. Slavutych was purposefully built 50km from Chernobyl, shortly after the Chernobyl Nuclear Power Plant (ChNPP) disaster in 1986 to house personnel of the ChNPP and their families evacuated from the abandoned city of Prip'yat. In the next section we identify several theoretical limitations in ICTD research and introduce activity theory as an alternative theoretical perspective. We then outline our study methodology. Following this we describe the cultural-historical context of the TIN implementation. In our analysis we demonstrate how an activity system approach (Engeström, 1987) can be used to frame ICTD activity. We highlight the tools used to mediate the activity, the implementation object and activity outcome. We also introduce the role of contradictions and identify the contested and ambiguous motivations and outcomes and the underlying tensions that led to the project. Using the notion of the relationship between activities we also provide some theoretical basis for conceptualising the impact of ICTD projects. The paper concludes with some discussion on the study findings and outlines the promise of an activity system approach for future ICTD research.

## 2 THEORETICAL OPENINGS IN ICTD RESEARCH

Several authors have explored the theoretical framings employed in the extant ICTD research and their contributions (Walsham & Sahay, 2006, Avgerou, 2010). A common conclusion is that despite the theoretical capability to study the interaction between technology and poverty, the theoretical contribution of the ICTD field remains weak. We identify several pertinent theoretical challenges. The first concerns the position of ICTD research in the broader IS and development research fields and the lack of articulated fundamental research problems and appropriate methods (Best, 2010). The second is related to developing theory and using approaches capable of addressing the inter-relationship of ICT within the cognitive and socio-political context (Avgerou, 2010). To counter this, Avgerou (2010) argues that underlying perspectives which hold that the development and use of ICT artifacts concern the construction of new techno-organisational arrangements are better placed than technology transfer and diffusion perspectives. A third theoretical challenge is strengthening the field's capacity to associate ICT with socio-economic development in order to form more convincing arguments about the role of ICT in development (Heeks, 2010, Avgerou, 2010). Intertwined within this challenge lies the issue of impact and the sustainability of ICTD initiatives (Heeks, 2010). Macro analysis and quantitative studies have made progress in this area (Qiang et al., 2009), however micro-level and qualitative study contributions are lacking. In the next section we introduce activity theory and explain how it offers an alternative lens, one which is both complimentary to existing approaches and appealing to the context of ICTD research. Following this we present an empirical case to demonstrate how activity theory, and in particular the notion of activity systems, can account for some of these theoretical openings.

### *2.1.1 Activity theory*

Activity theory is based on the cultural-historical school of Russian psychology, which was developed between 1920-1930 by Vygotsty, Luria and Leont'ev and centred on the unity of consciousness and activity. These ideas were an attempt by scholars to explain the interactions between human beings and the material world. Activity theory is not a "theory" in the commonly understood interpretation of the term. Rather, it consists of a set of basic principles which constitute a conceptual framework for enquiry to be used as a foundation for more specific theories, with an emphasis on social factors and interaction between agents and their environments.

Leont'ev, building on Vygotsky's work introduced the concept of "activity", as a specific form of the societal existence of humans, which is "object-oriented". One of the most conceptually contested areas of activity theory is the notion of the "object" (Kaptelinin, 2005). The term object or object-oriented refers to the "thing" towards which the subject (which may be an individual or group) directs themselves in order to achieve a desired outcome. Objects can be poly-motivational (Kaptelinin, 2005) and are constructed and reconstructed during an activity and are often problematised by external forces such as legislation and market forces.

Leont'ev (1978) developed a basic structure and common language for focusing on activity as the unit of analysis, as represented in Figure 1 (left-side). Engeström (1987) expanded on these concepts and included the community, social and cultural rules and norms and a division of labour in the activity structure (Figure 1, right-side). This activity system is also referred to as "third generation" and has been widely adopted in most recent use of activity theory to frame collective and individual activity (Allen et al., 2011). The activity system structure follows that an activity is undertaken by a subject, which is driven by a motivation to achieve an object. That is, a subject is an agent that acts towards the object. Therefore, the approach is interactionist as the subject transforms the object, while the properties of the object penetrate into the subject and

transform them (Kuutti, 1996). This process of interacting with the object is undertaken in collaboration with a community and mediated by tools, which carry socio-historical meanings. Tools are physical artifacts (such as computer, hammer etc.) or mental tools (such as language, skills etc.). The principle here is that humans on most occasions interpose culturally established artifacts between themselves and the object of interest, thereby enabling them to act more effectively. Furthermore, tools can be created and transformed during the development of an activity, introduced by the community or be an outcome of a previous activity and therefore embody a particular culture. This process of activity takes place against the backdrop of a division of labour and rules and norms, which are associated with values and social judgments. Taking the activity as a unit of analysis the researcher selects a member (or multiple members) of the activity, through whose perspective the activity is constructed (Engeström & Miettinen, 1999).

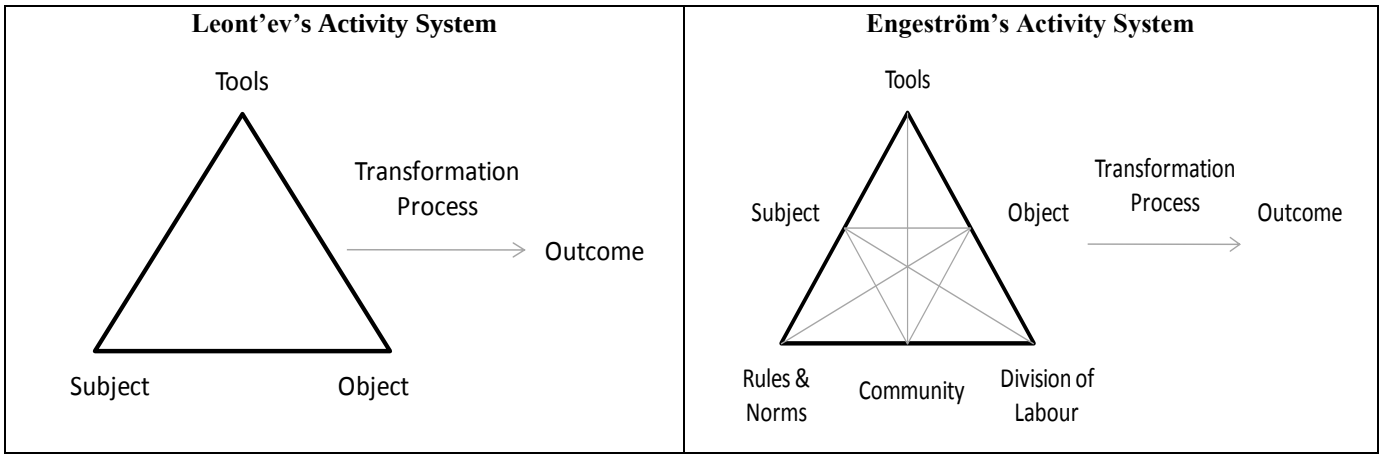


**Figure 1: Activity structure**

A fundamental concept in activity theory employed to explain change is the notion of contradictions and tensions within an activity (Engeström, 2001). As contradictions arise, or are observed, they expose the dynamics, inefficiencies and importantly opportunities for change (Helle, 2000). Contradictions exist at four levels. Primary contradictions are found within a component of the activity (i.e. the object). The major primary contradiction has been noted to be the use-exchange value of an object (cf. Engeström, 2001, Engeström & Miettinen, 1999) and is of fundamental interest in the context of the digital asymmetry and poverty. Secondary contradictions occur between constituents of the central activity (i.e. between the community and object). Tertiary contradictions occur between the central activity and a culturally more advanced form of the activity (i.e. an activity pre- and post-intervention). Quaternary contradictions occur between co-existing/neighbouring activities (Engeström, 1987).

In recent years activity theory has become an established analytical tool amongst several scholarly fields, including IS (Helle, 2000, Uden et al., 2008), providing semantic tools and a conceptual framework for enquiry. In the context of ICTD research however, despite the ability to provide a critical analytical framework and account for context, emancipation and other concepts that motivate ICTD research its use has been sparse. A search of the three predominant ICTD journals[1] reveals little application or reference to activity theory.

On the other hand, ICTD research has drawn upon contemporary social theory, which have deeper traditions in IS research, such as Actor Network Theory (ANT), structuration theory and institutional theory. These have offered vocabularies to address conceptual relationships such as technology-society, agency-structure and technical reasoning-institutional dynamics in ICTD (Avgerou, 2008). Rather than engage in an in-depth discussion on the emphasis of the predominant approaches, and their benefits and limitations, here we briefly describe some of the differences between these approaches and activity theory in the context of ICTD. Indeed, we argue that activity theory not only offers an alternative perspective, concerned with mediation and social action, but that it also presents some congruency with and accommodates other approaches (Nardi & O'Day, 1999) and is a fundamentally complementary perspective for ICTD research.

[1] Information Technology for Development, Electronic Journal of Information Systems in Developing Countries, Information Technology and International Development

As one of the major social theories, structuration theory (Giddens, 1984) has been employed in ICTD research (De & Ratan, 2009). A difference between structuration theory and activity theory is the focus on activity as opposed to a broader social phenomena and the incorporation of cultural-historical tools within the analytical framework. This is particularly useful in this study, where the focus was on a specified activity and tools. Nonetheless, there are several complimentary aspects between the two theoretical approaches (cf. Canary, 2010 Structuration Activity Theory). A major similarity is that they both consider structure and agency inseparable. This is different from Archer's (1995) analytical dualism where analytical separation of structure and agency is necessary in order to study their interplay; a view that is discordant with activity theory where they form a single unit of analysis, the activity system (Allen, et al, 2012). The separation of structure and agency, seems to contribute to the problem of understanding the inter-relationship of ICT within the cognitive and socio-political context; a problem in ICTD research (Avgerou, 2010).

In recent years ANT (Latour, 1993), which focuses on human and non-human actors, has been gaining attention in ICTD research and offered significant insights (Heeks & Stanforth, 2011, Faik & Walsham, 2011), with authors arguing that its symmetrical ontology can offer significant insights (Faik & Walsham, 2011). There are several major differences between ANT and activity theory (cf. Spinuzzi (2008) for comprehensive comparison of ANT and activity theory). ANT, avoids using concepts such as subject, object and culture, whereas the activity theoretical perspective considers it necessary to use them in order "to analyze how they evolve, are determined by each other, and change into one another" (Miettinen, 1999 p.176). Further, a "flat" ontology underpins ANT (for instance, humans and non-humans are given equal emphasis), as opposed to dialectical ontology underpinning activity theory. The latter is useful in this study of an ICTD intervention where few relationships and concepts are symmetrical. ANT does acknowledge the general notion of activity and networks, however it does so in general way that ignores mediating cultural resources and "phenomena as learning, development of expertise, complimentarity of resources, and know-how" (Miettinen, 1999 p.182).

Institutional theory (DiMaggio & Powell, 1983), which provides a lens by which structures become established as norms and guidelines for social behaviour, also falls within the category of established theoretical lenses, and is congruent with some of the aspects of activity theory. While institutional theory does not focus on the concept of activity or mediating technology, its focus on the establishment of rules and norms for explaining behaviour (Noir & Walsham, 2007) is similar to the notion of cultural-historical rules and norms.

From this discussion it is clear that the notion of activity and the focus on the mediation of human behaviour through tools and technologies is a major contribution of activity theory to ICTD research. A further concept that is largely unavailable, deemphasized, or abstracted (from the concept of activity), in the above mentioned approaches is the notion of contradictions (Allen et al., 2012); meaning that they are less capable of understanding constantly evolving and transforming activities and the dynamics, inefficiencies, and importantly, opportunities for change (Helle, 2000).

In our study, activity theory is particularly appealing as it provides a holistic framework which can be employed as a mode of analysis and underlying conceptual framework. The use of activity theory allows us to understand how actors bring about change in the local community through ICT and how the ICT intervention may lead to new arrangements in the community, a re-conceptualisation of its potential uses and become interlinked with other activities.

## 3 STUDY METHODOLOGY

The case study that forms the empirical base of this paper was part of a project on wireless communications development. The selection of the case study was guided by the possibility to investigate wireless communications in a complex development setting. Our frame of reference for this paper is evaluation of the ICT intervention roughly six months after implementation. The project evaluation focused on providing information on the delivery of the technology and benefits and selected program targets. Due to the relatively short implementation time and the scope of the evaluation our referents are limited to the inputs, the outputs, where possible some preliminary outcomes, the process of the implementation and future development.

To frame our study we were guided by the underlying principles of an activity system perspective, namely (i) the object-oriented activity is taken as the prime unit of analysis, seen in relation to a network of other activity systems (ii) an activity has "multiple-voices", which appear through interactions between the community and subject (iii) activity systems are historical activities that form over periods of time (iv) the identification of contradictions as sources of change and development, and finally (v) the possibility of transformation and the re-conceptualisation of the object and motive (Engeström, 2001). In line with the foundations of activity theory our research approach follows a critical philosophical perspective.

Data collection took place across two phases.

### 3.1 Phase one: Familiarisation

The familiarisation process involved developing an understanding of the study context, the technology employed and the people involved. To mitigate the absence of literature on Slavutych, the Ukrainian ICT context and the intervention, exploratory unstructured interviews were conducted with project management and project management documentation was reviewed (reports, funding, initial evaluations, planning documentation etc.) to augment understanding on the project and context. Interviews were not recorded, however detailed notes were taken and where necessary clarification was sought via email or telephone. Through this early analysis we formulated questions for the next phase of data collection and collaboratively identified key subjects and observation sites.

### 3.2 Phase two: Data collection

The primary data collection phase involved fieldwork, semi-structured interviews and observations. An initial schedule of interview subjects was outlined based on the first phase and complemented by the "snowball technique" once in the field. Interviews centred on key actors in the implementation of the project, the social enterprise (named Infoklass) managing the infrastructure, technical staff, technology suppliers, users and a community organisation involved in the initial needs assessment. Users included citizens, businesses, educational institutions, social agencies, emergency services, local government, a radio-ecology centre, an industry zone and a public internet access centre.

To achieve a critical perspective during the fieldwork the multiple perspectives and statements of the participants were verified using project documentation (meeting minutes, planning and reporting documentation), supporting statements by project personnel, technical checks and observations. Following the mandate of the evaluation, the fieldwork also involved site visits to observe implemented equipment to ensure all aspects of the infrastructure were "live". Given that the fieldwork was predominately a monitoring and evaluation exercise the line of questioning focused on the implementation process, the required resources, management of the infrastructure, the users and their use and challenges. An interview schedule scaffolded by activity theory was followed. Interviews were conducted in Ukrainian or Russian with the assistance of an interpreter (a small number of interviews were carried out in English) and digitally recorded where possible (comprehensive notes were taken where the interview was not recorded). Where necessary in order to clarify the data gathered and verify findings, subjects were contacted via email. As data was collected it was transcribed and coded in Nvivo software collectively by the research team.

## 4 THE CULTURAL-HISTORICAL CONTEXT: SLAVUTYCH & CHNPP

After the 1986 disaster and following international agreements the final ChNPP units were closed in the year 2000. At the time of closure 9,051 people were working at ChNPP, roughly half the adult population of Slavutych (population 25,000). Since the shutdown, the number dropped to about 3,000, mostly working on monitoring and maintenance tasks (dti & HTSPE Ltd., 2007), therefore, the socio-economic fabric of the town remained interwoven with ChNPP.

Despite the health, psychological and environmental impacts of the 1986 disaster, Slavutych is considered to have a higher standard of living than many Ukrainian cities and the local population maintains a positive outlook (Keen & O'Reilly, 2010). However, following the shutdown of ChNPP, which contributed up to 85 percent of the town budget, Slavutych faced a significant investment void, social problems and uncertain future. To mitigate these issues, in 2000, the Ukrainian president adopted a decree on activities aimed at the social protection of residents and declared Slavutych a Special Economic Zone. Strategies were created that focused on industry restructuring and job creation such as development of a credit union, SME support and the provision of telecentre facilities, amongst others. Alongside, several local and international collaborative efforts continued focusing on treating radioactive waste and environmental and health legacies.

It merits referencing these activities as it shows a concentrated effort by the national and local government and the international community to raise the physical and socio-economic conditions in an area where there remains international interest. A review of these activities have been described as "As a result, Slavutych is no longer a single industry town and its economy is undergoing a process of constant development and diversification" (dti & HTSPE Ltd., 2007 p. 81). Nonetheless, despite these efforts, since 2005 about 1,500 people had left the town, a trend which was predicted to continue.

Concerning telecommunications, despite Slavutych's relatively high economic indicators compared to other towns in Ukraine, like other towns it suffered from poor telecommunications infrastructure (EIU., 2009). Prior to the TIN, internet connectivity was limited, businesses often had to resort to posting or hand delivering documents, rather than rely on email,

and even international calls were problematic. Based on this in 2002, the Department for Business, Enterprise and Regulatory Reform (BERR)[2] and the Mayor of Slavutych agreed to fund the project titled Slavutych Town Information Network - modern, efficient and cost effective Telecommunications Network *utilising proven cutting edge "*Wi-Fi Technologies*"* (GTRP, 2007) and made available £750,000 in project funding. The funding body interest formed part of the broader UK Government Programme to address the threats of NPP closure (GTRP, 2008).

## 5 THE IMPLEMENTATION ACTIVITY

### 5.1 The activity and its motivation

The discussion above reveals the cultural-historical context and also a range of motivations for the TIN, which include high-level political agendas from the perspective of the funding body such as *"*mitigating threats of nuclear, chemical and biological legacies*"* as well as more town centric agendas such as improving communications, attracting inward investment and providing alternative employment opportunities, thereby addressing the problems caused by the closure of ChNPP (GTRP, 2008). Project documentation from the TIN operator (Infoklass) stating its motivations shows some congruency with the overarching town improvement vision from the funding body:

> *"Creation of the modern infrastructure of the town which will provide new opportunities for* development of information technologies…facilitate development of the social entrepreneurship on the sphere of telecommunication, expand the list of information services for the residents, enterprises and organizations of the town, improve the quality of services, create new jobs in the sphere of information technologies and increase the investment *attractiveness of the town".*

Figure 2 shows the "poly-motivational" nature of the activity. It also shows the subject as a collective of entities that converged to act upon the shared problem and realise the object. This perspective captures the implementation activity and the multiple-voices of the activity. While each individual entity that formed the subject could also have its own activity system the choice of abstraction should be manageable (Engeström, 1999, Allen et al., 2011). The selection and use of tools, the composition of the community, realisation of the object and the contradictions and tensions that existed within and between activity systems are discussed.

[2] Now the Department for Business, Innovation and Skills (BIS)

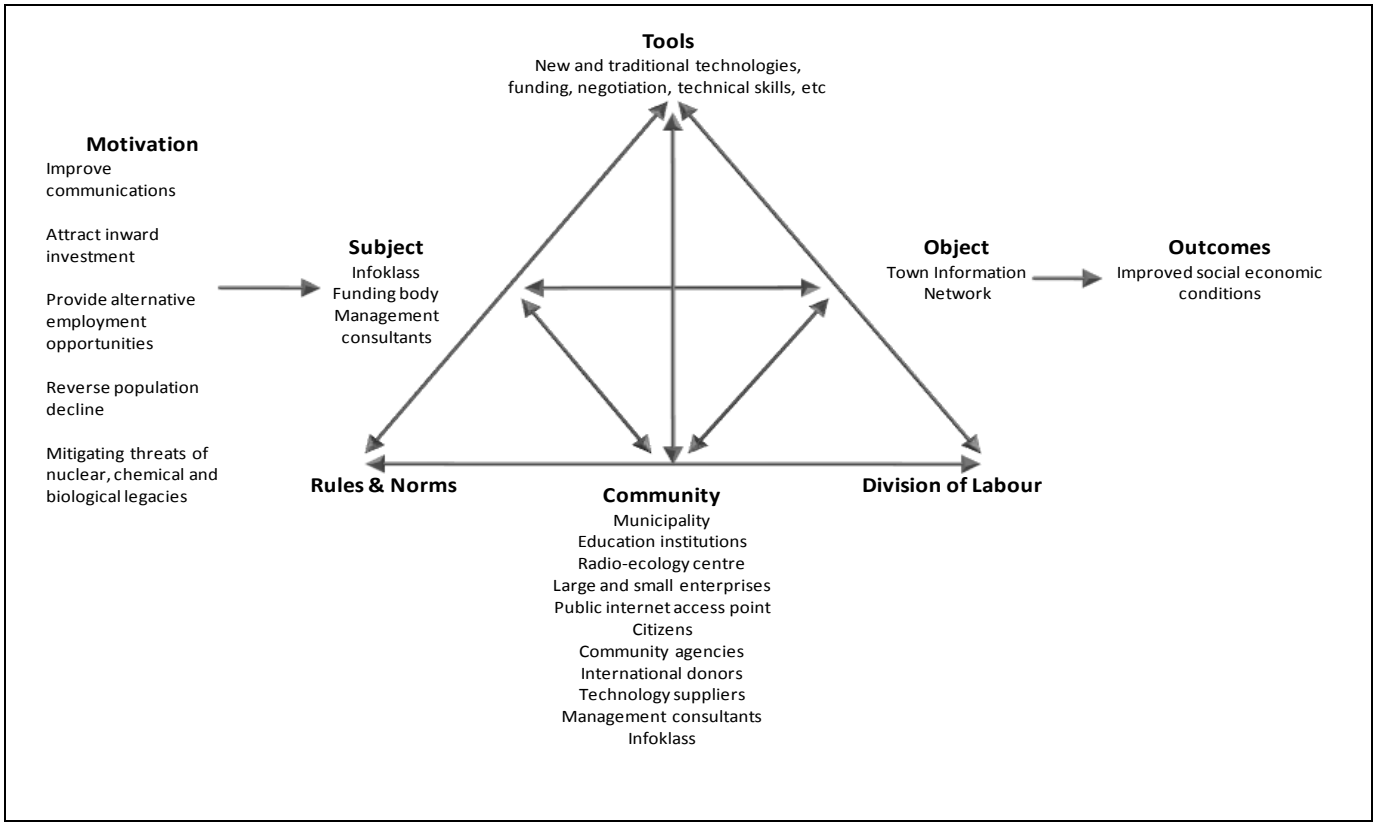


**Figure 2: Implementation activity**

### 5.2 The implementation community

Beyond the subject, the implementation activity encapsulated multiple stakeholders playing various roles in the realisation of the TIN, influencing the direction of the activity. For instance, an examination of the cultural-historical environment revealed a strong cultural characteristic amongst the local population of being viewed as a proud and resilient town, striving for departing from the perception of being a "nuclear disaster zone". This manifested in several ways that revealed a desire to improve local socio-economic conditions. Notably, citizens and business indicated high-levels of interest in the success of the project before and after its implementation. One community centre manager explained his underlying motivation for the TIN "before I needed to hand deliver documents in Kiev (400km return trip) because it was impossible to attach files to an email". In the project scoping phase a needs assessment survey commissioned by Infoklass in order to evaluate the level of necessity for the TIN revealed a high proportion of residents (76%) wanted access to Wi-Fi and quality telecommunications infrastructure. The primary reasons were summarised as better price (74%), improved connection quality (64%) and data speed (62%). The local government also strongly advocated the TIN deployment and provided support and linked its own projects to the TIN, thereby inter-weaving the success of local government projects with the TIN. One interviewee from a senior position in local government described the TIN as "the most important project taking place" in the town. The educational institution also expressed excitement at being connected to the TIN and had plans to integrate internet connectivity into many aspects of work and teaching and learning. A multi-national organisation working on the new ChNPP shelter provided a large stable source of income and legitimised the initiative and the selection of a social enterprise as opposed to a telecommunications operator as the TIN operator. ICT suppliers were also a significant member of the community providing provision of resources, training and support. The nature of such a high-profile project linked the success of the project to their involvement and was suggested to be a motivating factor.

The analysis of the community revealed that even though the initiative was supply-driven it clearly met the needs of local stakeholders and beneficiaries and fit within the socio-cultural realities. Further, it showed that by taking a whole town approach to providing connectivity (rather than focus on individual groups or site) the project was able to encapsulate the largest number of stakeholders in order to realise the project and obtain critical mass necessary for success.

### 5.3 Instruments for mediating the activity and transfer of knowledge

The activity analysis highlighted several key tools used to mediate the activity. An obvious instrument was the availability of project funding to enable the project (which from an activity perspective is the result of previous activities) and the management support that followed it. Less obvious intangible tools were also used such as language, knowledge and negotiation, through which power relations and legitimisation for the project were continually established. One of the major focuses of our enquiry was the range of technological artifacts used to mediate the activity, which were contributed by IT suppliers and created by a broader culture of technology developers.

In order to develop the broadband infrastructure a mixture of established and innovative technologies were employed. A Radio Relay link was created between Slavutych and Chernihiv (40km away). WiMAX supported with fiber-optic links to the base stations was used to create the backbone for the network, which enabled high-quality coverage for the town. Eight kilometers of fiber-optic cable was also utilised to provide reliable, high-speed connections between the Network Management Resource Centre, where monitoring of the network took place, and the base stations. Wi-Fi technology was used to provide organisations, business and some residents with access to the network and the Web. It was explained that WiMAX and Wi-Fi was selected because it overcame the issues of needing to lay down physical infrastructure and significantly reduced cost compared to previous choices. The technology selected were not only physical tools for enabling the project but also embodied an accumulation and transfer of knowledge into the community and in particular the operational and technical staff of the social enterprise. This was evident in statements by the technical staff concerning how their knowledge in network management and dealing with novel technology had surpassed that of persons that were responsible for training them (*"now we train them"*), and was supported by other project stakeholders and a review of maintenance of the network resources.

### 5.4 Realisation of the TIN

The TIN was launched live in March 2009. At the time of the study 55 buildings were connected, including community agencies, small and large business, government buildings, a public internet access centre, all schools, three libraries, five "cottages" (typically inhabited foreign consultants), a public space Wi-Fi and an industry-zone (which was brought online for this first time). It was planned that the remainder of the buildings would be connected within the year. While the TIN is considered a telecommunication architecture, its properties as an information and communication network connecting the town and its transformational opportunities reveal the "true-motive" (Leont'ev, 1978) for the implementation activity.

The implementation activity led to a number of embryonic outcomes and a horizon of possibilities, including training of local staff and connecting a range of information services including a local government Geographical Information System (GIS) project, which was described and presented by senior representative of government as an electronic platform that contained details of the local utilities, housing and infrastructure services for public use (an output of another project in Slavutych). This was a step towards developing TIN enabled e-government, technology enhanced learning, remote surveillance and hosting/ servicing of local government databases and websites.

### 5.5 The role of contradictions

Three major contradictions existed in the pre-TIN environment that acted as a catalyst for the project. The first was the inadequate telecommunications infrastructure that hindered local business, government and social activity. The second was the high capital and operating expenditure and low returns for commercial operators in providing the infrastructure in a remote and low populated area, partly due to the reliance on fixed-wire technology. The third was the repercussions of the closure of ChNPP. These contradictions aggravated tension within the cultural-historical context of becoming a modern town and mitigating cultural-historical problems and led to a transformation process which was enabled by a large amount of funding, a high-profile project and advances in wireless communications.

Several contradictions that emerged during and after implementation are described here as relevant to ICTD. The first concerns a primary contradiction and how it shaped the emergence of a social enterprise as the infrastructure operator. The second contradiction is between the subject and community in making sense of the TIN (secondary contradictions). We then turn to the notion of interlinked activities and the contradictions that exist between activities and how the relationship between activities can be used to conceptualise impact.

### *5.5.1 The cultural-historical context and primary contradictions leading to new techno-organisational structures*

In the pre-TIN environment, the existence of poor telecommunications was partly due to the low monetary value that could be derived by providing quality telecommunications. This in part led to the project and announcement of a large amount of funding and subsequent interest by telecommunications operators in providing improved connectivity to Slavutych citizens. However, while telecommunications are almost exclusively implemented and managed by commercial telecommunications operators, the funding body selected a social enterprise (Infoklass) as the TIN operator. Infoklass effectively competed with commercial operators to provide telecommunications to citizens; however it differed from traditional network operators by considering affordable communications (for instance, monthly connections for small business were approximately US$15 a month and $7.5 for community agencies) as a primary objective and injected profits into the local community showing how this original contradiction led to new techno-organisational arrangements (Avgerou, 2010). Therefore, a combination of the pre-TIN environment and concern about the profit motive and commercial operation of the TIN led to the emergence of a social enterprise as its operator.

### *5.5.2 Contradictions for reconstructing the object meaning*

A contradiction existed between the subject and community concerning the perception of the achievement of the object. That is, while there was initial consensus on the major motivations and set objectives for the implementation activity, during and after the implementation contradictions emerged on how the object could be transformed into favourable outcomes. In particular, the extent to which the original motivations were met is equivocal. Infoklass set quantifiable targets in terms of the number of buildings it expected to connect, however others were sufficiently broad and ambiguous, which resulted in an outcome that was difficult to quantify. This is an inherent problem in ICTD interventions. That is, beyond technology implementation it is difficult to account for outcome. In this case, this contradiction led to a shift in the promise of the benefit and the recognition that ICT itself will not engender outcomes but will rather enable a range of opportunities for desirable outcomes. For instance, one key project stakeholder explained "it has not been the purpose of the project (the TIN) to stimulate employment, population growth etc, this is an overall strategy of the combined projects", referring to the range of projects connected to the TIN. This was supported by another interviewee that understood that each information service attached to the TIN would require technical support, resulting in job creation and revenue. Similarly, there were several contradictions that emerged between the community and the object, in particular concerning interpretation of how the TIN could be used. For instance, video surveillance was pushed by certain members of the community as one use, even though there was no clearly defined surveillance issue. One interviewee articulated the benefits of video surveillance as "one can watch the market place and decide whether to go or not", another claimed that foreign consultants desired video surveillance for security purposes (100-200 consultants live in Slavutych). Another source suggested there was only one notable crime the previous year, revealing no clear security motivation. The focus on video surveillance fits within the need to be viewed as a modern town rather than any real security imperative. Conversely, another interviewee explained that when he made the suggestion to mount transmitters on vehicles in the nuclear protection zone for tracking purposes (there was concern that some vehicles were deviating from set paths) resources were not made available, even though this is congruent with other activities in the region. Here we can see how the object was slowly being reconstructed by project stakeholders for different purposes and directions.

### *5.5.3 Neighbouring activities, conceptualising impact and contradictions*

An activity theory perspective follows that an activity is part of a wider network of activity systems, forming a shifting mosaic of activity systems (Engeström, 2001). Figure 3 illustrates the notion of connected activity systems, which are activities that in some way for a period of time are connected or related, potentially hybridising each other through their exchanges (Engeström, 1987). In this case it highlights an activity as a complex network of inter-connected activities. Certain selected neighbouring activities are illustrated in Figure 3, which include activities that produced the tools for the TIN implementation activity, activities that led to the emergence of the subject, activities that led to the creation of rules and norms that governed the activity and concurrent activities from the perspective of the supplier. We also include activities that were beginning to use the object (the TIN) of the central activity, and may in fact transform the TIN based contradictions that exist between the related activities. From a theoretical perspective this demonstrates how the object of an activity engenders other related activities that can be conceptualised as impact.

A benefit of this approach is that it provides a structure for tracing the object of an activity and how it is then absorbed by another activity. As illustrated in Figure 3, the TIN will become a tool in subsequent activities. As an example, the government GIS project, which formed part of an associated activity, was converging with the TIN to enhance e-government services. Further, in the education sphere, there were plans to use the TIN to launch a range of technology enhanced learning applications. Where such an analysis highlights no interlinked activities could signal emergent contradictions and

sustainability issues. We view this as a particularly powerful lens through which to conceptualise impact of ICTD activities, showing how one activity system is woven within a network of activities (Spinuzzi, 2008). In many ways, this approach can overcome the difficulty in following impacts in ICTD projects, where traditionally there is a danger that impact assessments lead to false conclusions concerning causality. Using this concept of activity systems, researchers can map other subsequent and associated activities and indicate how they are related to a particular initiative, demonstrating the highly complex path of any ICT intervention to impact.

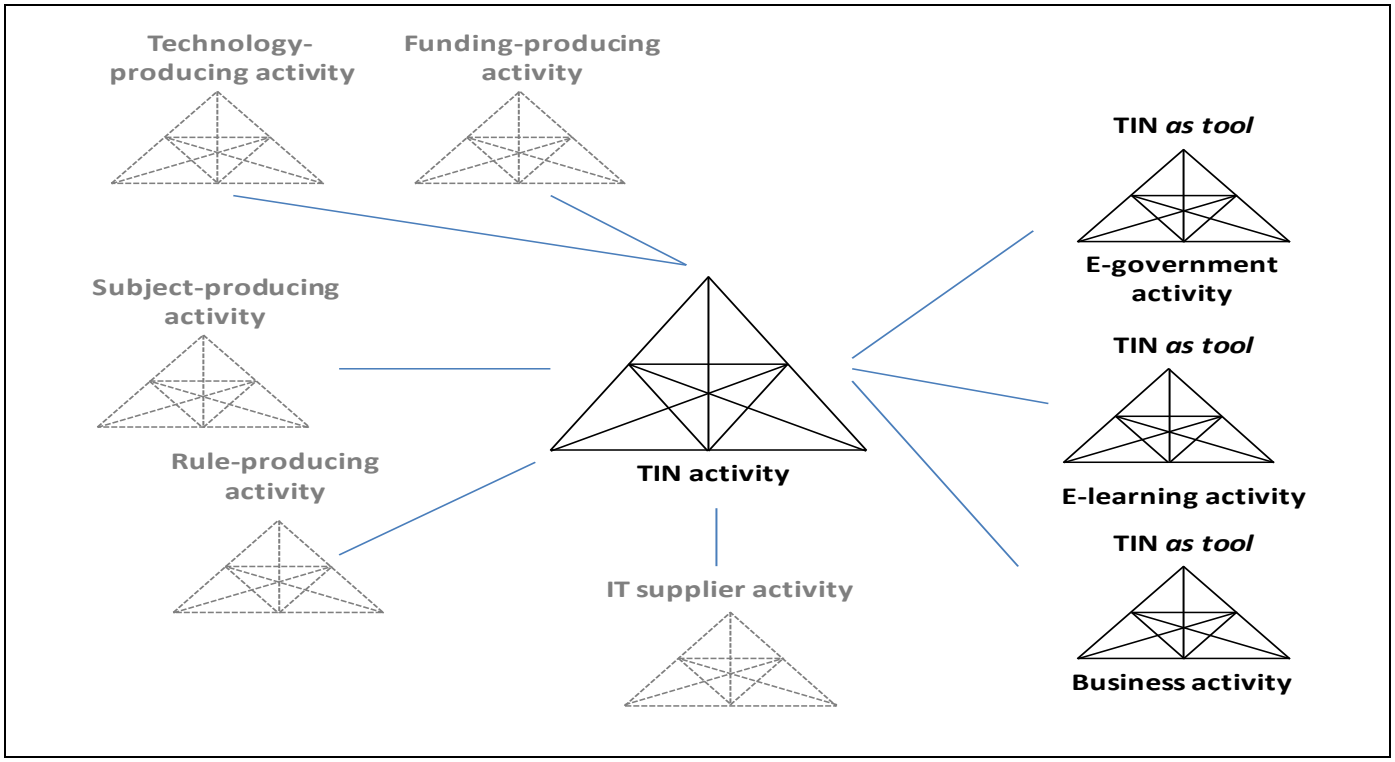


**Figure 3: Conceptualising impact**

## 6 DISCUSSION: AN ACTIVITY SYSTEM APPROACH TO ICTD RESEARCH

This paper embarked on an examination of an implementation of a broadband infrastructure. We used the concepts of activity theory and in particular activity systems to frame our investigation. The activity was described as poly-motivational, which although necessary when a group of entities converge to work on a complex activity can lead to difficulty in quantifying the outcome. The lack of quantifiable outcomes may also be a reason for how the purpose of the object was reconstructed and resulted in different meanings in the eyes of the community and subject. This may also be a process of negotiation and sense making by the subject and the community as the object is formed and realised.

As we have shown, a number of independent entities came together to work on the shared object of the TIN. The independent entities formed the collective subject of the activity system (see Figure 2) and included a range of organisations. The activity system also encapsulated a broader community of stakeholders that revealed a demand for the TIN. An important factor here was a cultural-historical characteristic amongst the population that desired to become a modern successful town. Similar observations of Slavutych have been noted (Keen & O'Reilly, 2010). A suggestion here is that an ICTD intervention should be viewed as collaborative process between the subject and community and ultimately demand driven by matching the cultural-historical context. This was evident by several community members (local government, education institutions, business etc.) embedding the TIN into their own activities. The project was designed according to local realities, involving multiple stakeholders and encompassing sustainability ideals by fitting in with the broader local development objectives, echoing the suggestions of other ICTD researchers (Heeks, 2010, Mallalieu & Rocke, 2007).

Given that ICTD involves significant focus on technology, an activity approach is particularly useful for highlighting the contextually relevant technology and its role in achieving the outcome. In this case, examination of the selection of tools

revealed that the hybrid infrastructure (fiber-optic/wireless) led to several technical and cost advantages. It is a critical point that without the selection of these tools the object could not be achieved; a contradiction that existed in the pre-TIN local context. Embedded in the use of this technology we also saw how the implementation resulted in a transfer of technical knowledge to the local operating staff.

The activity system perspective provides a lens for augmenting understanding of the complex relationships between activities. This follows that an activity takes place not from a clean slate, but rather as interconnected activities, and as such it is instructive lens to view an activity. In this case the needs for the new technology were first seen as unresolved problems in a pre-existing activity. We also expanded this to provide some theoretical basis for conceptualising the impact of the projects based on the notion that the TIN implementation has led to some embryonic outcomes and will become a tool in various subsequent activities.

Using the concepts of activity theory we explicated how an activity perspective may be applied to ICTD research. Its rich heuristic value and conceptual tools has been noted as particularly valuable in the IS, design and information management fields (Uden et al., 2008, Allen et al., 2011), however as we have argued its use in the fields of ICTD remains relatively unexplored. We identify three major contributions that an activity perspective offers ICTD research.

The first contribution is that activity theory brings together the actors (including a range of stakeholders), structure and the selection of tools and their development, within a single coherent framework, the activity system. By doing so it is able to capture the cultural-historical context (Allen et al., 2011) and the role of ICT in human activity and account for the criticism aimed at ICTD research for its the inability to account for the inter-relationship of ICT and socio-political context (Avgerou, 2010).

The second contribution is the notion of contradictions as an analytical lens to offer significant insights on change and development within an activity – a lens we argued is largely unavailable, underemphasized or separate from the notion of activity in other theoretical approaches. While ICTD studies often problematise ICT intervention the activity system lens coupled with an examination of contradictions provides a systematic method of highlighting change and development in context. We have only examined contradictions in this paper within the scope of our evaluation requirements. In doing so the focus on contradictions highlighted several sources of change and tension leading to the TIN, the subsequent new techno-organisational structures and importantly how certain contradictions led to a re-conceptulisation of the TIN. Greater examination of contradictions can provide insight into how ICTD activities could be improved and illuminate sustainability issues.

The third contribution is the notion of a network of activity systems, which follows that an activity is part of a wider network of activity systems (Engeström, 2001). The allows ICTD researchers to observe the connections and contradictions between activities and further conceptualise how tools developed in one activity are hybridised and/or transformed in other activities, providing a perspective that goes beyond the summation of ICTD project outputs. In this woven understanding, activities combine, merge, interpenetrate, divide and become more complex over time, creating increasingly wide networks (Spinuzzi, 2008).

While we have attempted to demonstrate the usefulness of activity theory to ICTD research in this paper, as with any approach it comes attached with several limitations. These have been noted as the nebulous nature of the concept of activity as encompassing broad and disparate concepts that cannot be tested (Josephs, 1996) and the possibility for varied interpretations of an activity (Livari & Lyytinen, 1998), amongst others (Bakhurst, 2009).

We note several limitations of the application of activity theory in our study, which also act as extensions for future research. The first is that we have not conquered its full frame of reference in this paper; in particular in our analysis we did not investigate in detail the rules and norms or the precise division of labour that framed the activity, or the actions and operations, in order to focus on our research objectives. These aspects provide fruitful areas of analysis for future ICTD research, as understanding of cultural-historical rules and norms, labour division and micro level analysis of actions and operations may provide significant insights in ICTD research. A further limitation is that the timeframe of the study following the implementation of the TIN was relatively short, allowing us only to theorise on the subsequent outcomes.

In this paper one of the main arguments has been that activity theory offers the distinct notion of contradictions which provides significant insights into change and development surrounding ICTD intervention. At the same time, we note several ways in which contradictions are problematised. For instance, contradictions may not be resolved, meaning that transformation may not take place or undesirable transformation may occur (Murphy & Rodriguez-Manzanares, 2008). Equally important is the interpretation of the contradiction amongst actors, the sense making that occurs and how the cultural-historical context influences the direction of action. A related theoretical problem is that contradictions are seldom

straightforward (Peim, 2009) and therefore may not be obvious or openly identified and discussed. The notion of contradictory or poly-motivational activity, which was evident in this study, may seem to problematise the notion of an activity system which is ultimately stimulated by a "motive". However, recognition of multiple motives reflects the complexity of the social, cultural, political and other factors concomitant with ICTD initiatives.

## 7 CONCLUSION

In this paper we expanded traditional understanding of ICTD interventions by drawing on activity theory and in particular an activity system perspective to frame ICTD intervention. We suggest a pragmatic approach which can be suited to a particular study objective and one which allows for the accommodation of other theoretical approaches. This paper contributes to recent scholarship in the field of ICTD using an empirical case of an ICT intervention in a complex setting and furthers theoretical development by advancing an activity system perspective for understanding and theorising ICTD interventions. We focused on several key aspects, highlighting the tools used to mediate the activity, the motivation for the activity and the relevant stakeholders and examined the role of contradictions. Using the notion of connected activities we also provided some theoretical basis for understanding the emergence of activities and conceptualising the impact of development projects, arguing that the outcome of an activity leads to/is consumed by other related activities.

There are several factors that separate this case from other ICT interventions that act as caveats for generalising the findings and provide lessons for other ICTD initiatives and direction for future research. First, ChNPP is an iconic site, where there is significant international attention and subsequent pressure for projects to succeed in Slavutych, influencing the dynamics of the intervention. Second, the scale and funding of the project sets it apart from many other ICTD interventions. Third, the blanket approach to connectivity, whereby the whole town is captured typically differs from ICTD intervention where specific groups or single sites are the focus. Fourth, the use of a social enterprise to manage and operate the TIN is a new paradigm for ICTD and one that needs further enquiry as it could provide a new sustainable model for rural and last-mile communities suffering from poor telecommunications access.

**Acknowledgement**

We thank the participants of Slavutych that assisted in the study and in particular the staff at Infoklass. We also thank Prof. Markarian of Rinicom Ltd and International Consultant Mr Hart for their support. The research received funding from the European FP7 ICT-Project 215167 WiMAGIC. The views and opinions expressed in this paper are those of the authors.

**References**

Allen, D.K., Brown, A., Karanasios. & Norman, A. (2013) How should technology-mediated organizational change be explained? A comparison of the contributions of critical realism and activity theory. MIS Quarterly. 37(3), 835-854.

Allen, D., Karanasios, S. & Slavova, M. (2011). Working with activity theory: Context, technology, and information behavior. Journal of the American Society for Information Science and Technology, **62,** 776-788.

Archer, M. (1995). Realist Social Theory: the morphogenetic approach, Cambridge, Cambridge University Press.

Avgerou, C. (2008). Information systems in developing countries: a critical research. Journal of Information Technology, **23,** 133-146.

Avgerou, C. (2010). Discourses on ICT and Development. Information Technologies & International Development, **6,** 1-18.

Bakhurst, D. (2009). Reflections on Activity Theory. Education Review, **61,** 197-210.

Best, M. L. (2010). Understanding Our Knowledge Gaps: Or, Do We Have an ICT4D Field? And Do We Want One? Information Technologies & International Development, **6,** 49-52.

Canary, H. E. (2010). Structurating Activity Theory: An Integrative Approach to Policy Knowledge. Communication Theory, **20,** 21-49.

Datta, P. (2011). A preliminary study of ecommerce adoption in developing countries. Information Systems Journal, **21,** 3-32.

De, R. & Ratan, A. L. (2009). Whose gain is it anyway? Structurational perspectives on deploying ICTs for development in India's microfinance sector. Information Technology for Development, **15,** 259-282.

DiMaggio, P. J. & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. American Sociological Review, **48,** 147-160.

dti & HTSPE Ltd. (2007) Building Blocks for Regeneration: Achievements and Lessons from the UK Programme Addressing the Social Consequences of Nuclear Power Plant Closures in Central and Eastern Europe, Department of

Trade and Industry, HTSPE Ltd.
EIU. (2009) E-readiness rankings 2009: The usage imperative, Economist Intelligence Unit, IBM.
Engeström, Y. (1987). Learning by Expanding: An Activity-Theoretical Approach to Developmental Research, Helsinki, Orienta-Konsultit.
Engeström, Y. (1999). Activity theory and transformation. In: Engeström, Y., Miettinen, R. & Punamäki-Gitai, R.-L. (eds.) Perspectives on activity theory. Learning in doing : social, cognitive and computational perspectives. Cambridge: Cambridge University Press.
Engeström, Y. (2001). Expansive Learning at Work: Toward an Activity Theoretical Reonceptualization. Journal of Education and Work, **14,** 133-156.
Engeström, Y. & Miettinen, R. (1999). Introduction. In: Engeström, Y., Miettinen, R. & Punamäki-Gitai, R.-L. (eds.) Perspectives on activity theory. Learning in doing : social, cognitive and computational perspectives. Cambridge: Cambridge University Press.
Faik, I. & Walsham, G. (2011). Flattening the Development Landscape. Understanding Development Through Actor-Network Theory, June 30 London.
Giddens, A. (1984). The constitution of society, Cambridge, Polity Press.
GTRP. (2007) Global Threat Reduction Programme, Foreign and Commonwealth Office, Department of Energy and Climate Change, Ministry of Defence, London.
GTRP. (2008) Global Threat Reduction Programme, Foreign and Commonwealth Office, Department of Energy and Climate Change, Ministry of Defence, London.
Heeks, R. (2010). Do information and communication technologies (ICTs) contribute to development? Journal of International Development, **22,** 625-640.
Heeks, R. & Stanforth, C. (2011). Understanding the Politics of Development Project Implementation: An Actor-Network Perspective on Local-Global Interactions. Understanding Development Through Actor-Network Theory, June 30 London.
Helle, M. (2000). Disturbances and contradictions as tools for understanding work in the newsroom. Scandinavian Journal of Information Systems, **12,** 81-113.
ITU. (2010) The World in 2010, International Telecommunications Union, Geneva.
Josephs, I. (1996). Does cultural psychology need the concept of activity? A Challenge to Ratner's Exposition (1996). Culture & Psychology, **2,** 435-456.
Kaptelinin, V. (2005). The Object of Activity: Making Sense of the Sense-Maker. Mind, Culture, and Activity, **12,** 4-18.
Karanasios, S. (2012). New & Emergent ICTs and Climate Change in Developing Countries. In: Heeks, R. & Ospina, A. V. (eds.) ICTs, Climate Change and Development: Themes and Strategic Actions. Manchester: Centre for Development Informatics Institute for Development Policy and Management, SED.
Karanasios, S. & Burgess, S. (2008). Tourism and Internet adoption: a developing world perspective. International Journal of Tourism Research, **10,** 169-182.
Keen, M. & O'Reilly, S. (2010) External Impact Evaluation of the UK Funded Programme to Ukraine, Lithuania, and Bulgaria to address the social and economic consequences of Nuclear Power Plant Closure Report, International Organisation Development (IOD) Ltd, Sheffield.
Kuutti, K. (1996). Activity Theory as a Potential Framework for Human-Computer Interaction Research. In: Nardi, B. A. (ed.) Context and Consciousness: Activity Theory and Human-Computer Interaction. Cambridge, Massachusetts: The MIT Press.
Latour, B. (1993). We Have Never Been Modern, New York, Harvester Wheatsheaf.
Leont'ev, A. N. (1978). Activity, Consciousness, and Personality, Prentice-Hall.
Livari, J. & Lyytinen, K. (1998). Research on information systems development in Scandinavia - unity in plurality. Scandinavian Journal of Information Systems, **10,** 135-186.
Mallalieu, K. I. & Rocke, S. (2007). Selecting Sustainable ICT Solutions for Pro-poor Intervention. In: Galperin, H. & Mariscal, J. (eds.) Digital Poverty: Latin American and Caribbean Perspectives. Practical Action Publishing/IDRC.
Miettinen, R. (1999). The riddle of things: Activity Theory and Actor-Network Theory as approaches to studying innovations. Mind, Culture & Activity, **6,** 170-195.
Miscione, G. (2007). Telemedicine in the Upper Amazon: Interplay with Local Health Care Practices. MIS Quarterly, **31,** 403-423.
Murphy, E. & Rodriguez-Manzanares, M. A. (2008). Using activity theory and its principle of contradictions to guide research in educational technology. Australasian Journal of Educational Technology, **24,** 442-457.
Nardi, B. & O'Day, V. (1999). Information ecologies, using technology with heart, Cambridge Mass, MIT Press.
Noir, C. & Walsham, G. (2007). The great legitimizer: ICT as myth and ceremony in the Indian healthcare sector. Information Technology & People, **20,** 313-333.

Peim, N. (2009). Activity theory and ontology. Education Review, **61,** 167-180.
Qiang, C. Z.-W., Rossotto, C. M. & Kimura, K. (2009). Economic Impacts of Broadband. Information and Communications for Development 2009 Washington, DC: The World Bank.
Rajão, R. & Hayes, N. (2009). Conceptions of control and IT artefacts: an institutional account of the Amazon rainforest monitoring system. Journal of Information Technology, **24,** 320–331.
Sayed, H. E. & Westrup, C. (2003). Egypt and ICTs: How ICTs bring national initiatives, global organisations and local companies together. Information Technology & People, **16,** 76-92.
Spinuzzi, C. (2008). Network: Theorizing Knowledge Work in Telecommunications, Cambridge, Cambridge University Press.
Uden, L., Valderas, P. & Pastor, O. (2008). An activity-theory-based model to analyse Web application requirements. Information Research, **13**.
Walsham, G. & Sahay, S. (2006). Research on Information Systems in Developing Countries: Current Landscape and Future. Information Technology for Development, **12,** 7-24.