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Abstract

The role of ICT in rural and undeserved regions is receiving increasing attention. The disparity between information haves and have-nots (the "digital divide") in the urban versus rural areas is significant. This divide is even more pronounced in developing countries. While there appears to be a general agreement on ICT being a crucial component to reduce the digital divide, it is not yet clear how exactly ICT alone helps alleviate poverty. This field has been driven by activism and action-orientation. Hence, the theoretical basis for ICT's role in development has not yet received much attention. This paper addresses the complementary role of ICT as an input for developmental initiatives. Given the absence of theories, we employ an empirically grounded approach to develop a preliminary theoretical understanding. By adopting a case study approach we list out issues that are cognate to the developmental process in rural India. By employing Kelley's theory of personal constructs, we subject those issues to interpretive structural modelling. By employing this research process, we are able to synthesize the knowledge of experts and practitioners. Doing so reveals many of the contradictions and opportunities that are present in ICT interventions in developmental contexts. We highlight two aspects of ICT intervention i.e complementarity and direct and indirect benefits. Our findings assume increased importance because the role of context is shown to be crucial. As a result, the methodology adopted by us can be used by practitioner's to seek clarification across multiple stakeholders, build consensus models, negotiate tradeoffs, allocate budgets and, most importantly, develop an appropriate and meaningful evaluation framework. The main contribution of this work lies in providing a theoretical framework that can be refined in future studies. We expect other researchers to join us in our future efforts to subject these models to rigorous variance-theory based scrutiny.

Keywords: information and communication technology, ICT, digital divide, structural model

1. Introduction

This paper examines the role of information and communication technology (ICT) as a developmental input. While there appears to be a general consensus on the potential of ICTs, the efficacy of ICT as a developmental input is still under scrutiny. While there is a minority opinion that believes ICT to be a luxury for underserved regions, the understanding of how ICT enables development, alleviates poverty, empowers underprivileged groups or improves governance is not yet well understood by those who believe that ICT has a definite role to play in rural development. It is reasonable to expect that there will exist multiple levels of understanding and varied standpoints because of the multiplicity of actors involved. For instance, governments, which are a major source of funding as also initiators of rural ICT interventions will naturally tend to weigh the role of governance more heavily. Donor agencies will most likely focus on the outcome of ICT initiatives and non-governmental organizations (NGOs) would most probably relate to the ground-level realities. It is perhaps for this reason that the Government's top-down approach is less effective and villagers are

less trusting compared to NGOs bottom-up approach and are more trusting because the NGOs tend to have a positive presence in the lives of the rural poor. The notion of the digital divide is also exacerbated by the lack of access to information as well as technology exclusion in rural areas. This then becomes an infrastructure issue for national governments. There are also other complementary factors (like education, women's empowerment and social change) that help in leverage the effects of role of ICT in a developmental context.

Given this background and a mosaic of issues that confront policymakers and field personnel when understanding the role of ICT in development, we use interpretive structural modelling, ISM (a qualitative methodology explained briefly in Appendix A) to synthesize the relationships that exist in a rural ICT project and apply those findings with simple prioritisation schemes that are often used to assess the importance of factors in any developmental setting.

2. Literature Review and research gaps

The role of ICT in primary education has received a lot of attention and funding (UNESCO 2003) and there is evidence that ICT and education are related when it comes to poverty reduction (Sharma 2001). ICT also has much to offer in the delivery of health care to rural areas, both generally and in the context of initiatives such as village websites. Given the extent and likely longevity of the digital divide, however, it must be regarded as an enhancement of conventional delivery, or a way of focussing them on specific, 'offline' sectors of the community, rather than a wholesale substitution (Warren 2003; Annam 2002). Other issues that have received importance, or have been the focus of ICT in rural and underserved regions, include economic opportunities (UNDP 2001), gender emancipation (Dumas 2002; Patel 2002), agriculture (Janakiram 2002), local governance (UNDP India 2003), social change (Gilhooly 2002), food security (FAO 1998) and power and infrastructure (NIC 2003).

It is becoming clear, as a result of anecdotal evidence and vignettes, that some commonly known and broad issues have been recognized. They include the challenge of infrastructure, policy considerations, lack of local content and language barrier, high rate of illiteracy in rural areas, inadequate human resources, gender insensitivity, adequate training for staff managing ICT, and sustainability of projects (Crede 1998). Many of the failures seen in case studies of the African telecenters arose because factors in this list were not properly addressed (Odedra et al. 1997). Quibria and Tschang (2000) report that in the MSSRF project, appropriate design took into account the users' information needs; volunteers and paid NGO staff were required to maintain information systems and databases; and external financial resources were necessary to maintain the staff centers and supporting infrastructure. Many knowledge centers (KCs) have not been able to experience the level of success experienced by those supported by the MSSRF. Therefore I seek to address the gaps associated with knowledge that have to do with the questions like those that Quibria and Tschang have left open for researchers: How do we resolve the issues associated with scalability? Who is controlling and facilitating the information flow? What content do they make available? And how does that information help improve people's livelihoods and quality of life.

Given this flux in the state of knowledge regarding ICT and development, there is no integrative framework. While there are integrated frameworks available for organizations (Marchand et al., 2000), we do not have any such integrative framework in the development literature.

Since there is no integrated framework available in the development literature, we formulate the challenge before us as a problematique. All these elements identified in the literature review constitute the problematique (Meadows et al. 1972). From an IS standpoint, the problematique is captured by an ensemble view of IT (Orlikowski and Iacono 2000) where IS use is one of the many variables in a problem that has social, economic, and technical dimensions. "Problematique" refers to the concept used to describe the set of the crucial problems – political, social, economic, technological, environmental, psychological and cultural - facing a group. The complexity of the problematique lies in the high level of mutual interdependence of all these problems on the one hand, and in the long time it often takes until the impact of action and reaction in this complex system becomes visible. We have adapted this definition from Meadows et al. (1972).

Over and above this problem of complexity, we have the situation of one size can not fit all when it comes to problem resolution approaches in rural development and more so when it comes to the role of ICT in development. This is because even in a small region like Pondicherry in Southern India, four different information kiosk projects have been implemented using six distinct implementation models and frameworks. (Kanungo 2002a, 2003).

As a result, given the theoretical challenges and the practical requirements, there is a need for a framework based on an approach that is inclusive and sense-making. Inclusivity is important because insights should come from and be accepted by villagers. The sense-making (Weick and Roberts 1993) dimension is important because it highlights and recognizes the socialization dimension of the process of introducing and sustaining ICT initiatives in rural contexts.

Lastly, an implication of the gap we have identified in the understanding of the state of knowledge about ICT and development requires a framework that can take normative factors and generate locale-specific insights. Our methodological response is based on this academic and practical knowledge gap.

3. METHODOLOGY

Following Weick's (1995) sense-making strategy, we have used interpretive structural modelling as our methodological tool to make sense out of the many insights and elements that have been accrued as a result of field-based studies and theoretical developments. Our theoretical justification for adopting this approach lies in the personal construct theory. Kelly's (1955) theory of personal constructs allows us the basis to use individuals' viewpoints (individually or collectively) to ascribe meanings to complex relationships. This theory stipulates that individuals construe their experiences to produce a system of constructs that are subsequently used to anticipate action in the world. When individuals experience changed situations, they reconfigure their system of constructs as sense-making response. In the context of information systems, such emergent behavior also involves interplay between both technological and business artifacts and individual assumptions. Support for such a linkage comes from Hebel (2000) who formalizes the relationship between human value systems and technological change and in doing so shows behavior as emergence.

In order to preserve the richness of this conceptual framework and to be true to the metaphor of a "person as scientist", a participatory research design methodology was called for. Furthermore, it was required that participants in the research move beyond the independent consideration of key issues to evaluating how issues at hand interact (Morgando et al. 1995).

4. Data and Analysis

Based on the review of the literature, ten issues were identified as being cognate to the role of ICT in developmental settings. These issues, discussed in Section 2, and shown in Table 1, were broad enough to subsume some of the elements that participants in this study brought up. The participants for this study included field researchers (who had experience with ICT implementation in India) and research staff in the area of development and gender research at a leading development bank. We adopted a consensus approach whereby the group concensus on each pairwise input was recorded. This process is described below.

In order to develop a complete picture of the elements identified in the literature review, we employed ISM to combine the qualitative inputs from the respondents. In order to do that we listed the 10 issues that had been identified as impacting ICT implementations in our interviews (see column 1 in Table 1). We then requested the respondents to relate each pair of these issues using "leads to" as the contextual relationship. The letters V, A, X and O were used to elicit users inputs. V meant that the row impacted the column, A meant that the column impacted the row, X meant that the row and column elements impacted each other and O meant that the two elements in question had nothing to do with each other. The results of that exercise appear in Table 1. For instance, we read the "V" associated with row 1 and column 4 reads as follows: "*primary education* leads to *economic opportunities*." These are qualitative inputs and are based on the experience of the experts who have field experience in implementing or assessing rural ICT projects.Note that the directionality of the relationship is not involved. In other words, we cannot impute whether the impact is positive or negative. This set of user inputs resulted in the structural model shown in Figure 1.

	Elements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	Primary education		O	O	V	V	O	O	V	O	O
2	Rural ICT			V	V	V	O	O	V	O	O
3	Health care				O	A	O	O	O	O	O
4	Economic opportunities					V	V	V	V	V	A
5	Gender emancipation						O	V	V	O	O
6	Agriculture							O	O	V	O
7	Local governance								V	O	O
8	Social change									A	A
9	Food security										O
10	Power and infrastructure										

Table 1. Collated respondents' inputs from experts

It is clear from the interpretive structural model that the drivers for rural development appear to be primary education, rural ICT and power and infrastructure while the outcome or impact variables are health care and social change. Figure 1 also communicates to us that the variables that are most likely to be managed effectively are the ones at the middle. They include gender emancipation, agriculture, local governance and food security. Two things stand out. The role of ICT is closely intertwined with many other elements. So it is extremely difficult to delineate and separate out the role of ICT when it comes to rural development. Secondly, and in a related vein, the impact of ICT on rural development is not so much on economic opportunity (although it appears so) as on many other intermediate variables. In other words, we should not expect any direct effects from the introduction of ICT into rural development programmes. ICT has a definite role. That role appears to that of being a necessary but not sufficient ingredient for development. Equally important is the notion of what the outcome variables are. Development is not understood as economic development

alone. On the other hand, the quality of life issues (health care and social change) are the outcome variables.

While this was how a group of development professionals viewed generic concepts to be related in the context of rural development, we also studied how issues that emerged from a specific field study could be related to help understand the role of ICT in underserved regions. For that we analysed the information village program carried out by the M. S. Swaminathan Foundation (where one of the authors has direct field experience). The inputs for this component of the research were provided by one of the researchers based on empirical data (Kanungo, 2001, 2002a and 2002b, 2003).

This program consists of a group of villages that have chosen to support information kiosks[1] or knowledge centres (KCs) as part of the Information Village Project (IVP) carried out by the M.S. Swaminathan Research Foundation (MSSRF) in India. These KCs enable villagers to access diverse information and communication services.

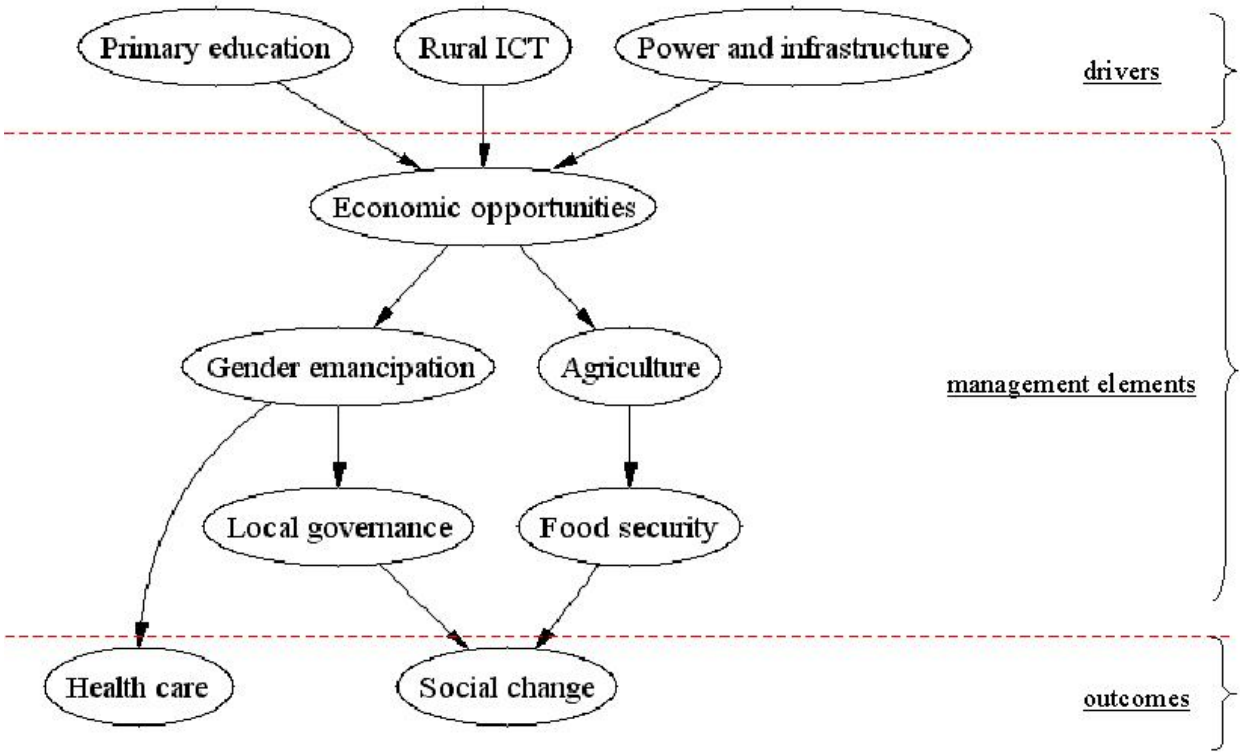

Figure 1. The interpretive structural model for understanding the role of ICT in rural development at a generic level

The KCs are kept running by trained volunteers who operate and maintain the KCs and processing generic information into something that is locally relevant. The underlying premise is that knowledge and information are vital to the process of empowering the poor instead of just providing them "chemical and capital.[2]" While this project has shown positive

[1] In generic terms, information kiosks have emerged as the archetypal framework for electronic information access and delivery. In remote rural areas, where population density is sparse and connectivity is poor, a single-room booth typically staffed by a single individual with a PC, printer, and some form of Internet connection and a phone line (wired or wireless) can be considered an information kiosk.

[2] www.mssrf.org/information%20village/pobj.html

results, subsequent focus has shifted to seeking resolutions to ensure how information technology (IT), as one of the developmental inputs, can be made independently viable. This is an important concern because, while the villagers are willing and able to pay for the upkeep and maintenance of the KC, there are areas where deficiencies remain. For instance, social network functions (developing linkages with government agencies, markets and other villages) are extremely challenging for a single village or a group of villagers. This concern assumes importance given the finite tenure that developmental "projects" tend to have. While pulling the plug from a clearly beneficial intervention is inappropriate, indefinitely extending project support for such interventions is not possible either. This is a generic problem that is faced globally by other rural information kiosks.

The initial setting for the IVP was four villages in the Union Territory of Pondicherry in South India. Subsequently, the number of villages with KCs increased to 10. The level of poverty is high in these rural areas. Total population of the information villages is 13,097 of which 6,353 are women and 777 are dalits[3]. The number of those who qualify as literates is 4,700. Life in these villages is dominated by agriculture while a few are dominated by fishing. Only 12 public and 27 private telephones exist in the project area, covering 19 villages with a population of 22000. Of the 1130 television sets in this area, a third of them have cable connection. The cable provides 3 channels, all in the Tamil language, produced from the city of Chennai.

A hub-and spoke model of data-cum-voice communication has been installed in these villages. The value addition centre was set up in Villianur village, located in the western part of the region, where the hub of the wireless system has been placed. The staff at the hub adds value by creating locally useful content in Tamil (the local language). The KCs receive queries from village residents and transmit information, collected from the hub, back to them so that information needs are realistically assessed. Quantitative data are collected on usage patterns, and stories of KC-enabled benefits have been chronicled. The hub functions as the project office, as well as an interface for public and the government offices in the locality. The hub has access to the Internet through two dial-up accounts, and it functions as the hub of a local area network for data and voice transmission covering the KCs in project villages. This arrangement allows the KCs to communicate with each other as well as connecting to the Internet. A hybrid of technologies has been used for communication (wired and wireless) and for power supply (solar with mains). The Internet was initially based on hybrid of 2-way VHF radio and the wired public telephone network. Data transmission was restricted to a maximum speed of 14.4 KBPS on the wireless, where email or fax protocols were used. A private branch exchange (PBX) connects every KC to this hybrid network. Every location on the network functions with VHF radio (full duplex) (rather than copper wires) as the medium of signal transmission. To overcome power outages, a hybrid system of solar photovoltaic panels and grid power, has been used as source of power.

Volunteers who are educated unemployed/school teachers/students/women of the village manage these KCs. These managers of KCs act as information seekers for the village and help to meet the information demands of the end users. In the KCs, both traditional (like folk media, demonstrations) and information technologies are blended to preserve traditional and contemporary knowledge. Information seekers obtain what they need from among a set of

[3] Dalit usually refers to that portion of the population falling outside the pale of Indian caste society; those who are traditionally known as the "outcastes," or, "untouchables."

information resources centres using an appropriate communication medium. In order to meet the various information needs of the villagers, the concept of resource centre was used. The resource centre essentially acts as a single-point source for all types of information products. The information resource centre is fed by a set of information producers. The specific content of the information package is determined by the needs and requirements of the villagers. The information needs of the villages were identified using the participatory rural appraisal (PRA) methodology[4]. The nature of the information package as well as mode of communication varies from village to village. Major information producers or stakeholders in the information system include farm men and women, remote sensing and meteorological centres, national information centres, research laboratories and universities, industries, government departments and institutions, non-governmental organizations (NGOs), and financial institutions and markets.

Table 2 shows how the data from the case study was synthesized using ISM. The results are shown as the model in Figure 2. This diagram is far more enlightening because it clearly shows the factors that can be used to leverage ICT effectiveness in villages. The contextual relationship for this ISM is "depends on." That means arrows are read as "depends on." For instane, in Figure 2 the arrow from "quality of KC volunteers" to "information use" needs to be read as follows: Information use depends on quality of KC volunteers. This makes the village governance structure a critical variable in determining the efficacy of not only the ICT initiative but also all other rural development initiatives. In other words, what appears to make a difference is whether the village governance structure is elected or nominated and what their perceptions of the role of ICT are.

Elements	1	2	3	4	5	6	7	8
1 Information use		V	A	O	A	A	A	O
2 ICT-based economic opportunities			O	O	O	O	O	A
3 Quality of KC volunteers				A	O	A	A	O
4 Village governance structure					V	V	V	O
5 Role of women in KC						A	A	O
6 Role of project staff							O	O
7 Quality of primary education								V
8 Other income generation opportunities								

Table 2. Collated respondents' inputs from participants' views from the project as derived from the case study

It is also interesting to note that ICT-based economic opportunities are a function of information use and other income generation opportunities. The logic of this codetermining relationship is premised on the fact that ICT is useful in providing information access. If there are opportunities in neighbouring towns and villages, the information network can provide access to information (even faster and more timely access). However, it is important to note that ICT, per se, cannot, and does not create economic opportunities.

Another interesting insight is the role of women. Information use depends on the role of women as also the quality of the KC volunteers. Women can be important consumers of information and participants in decision-making that relates to themselves (health and

[4] PRA is a way of enabling local (rural and urban) people to analyse their living conditions, to share the outcomes and to plan the activities. It's a "handing over the stick to the insider" in methods and action. The outsider's role is that of a catalyser, a facilitator and a convener of processes within a community, which is prepared to alter their situation.

domestic issues primarily) and to their families. In addition, since the role of women was encouraged in the running of KCs, the faster the women got up to speed, the sooner did the KC start showing results and demonstrating maturity (in terms of viability and value addition). Emancipation of the role of women is important because it was identified as one of the objectives in the information village program. The idea is that unless such a goal is explicitly stated and built into developmental programs, it will not be addressed. We say this because, while the equality of opportunity for both men and women may be a theoretical possibility, ground realities work against the automatgic participation of women in such initiatives.

Equally important is the pivotal role of project staff (scientists from the MSSRF) who interact with the villagers on an almost daily basis to ensure that the technology works, the information that is provided is useful and the setting of the KC is accessible to everyone in the village (in that there is no discrimination). The reason that the role of the project staff depends on the village governance structure is because it is the village governance structure in the first place that provided project staff access to the villagers.

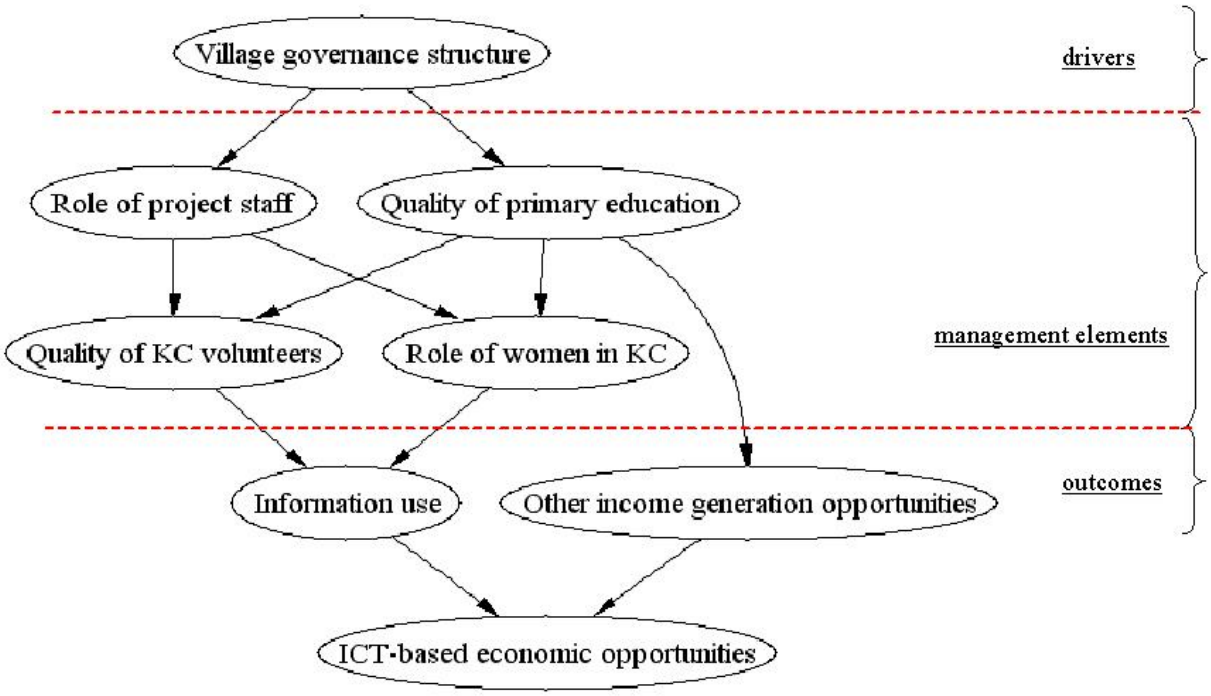

Figure 2. The interpretive structural model for understanding the role of ICT in rural development for a specific

Also pivotal is the role of primary education in the ability of individuals and groups in the village to use ICT effectively. The notion of complementarity is shown out clearly. ICT by itself is not enough. Nor is education. Nor is gender emancipation. What is important is the investment (both economic and social) in these elements so that opportunities that exist can be leveraged better.

5. Discussion

There are two issues that we wish to highlight. They are: first, importance of complementarity and second, the importance of adopting the process-view when viewing the

results of ICT in the realm of rural development. The methodological aspect that we want to highlight is the ability of our proposed method to synthesize the qualitative and quantitative aspects of the complicated terrain of ICT in development.

The notion of complementarity becomes central to analysing the effectiveness of the outcome as a result of investments made in rural ICT. As is clear from Figure 2, there are many intervening and intermediate variables that can moderate the effects of ICT investments on ICT outcomes. Some of the principal factors that were apparent in the our case study were primary education, role of project staff and the role of women. An important implication for field researchers is to ensure that enough has been invested in such co-determinants of ICT-enabled effectiveness in order to build up the capability of the individuals in the villages to leverage the ICT potential. Such a build-up and requisite preparation for the IT infusion, may, in large part be responsible for the relative success of the information village. Support for this comes from Dewan and Kramer (1998) when they conclude that, "the estimated returns from IT investment reflect other changes in the economies of developed countries that are complementary to IT investments such as infrastructure, human capital, and informatization of business processes (p. 62)." Additional support for such requisite build-up comes from Bresnehan and Brynjolfsson (2000) who use the phrase "complementary investment." Since Bresnehan and Brynjolfsson offer a theory of causation that "more firms with skilled workers find computers more productive and buy more of them," we have reason to believe that rural contexts that are better prepared to absorb information technology will be able to leverage the benefits of information technology. Brynjolfsson and Hitt (2000) provide an alternate explanation when they state "firms must occur substantial *adjustment costs* before IT is effective." We believe that these adjustment costs may tend to prohibitively high for rural contexts to absorb if they are note staggered in time.

Investments in rural ICT can be seen in the context of the process view. A process is a transformation of an input (or a set of inputs) in to an output (or a set of outputs). This systemic view of a process allows us to focus on the outcomes of processes (be they IT investment, IS management, IS use, decision support, IS enabled personal productivity, etc.). IS processes (and IS use processes in particular) fall under the category that Ackoff (1971) calls purposive systems[5]. Importantly, a process view allows us to frame our analysis in terms of *it does not matter what you have, what matters is what you do with what you have*. This view is brought out well by Marchand et al. (2000) who show how one of two banks (comparable in most respects), was able to leverage its IT investments significantly better than the other. The ISM approach does not depend on typical econometric methods to validate or prove that investments have been successful or not. These methods are called variance approaches. Variance theories comprise constructs or variables and propositions or hypotheses linking them (Crowston 2000). The notion of a process connotes recurrence and a non-stationary view of things. By assuming a process view of the world we can conceptualize events and outcomes in relation to each other. The primary attribute of this relationship happens to be time. The advantage of understanding the role of ICT in rural setups using ISM is that the insights are generated by the participants, using generic constructs (that have been configured to respond to locale-specific requirements). Using the ISM, the users and project personnel can activate different pressure points to ensure that the investment in ICT is paying

[5] A purposive system is a multi-goal seeking system – the goals of which have a common property. Production of that common property is the system's purpose. IS use is a purposive system because "deriving additional value" is the common property of the various information systems that are used by the user.

off. One can also realistically analyse whether the payoff in a certain rural setting will pay off or not, given the interactions that the ISM reveals.

We had justified this study based on Kelly's personal contructs and Weick's sense-making frameworks. The primary lesson that is actionable can be stated in terms of managing technology enabled change. From behavioral science we know that people support what they help create. Moreover, people are rarely afraid of change. If at all they are, they are afraid of the negative fantasies associated with change. In order to elicit desired changes stakeholders should strive to create the conditions that enable and facilitate the desirable outcomes. This can only be possible if all the stakeholders have a common understanding of the underlying assumptions and connections. Hence collective sense-making (which becomes practical with the use of ISM) can become the basis of both a personal and shared construct system. Therefore, we see ISM as an integrative tool that is inclusive and treats the participants (villagers for whom the ICT is being implemented) as equals in an emancipatory process that ought to be premised on participation.

6. Conclusion

Information and communication technology (ICTs) initiatives to reach the poorest of the poor are still limited in spite of tremendous interest of Governments and developmental organizations. While many such initiatives need to be operationalized within a larger explicated framework that is premised on empowerment, dignity and the preservation of traditional technologies and knowledge, a majority of ICT interventions in rural areas have had a technical focus. This technical focus often results from formal Governmental program thrusts such as infrastructure building, providing access, and of fulfilling connectivity targets. An increasing number of attempts at ICT interventions are been reported in less-developed regions of the world. However, most of them have reported results from the viewpoint of the donor agency that supports such efforts. Needless to say, it is understandable, that there would be a bias toward reporting measurable success and downplaying the inhibitors to such initiatives. Moreover, rigorous research that raises and responds to hard questions has been lacking in this area. Following this research and our preliminary results, we plan to extend this work across multiple stakeholders simultaneously. The main advantage of this approach lies in that it is economical (takes little time) and encapsulates local knowledge and insights and prevents the feeling of imposition from outside – without compromising academic rigor.

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Appendix A

ISM is a technique that attempts to analyze a system of elements and resolve these in a graphical representation of their directed relationships and hierarchical levels.

i) Identification of Elements: The elements in Tables 1 and 2

ii) Contextual relationship: The basis for pair-wise comparison of elements; in our case element x impacts element y. Hence the contextual relationship is “impacts.”

iii) Structural self-interaction matrix (SSIM): This matrix represents the respondents perception of element to element directed relationship. This is shown in Table 2.

iv) Reachability matrix (RM): A Reachability Matrix is then prepared that converts the symbolic SSIM Matrix into a binary matrix. The following conversion rules apply: If the relation E_i to E_j = V in SSIM, then element E_{ij} = 1 and E_{ji} = 0 in RM; If the relation E_i to E_j = A in SSIM, then element E_{ij} = 0 and E_{ji} = 1 in RM; If the relation E_i to E_j = X in SSIM, then element E_{ij} = 1 and E_{ji} = 1 in RM; If the relation E_i to E_j = O in SSIM, then element E_{ij} = 0 and E_{ji} = 0 in RM; The initial RM is then modified to show all direct and indirect reachabilities, that is if E_{ij} = 1 and E_{jk} = 1 then E_{ik} = 1.

v) Level partioning: Level partitioning is done in order to classify the elements into different levels of the ISM structure.

vi) Digraph: Digraph is a term derived from Directional Graph, and as the name suggests, is a graphical representation of the elements, their directed relationships, and hierarchical levels.

vii) Interpretive Structural Model: Replacing all element numbers with the actual element description generates the ISM. The ISM, therefore, gives a very clear picture of the system of elements and their flow of relationships.