Scalability of sector-wide ICT applications

8.1 Introduction
8.2 Theoretical perspectives to understand constraints in scalability
8.3 Data collection and research method
8.4 The Tanzanian case study on scaling of novel ICT applications for education
  8.4.1 The socio-technical landscape
  8.4.2 The evolution and performance of the educational system
  8.4.3 The generation and development of the ICT prototypes
  8.4.4 Integration and resistance in the specific regimes
  8.4.5 Interventions to enhance the scaling of the ICT applications
8.5 The properties for scalability of the pilots
8.6 Processes and interventions for integration of ICT in the educational policy regime
8.7 Discussion
8.8 Conclusions and implications for development co-operation
8.1 Introduction

Technology plays an important role in economic performance and development. Innovations are often tried out in pilots and if successful, they are scaled up or scaled out. But the experience with the scalability of pilots is very mixed. ‘Natural trajectories’ is the label for innovations that scale-up and diffuse relatively rapidly and without specific interventions. For example the car easily found its way in sub-Saharan Africa. A more recent example is the mobile phone, although in this case deregulation contributed to the fast diffusion. Other innovations stop abruptly, slow down or only capture a very small market. Especially in development cooperation the scalability of pilots is a major problem. This also applies to many ICT applications. ICT has the potential to contribute meaningfully to sustainable development and poverty alleviation (Unwin, 2009; UN Millennium Project, 2005). Yet the successful application of this technology is still very limited in many developing countries (Heeks 2002; Walsham & Sahay, 2006) and is considered quite complex (Unwin, 2009). Scaling up is even more of a problem (Braa et al. 2004; Braa et al., 2007; Weigel & Waldburger, 2004). The urgent question addressed in this chapter is to better understand what influences the scalability of ICT applications that are novel to the local context and that have, as a pilot, a proven functionality in that environment?

In line with Sein and Harindranath (2004), technology is perceived as heterogeneous, consisting of material and immaterial elements. Technology is deployed to fulfil a specific function. Scalability refers to the expansion of the socio-technological system in scope and size (Braa et al., 2007). It includes the spreading to other sites (replication or scaling out) or enlarging of the ICT application capacity (scaling up). Scalability can be further refined as extendable in functionality, the ability to do more work (load factor), to cover larger areas (geographical factor) or to serve more organizational units (administrative factor). Scalability implies that potential users, other actors and the wider context in general, allow embedding of the ICT application into existing practices and at the same time, enable the development and enacting of new work practices (Miscione & Sahay, 2007). These existing practices are not isolated, but part of a wider context. Therefore scalability is about the acceptance and the integration of the ICT application in a broad sense: not only by its daily users, but also in the wider context relevant to the social function performed by the technology. This view on scalability contains a static notion of the right properties of an ICT application to be ‘scale-able’ in scope and size. It also contains a dynamic and multi-level notion: how the properties of the ICT application, its functions and its impact are perceived (not only by its users, but also by actors at higher levels), how these perceptions change during the process of scaling and how such perceptions interact with the properties of the application. This suggests that the degree and the nature of change provoked by the ICT application play a role.

1 Pilot and ICT prototype are used interchangeable.
This study is based on the RT process in education in Tanzania as presented in previous chapters. During the initial phases of the RT process, the focus became more and more on the domain of ICT for teaching and learning in secondary and teacher education. In the RT process, there is an involvement of stakeholders from socio-political networks as of the onset. The initial phase has similarities to Participatory Design, but searched to overcome the limits that Puri and Sahay (2007, p. 141) describe as:

“Often it has been found that both development projects and IS initiatives are unable to be sustained, because the design process tends to be localized, short-term, and unable to link with broader socio-political networks “to keep them going”.

As mentioned in the previous chapter after initial success, the scaling of some ICT applications turned out difficult. This might have parallels with the more general problem set out above of turning pilots into full programmes.

The structure of this chapter is as follows. First a theoretical framework is developed. Thereafter the case study is recapitulated and expanded with a description of the context and the interventions undertaken to achieve scalability, including an interactive policy process. Next we analyse the case regarding the properties for scalability of the ICT applications and thereafter the processes and interventions for integration of ICT in the educational policy regime. The findings are discussed in the light of the SST and IS literature. The chapter wraps up with conclusions and implications for information systems research and development co-operation.

This practise-oriented study is relevant for various fields. First it contributes to a better understanding of the, relative under-researched, topic of scalability as a dynamic and multi-level phenomenon and the need to develop heuristics in this field. For technology management, it contributes to the discussion on the breakthrough of new technologies. For development studies, it provides reflections and practices to overcome the stalemate between grass root or post-development approaches and top-down, neo-liberal approaches (Willis, 2005).

### 8.2 Theoretical perspectives to understand constraints in scalability

The perspective of SST starts from the premise that technology is inherently a social construct. SST spans a wide range of perspectives including CTA. In our case study, CTA is the approach followed to the design the ICT applications. Such a participatory approach with the main stakeholders concerned, would suggest that the ICT applications are well adapted to the local context and would be accepted by the socio-political networks and therefore easy scalable. In this section we elaborate
on the theoretical perspective to better understand the premises and constraints in scalability in general.

As the ICT prototypes identified are novel to the local context, they can be considered innovations (Avgerou & Madon, 2004). Innovation can be conceived simply as “implementing new ideas that create value” (Davenport, 1993, p. 10). Innovation signifies a breakaway of current practices. This is in line with the conceptualisation of technology as a social construct. Viewing a prototype or an ICT application as an innovation in the local context has two implications for our research topic. Firstly that innovation generates a new value proposition and provokes change. This influences the positions of the actors concerned in a direct or indirect way (Janszen, 2000). In the design-reality gap model of Heeks (1999) this aspect is emphasized in the sense that chances of failure of the ICT application increase with the degree of change invoked. Change means that re-alignment is required between actors, rules etc. not only within the organization using the ICT application, but also in the wider context depending on the linkages between the actors. Therefore scalability should be further differentiated according to the impact of the application and the level of re-alignment required.

The second implication is that the diffusion theory of innovations of Rogers (1971, last reprint 1995) is relevant to understand the properties for scalability. The diffusion theory distinguishes five aspects that influence the speed of diffusion:

1. perceived relative advantage to whatever it replaces;
2. compatibility or congruence with cultural values, behaviour patterns, the existing organizational structure etc.;
3. simplicity or the ease with which the innovation can be understood and how many actors and processes are involved in its diffusion;
4. trialability, can it be tried out on a limited scale or does it require major changes;
5. observability or how visible are the effects of the innovation.

Designing scalable ICT applications should match these five aspects and at the same time it should generate significant value for the organization concerned. But the provoked changes are not limited to the organization. They interact with the environment of the organization: other organizations, government, cultural values, suppliers and clients, financial relations, vested interests etc. Especially the aspect of compatibility and to a lesser extent the aspect of simplicity, refer to these linkages with the environment. In general, the adoption by users of novelty, is conditioned, facilitated or blocked by the wider context. This is certainly the case if changes affect a number of actors like for example learning and teaching methods or national
management information systems. This dependency of innovations on the wider context becomes very clear when they depend partly or fully on public or other external funding. So, to understand scalability a theoretical framework is required that covers the two aspects ‘degree of change provoked’ and the ‘wider context’ of the innovation.

The emerging field of socio-technical transitions and system innovations provides a theoretical framework to this end (Geels, 2002, 2005; Loorbach, 2007; Verbong & Geels, 2007). It is a descriptive approach in order to understand technological transitions e.g. from sail ships to steam ships. It emphasizes the co-construction of the technology by suppliers, the agents involved in technology transfer, the users, the markets, the political decision makers etc. This perspective is worthwhile as it searches not only to understand the emergence and integration of a new technology, but also the transition from an old to a new technology. Hence, it addresses degrees of change and resistance to change. Our description is largely based on Geels (2002, 2005, 2006), and Geels and Kemp (2007). It should be noted that CTA preceded socio-technical transitions and is closely linked to it (Raven, 2005).

Socio-technical transition is rooted in a quasi-evolutionary theory on technical change with the core concepts of variation, selection and retention. A technology is understood in a broad sense as ‘configurations that works’ (Rip & Kemp, 1998). Different elements of this configuration are aligned in such a way as to fulfil a particular function. In other words there is an alignment between the (technical) form and the (social) function. This poses the question how this alignment is realized: how is the technology shaped and selected? In the theory of socio-technical transitions a ‘regime’ is defined as the selection space for a technology, e.g. the school system. A regime is a set of rules shared within a group related to the selection and use of the technology for a particular social function. A regime moulds its members in a semi-coherent set of rules, e.g. the hierarchies and norms in a school system. It is difficult to change one rule, without altering others. As a school is composed of different groups that are mutually dependent, e.g. students, teachers, policy makers etc., it is clear that different specific regimes can be distinguished. Geels (2005) distinguishes the following specific regimes: technology, markets and user practices, infrastructure, culture and the symbolic meaning of technology, techno-scientific knowledge, industrial networks and policy. With respect to the study on ICT in developing countries, we add as another specific regime donor agencies and aid organizations. A socio-technical regime is the complex alignment of all rules upheld by the different specific regimes that influence each other, so it is not the sum of the rules of the separate specific regimes. While ICT can be integrated in a specific regime, it is the

---

2 This concept has similarities with the notion of ‘seamless web’ advanced by Hughes (1987) as related to large technical systems like e.g. the Internet.
integration in the socio-technical regime – the dynamic alignment between the specific regimes – that allows innovations to develop and spread\(^3\) (see Figure 8.1).

The socio-technical regime is one analytical dimension that should be perceived as interrelating with two other analytical dimensions: (a) the tangible elements needed to fulfil societal functions, including resources and (b) the actors, the social groups who maintain and refine the elements of socio-technical systems (see Figure 8.2). The socio-technical system is maintained and reproduced by the actors guided by the rules of the socio-technical regime.

The socio-technical system “remains ‘dynamically stable’ as long as the activities of the social groups and the incremental changes are aligned and go ‘in the same direction’” (Geels, 2005, p. 86). To understand changes in a socio-technical regime, a model of a nested hierarchy with three levels is developed, the so-called ‘multi-level perspective’:

- The socio-technical landscape refers to the material and immaterial context of societies and major trends that, analytically, are hard to change from a socio-technical perspective;
- A patchwork of regimes and;
- Niches as the breeding places for novelty.

![Figure 8.1 Meta-coordination through socio-technical regimes (Geels, 2004).](image)

\(^3\) A technological regime is the rule-set or grammar embedded in complex of engineering practices, production process technology etc. Based on neo-institutional theory (Scott, third edition, 2008), Geels (2004) distinguished three types of ‘rules’; cognitive, regulative and normative that are applicable to social groups like scientists, users, policy makers. He widened up the concept of technological regime to a socio-technical regime, i.e. from the community of engineers to the social groups that interact and form networks of mutual dependencies. The concept of socio-technical regime describes the intergroup coordination (Geels & Schot, 2010).
The term socio-technical landscape reflects a notion of relative ‘hardness’; slow changes and trends. It constitutes the context for interaction of actors. Literature suggests that landscape changes have a major influence on enabling or disabling the breakthrough of a technology. Most resistance to change stems from the level of the patchwork of regimes, in view of the relative large power the actors yield and their vested interests.

Modulation occurs if developments at the three levels reinforce one another and this creates the possibility for breakthrough of the technology. Therefore diffusion and breakthrough of technologies are an outcome of linkages between developments at multiple levels. Novelty develops as a bottom-up process in the system and is often located in a niche. A niche is a protected space where actors can experiment, exchange and codify knowledge and expectations. Within niches, new heuristics are building up and expectations are developing in relation to the new value propositions, while uncertainties are reduced. The looser the ties are between the participants in the niche network and the established actors in that sector, the more radical the innovation is likely to be (Raven, 2005). At the level of the niche, its scope increases with a better alignment of the actors involved (Hoogma, 2000) and supposedly, with the number and complementarities of the actors involved. Concerning the development trajectory

Figure 8.2 Three interrelated analytic dimensions (Geels, 2004).
of novelties in niches, the pattern can be ‘fit & stretch’, but also ‘fold back’ or even become ‘extinct’.

To conceptualise further on the nature and degree of change provoked by the technology, we distinguish between incremental and radical innovation. We would expect substantial changes to be induced by ICT (Castells, 2004), as it also did in the OECD countries. This might lead to system innovation. This means a socio-technical regime change, which enables a transition to take place from one socio-technical system to another (Geels, 2005). It is close to the classical notion of changes of ‘technology systems’ (Freeman & Perez, 1988), but a system innovation focuses on one societal function only and involves explicitly users. For example an incremental innovation like a shift in a class room from ‘chalk and board’ to ‘power-point based presentations’, represents a change in technology only. But a more radical innovation that gives students access to computers and learning materials in a flexible manner, changes their opportunities and ways of learning. Combining innovations enables to move from a ‘teacher-centred’ to a ‘student-centred’ educational system, which is a substantial change in technology, roles and working practices of the educational system and represents a system innovation. The integration of the technology can be described as a ‘fit’, meaning integration with limited changes in the socio-technical system or as a ‘stretch’, meaning substantial changes. The most common pattern is first ‘fit’ and thereafter ‘stretch’.

However, some ‘persistent problems’ might occur in a system. Persistent problems are produced by perverse couplings, i.e. linkages in the system that produce besides the intended positive effects also negative ones. Persistent problems reflect ‘weaving errors’ in the system that cannot be solved easily. They are messy in nature. The actors involved produce ineffective and incoherent ‘solutions’ that seem to solve the problem, but in fact make things worse. The relevance for scalability is illustrated by Braa et al. (2007), who state that the persistent problem of the fragmented funding of health programmes, especially HIV/AIDS, jeopardises the development of appropriate, integrated and scalable information systems in the health sector.

Summarising, scalability is not only dependent on the static, technical properties of an ICT application, but it should be understood in terms of introducing a novelty in a socio-technological system and the reactions at (and between) the various levels of

---

4 Being far-reaching changes in technology based on combinations of incremental and radical technical innovations, together with organizational and managerial innovations and affecting great parts of the economy and even giving rise to new sectors.

5 In terms of the innovation classification of Abernathy and Clark (1985), a system innovation represents an architectural innovation (at the level of the relevant social function and not at firm level only), because it disrupts technology and on the functional side users, markets, policies, symbolic meaning etc. are disrupted.

6 Uncertainty and normative dissension play a role in the appreciation of these couplings. Hence the structuring of the problem also influences the possible solutions (Hisschemöller and Hoppe, 1996).
this system. A new application introduces new practices. Introducing a new application provokes changes in the social-technical regime, i.e. the dynamic alignment of the rules in the various specific regimes. Scalability is dependent on the degree of change in the system. Properties such as compatibility, advantages and easiness to understand vary among various types of ‘users’, from end-users to high level decision makers. They have different interests and use different criteria to judge the value of the application. Scalability, in this sense, is defined by the properties of an application to be understood (and adapted) by the relevant regimes, to be perceived as having an overall positive balance between costs and benefits, to be congruent with cultural values and to keep the changes in the system below acceptable limits. These properties emerge interactively during the development of the application and they can change during this process; therefore they can be influenced by adequate interventions. The outcome of the process of defining properties determines whether integration succeeds or fails. Along these lines, we analyse the case.

8.3 Data collection and research method

The case study spans a period of six years. The ICT prototypes were generated through the participatory RT process. The starting point was an RT workshop that brought together the major stakeholders in education. They identified the most relevant ICT applications from a development perspective. This was followed by the development of ICT pilots or prototypes and an interactive policy project (see Figure 8.3). The analysis of the RT process and its outcomes is based on a rich data set collected over the period 2002 till 2008. This is reported in chapter 6 in the study on the RT workshop (chapter 6) and on the implementation of the ICT applications and their integration at organizational level (chapter 7).

Data on the resistance to integration in the educational domain was collected through documentary analysis, 15 in-depth interviews and participatory observation. Most interviews were tape recorded and transcribed, but in a number of cases consent for tape recording was not obtained. Interviewees included the assistant director of secondary education, other staff from the secondary, primary and teacher training department and the inspectorate of the Ministry of Education and Vocational Training, the programme officer of the main bilateral donor involved. Rigorous peer review

---

7 Moens and Tilya were involved in different roles in the policy making process. Moens acted as country programme manager/facilitator for the RT process, including the participatory policy making process. The director of IT of the Commission on Science and Technology (COSTECH) acted as co-facilitator. Tilya was advisor to the e-school initiative. All were acquainted with the main policy processes in the Ministry as of 2001, including the primary and secondary education programme and interacted with the main stakeholders in this field. Prof. Osaki, who provided critical comments and reviewed this study, was consultant to the Ministry of Education and World Bank and was involved as consultant in the interactive policy-making project.
by Tanzanian researchers reduced subjectivity. This was achieved through intensive interchange of ideas between the researchers with different Tanzanian experts in the area of political science, economics, administration, policy making, and an education specialist in matters pertaining to ICT as an instrument for education.

Evaluation data on the interactive policy making activities were collected through 70 questionnaires filled out by the participants at the end of four out of eight sessions. This was complemented by comments of two observers per session and through participatory observation. The research covered the period 2002 – early 2009. To develop a better understanding of policy implementation, the analysis also drew on the experiences with the formulation and the implementation of the primary and secondary education development programme that started officially in 2001 and 2004 respectively.

8.4 The Tanzanian case study on scaling of novel ICT applications for education

This section starts with a short description of the general Tanzanian context, followed by the evolution and the performance of the educational system. Next the generation and the development of the ICT prototypes are recapitulated, as well as their impact and their integration in the different specific regimes. The case description is concluded with a repertoire of interventions to stimulate the integration of ICT in the education policy.

8.4.1 The socio-technical landscape

Political scientists generally agree that in sub-Saharan Africa, the sovereignty of the state is fragile or problematic and that the Weberian substance of the state is weak. The political elite of Tanzania is a rather coherent and ‘closed group’. It allowed the transition from a socialist experiment that failed, to a liberal economic course (Coulson, 1982). Donors strongly pushed for the liberal course (structural adjustment), which resulted
in a steep fall of social service levels. Institutional reform is ongoing, but slow. The economic liberalisation, multiparty democracy and governance reforms, have on the one hand, introduced measures conducive to building a legal-rational bureaucracy and a liberal civil society, and on the other hand accelerated political struggle for economic resources through personalised networks (Kelsall, 2002).

Another important aspect is that African societies tend to emphasise personalised leadership and hierarchy. The distinction between the public and private domain might fade away in view of the dominance of the vertical and/or personalised relations that drive the very logic of the political regime “with a dominance of the short term view and the imperative of the micro-perspective” (Chabal & Daloz, 1999, p. 161) as opposed to the macro-picture of society. One of the consequences is that the formal organization has generally less impact on its members, compared to informal networks. It is within this context that the educational system has to function.

**8.4.2 The evolution and performance of the educational system**

During the socialist period that lasted from independence in 1961 till the mid eighties, primary education was the main source of education with an extended curriculum to develop ‘self reliant’ persons able to guide their own development (Arusha Declaration by president Nyerere, 1967). The transition to secondary education was only required for a small group. The sector was entirely public, easily accessible and initially well financed. However, the quality and the number of teachers was always a problem. The way of teaching, positions the teacher at the centre as the source of knowledge and the sole custodian of the learning process. This degenerated to ‘rote learning’ over time. This was caused by factors like shortfalls in training of teachers and supervision, scarcity of teaching materials, cultural impediments in community feedback to teachers, and relatively low salaries. Within this system, tuition was a major additional source of income. In the eighties a more liberal policy was introduced and private schools were allowed and soon mushroomed.

The performance of the sector was hampered by a number of persistent problems. Some problems were difficult to notice for the actors concerned, because ‘we always took them for granted’. Through literature review, discussion with experts and field experience of the researchers, some main problems were identified and analysed (see Box 8.1).

**8.4.3 The generation and development of the ICT prototypes**

In 2002, ICT was little used in education (Nielinger, 2006). In general ICT started to diffuse in the large urban areas, but up-country this was far less. The RT process started in February 2002 with a RT workshop that brought together representatives of all relevant stakeholders in the education sector. During the workshop, the participants
sketched future scenarios for the domain studied of secondary education and teacher training. Next they identified leverage areas for change and analysed the present and future role of information and communication. The participants identified, more or less in consensus, 10 ICT prototypes and stressed the need for an interactive policy process (see Table 8.1). After the RT workshop, one idea was considered unfeasible (#1) and not further elaborated. One idea was formulated, but not implemented (#2). And one stopped, even though some prototyping had been done (#3). By mid-2008, four ICT applications were scaled-up or copied and branched (#4, 5, 7, 10), one was

8 The telecentre part went smoothly. The computerisation of the administrative processes was planned for in an early stage, but came off much slower mainly due to financial constraints.

Box 8.1 Persistent problems in the domain of education

Uneven access and low quality of public education is an evident persistent problem, but it needs further decomposition to reveal the perverse couplings to be addressed. Below six persistent (and interlinked) problems are described briefly as a more in-depth analysis is beyond the scope of this chapter.

A. The poor learning and teaching environment is mainly caused by large class sizes, poorly qualified teachers and inadequate learning materials. All programmes (in the 70s, 2000 and 2004) set up to address this issue were insufficient. For example the government embarked heavily on teacher training, but duration and quality was too short (Galabawa, 1994). So history repeats itself as one participant remarked when this analysis was made during a session with the prototype owners/developers.

B. Teacher centred education and rote learning. Researchers (Mafumiko, 2006; Osaki et al., 2003) have argued that the curriculum is too theoretical and conservative and does not encourage inquiry, critical thinking and reflective practice.

C. Private schools generate more capacity, but weaken the quality of the public system and reduce equity. The private schools (organised as foundations) address a market with an increased purchasing power as a consequence of economic growth and increased income disparity. These schools contribute to the quantity and quality of education. But they have a marginalising effect on public schools as they draw away the more qualified teachers.

D. Curriculum insufficiently responds to real demand. Decentralisation, liberalisation and globalisation have changed the circumstances and the market requirements over the past 20 years. The basic curriculum is strictly regulated, has little changed and hinders schools in responding to real demand (Galabawa, 1994; Lillis, 2005).

E. Centralisation, limited implementation capacity and suffocation of innovation With the rise of a sector-wide approach, the donors and the Ministry pooled all funds into the national education budget with limited earmarks. A negative spin off is a strong concentration of power at the level of the Ministry and a ‘congestion in implementation’. It discourages innovations (Lawson & Rakner, 2005).

F. Resource scarcity is not a root cause as such, but a consequence of the political choices made. These choices influence economic growth and hence the resource availability on the longer term. The financing mechanisms deployed have a direct impact on access, equity and external dependency (Chonjo et. al, 1996).
Table 8.1 Overview of the ICT pilots and their development

<table>
<thead>
<tr>
<th>Name</th>
<th>Type of organization</th>
<th>Status</th>
<th>Level of development of prototype</th>
<th>Relation to persistent problems in the domain studied (see Box 8.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Virtual class rooms</td>
<td>–</td>
<td>Idea</td>
<td></td>
<td>Improve resources and equity (F)</td>
</tr>
<tr>
<td>2 Teacher training resource center</td>
<td>NGO (new)</td>
<td>Formulated</td>
<td></td>
<td>Improved quality teachers (A) and Student centred education (B)</td>
</tr>
<tr>
<td>3 Networking education inspectorate for decentralised upload and use</td>
<td>Ministry</td>
<td>Formulated</td>
<td></td>
<td>Improved quality teachers (A) and Improve resources and equity (F)</td>
</tr>
<tr>
<td>4 National libraries incorporate telecenters and computerised</td>
<td>Public agency</td>
<td>Implemented</td>
<td>Upscaled</td>
<td>Improve resources and equity (F)</td>
</tr>
<tr>
<td>computerised administrative processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Model schools, “poor school” using computers for teaching and</td>
<td>Ministry</td>
<td>Implemented</td>
<td>Copied</td>
<td>Student centred education (B) and Improve resources and equity (F)</td>
</tr>
<tr>
<td>provide ICT classes for students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Training of teachers in the use of ICT in teaching and lesson</td>
<td>NGO (new)</td>
<td>Implemented</td>
<td>Folded back and stopped</td>
<td>Improved quality teachers (A) and Student centered education (B)</td>
</tr>
<tr>
<td>planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Educational website providing info on educational sector, exams,</td>
<td>NGO (new)</td>
<td>Implemented</td>
<td>Integrated and copied, partly</td>
<td>Reduce centralisation (E) and Improve resources and equity (F)</td>
</tr>
<tr>
<td>quality of schools, learning materials, student counseling</td>
<td></td>
<td></td>
<td>transferred</td>
<td></td>
</tr>
<tr>
<td>8 Computer procurement, maintenance and training for public schools</td>
<td>NGO (existing)</td>
<td>Implemented</td>
<td>Copied</td>
<td>Improve resources and equity (F)</td>
</tr>
<tr>
<td>9 Website operated by students providing a variety of info including</td>
<td>NGO (new)</td>
<td>Implemented</td>
<td>Slowed down</td>
<td>Reduce centralisation (E)</td>
</tr>
<tr>
<td>on ICT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Networking teacher training colleges, service desk and</td>
<td>Public agency</td>
<td>Implemented</td>
<td>Upscaled</td>
<td>Improved quality teachers (A), Reduce centralisation (E), Improve resources and equity (F)</td>
</tr>
<tr>
<td>development of relevant contents for their colleges</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
copied and became extinct (#8), one folded back (#9) and one folded back and was stopped (#6). Learning from the prototypes occurred through network sessions, some specialised training and presentations to third parties.

The ICT prototypes were technically rather simple and based on ‘proven’ technology, such as a web-based data base to upload and use data in a decentralised manner, or a computer lab in school accompanied by training to use ICT in the education process and for planning and administrative purposes. The names and a short explanation of the types of ICT applications are presented in Table 8.1 along with the organizations that owned them and the level of development of the prototypes. The value propositions of the ICT applications are put in perspective by indicating their potential contribution to persistent problems in education. Most ICT prototypes can be labelled as incremental innovation, except the virtual school (#1), the model school (#5) and the educational website (#7) that were more radical innovations. The methodology deployed by the RT process generated closely linked and complementary ICT prototypes. From the perspective of a user (for example a school), these ICT applications are mutually reinforcing. The use and functioning of the prototypes was adequately backed up by training and support services. The RT process was subject of evaluation and the quality and outcomes were found to be adequate.

The outreach of the ICT applications was substantial. A prudent estimate is that it reached about one third of the students, most head masters and most decision-makers country wide. Each application was ‘visible’, ‘certain’ and widely recognised in the education sector. Also the impact was strong according to the users. Ninety per cent of the end-users stated to have reached their goals. Yet the score for empowerment of 45% was low compared to other RT processes on education in other countries. Also

9 For the sake of completeness, we should mention a prototype (called Diles) that was developed with IICD support two years earlier. Diles was organised as a NGO. It disseminated, on the website and in cheaply printed version, study materials written by Tanzanian teachers and in line with the curriculum. Their most successful product was a set of questions and answers of past exams. Diles marketing was frustrated by problems of certification. Later, this was solved through another public agency. Selling of materials was sabotaged in a number of places as intermediates topped up more than agreed or did not pay at all. Most resistance came from teachers who perceived it as a threat to their ‘additional income from tuition’. Consequently, the activities diminished. On a smaller scale Diles continues and is fully sustainable.

10 Teacher training (BETF) was less visible and less recognised as project activities were limited.

11 It was measured conservatively for the aggregated construct on empowerment by considering a score of 5.5 or higher only, measured on a Likert scale of 1 to 7. Another observation is that the expectations of the users increase and consequently the user satisfaction declines if the infrastructure or access possibilities to the internet are perceived insufficient.

12 The users of two prototypes pulled down the average score strongly. For one prototype, teachers became frustrated, because they had been trained to use ICT in a teaching and learning environment, but discovered they were not able to implement these tools in their schools, due to, not so much a lack of infrastructure, but rather a strong resistance to change by their peers. For another prototype it was a mismatch between the knowledge offered and the knowledge expected.
the direct impact on poverty was relatively low, because only one prototype addressed directly poor parents and students.

8.4.4 Integration and resistance in the specific regimes

In the users and market regime that includes the private sector, the technology was gradually integrated. In the beginning the RT process assisted in the development and diffusion of ICT applications, largely through dissemination of knowledge and best practices. Thereafter it ran on its own. This was largely economically driven as computer skills were paid for in the market and parents became more aware of the importance of ICT, although some resistance remained (mainly linked to porno and other improper web contents).

The donor regime largely ignored ICT, only the Swedish development cooperation (SIDA) became active with ICT in education by early 2005. The industrial regime (like the educational publishers, software industry) paid little attention to ICT in education as well. The educational science regime was slow to respond to the technology. The main resistance to the integration of ICT came from the present culture and practice of teaching, but most from the specific educational policy regime. This meant that ICT was less used in the public sector and this resulted in a growing inequity with the private sector.

Initially, the directors of primary, secondary and teacher training showed an interest in ICT as being a potentially important technology in the domain of teaching and learning. However, an unlucky constellation of circumstances (see Table 8.2), made the top of the Ministry oppose further exploration of the potentials of ICT. Personality and political goals played a role. This made the further development and scaling of ICT applications problematic for public organisations and for NGOs that depended on public funds through subsidies or the purchase of services. One ICT project at the Ministry stopped. As one staff member of the Ministry remarked:

“Yes, there was something new about putting the educational materials on the Internet, very interesting, because we are facing shortage of books. The student in our working group was very much interested. So we took it as a challenge as educationalists… We came up with a project and we presented it to the ministry… So we were asked to collaborate with a person from the planning department to decide how to go about it. That is where it ended.”

13 Only one lecturer was well versed in ICT and education. He was a ‘driver’ behind an idea for in-service training of teachers through e-learning. This programme was only developed in 2008 when the political pressure demanded the upgrading of teachers and a marketing study showed it could generate additional income for the university.
This resistance manifested itself sometimes blunt, but mostly in subtle ways and sometimes just by a lack of support. It resulted in a lack of funds and a lack of collaboration to develop the ICT prototypes. The following case is illustrative.

The website prototype (Tanedu, #7) grew out to become a well-known NGO, even internationally. It played a key role in disseminating knowledge on ICT in education, also in rural areas and therewith challenged the information monopoly of the Ministry. This yielded pressure to dissolve this NGO. Tanedu supported a Swedish initiative to introduce ICT at secondary schools (the e-school programme). It won several contracts in the market, but insufficient to sustain. As the e-school programme had not started implementation by mid-2008, Tanedu had to close its doors. Its activities of uniting students and alumni continued on a voluntary basis. The training and the website activities were restarted by young staff (one participated in the RT workshop as a student) and with a lower cost structure and learning explicitly from the previous experience. Also during the existence of Tanedu, parts of the website were copied by others, like the highly successful online publication of examination results. Or as remarked by someone from the public sector:

“*We see what you do and then we also do it*”.

---

14 Over a million hits per month after examinations.
8.4.5 Interventions to enhance the scaling of the ICT applications

To work on the acceptance of ICT by the educational policy regime, a number of interventions were undertaken. The niches were active with peer learning, demonstrations and awareness raising to all headmasters in the country, parliamentarians and the urban public. Helpful was the emergence of pockets of scaled ICT applications in the public sector like the teacher training colleges. This was complemented by pressure and passive support in the socio-technical landscape and the nomination of a more supportive top at the ministry of education. Coalition-building between niches and donors were only helpful for the teacher training colleges. An important intervention by the facilitators of the RT process was the initiation of an interactive policy process\textsuperscript{15} to arrive at a formal institutionalisation of the technology. The process consisted of eight sessions of $\frac{3}{4}$ day over the period from August 2003 till May 2006. The participation varied from 12 participants to over 50 participants representing all institutions, including the developers of the newly identified e-school programme. Participants perceived the sessions as relevant or very relevant. It gave ‘a comprehensive overview’ of the sector and provided insights in the routines and options for manoeuvre of each stakeholder. Some stressed that the emphasis on routine in the bureaucracy, required more intensive efforts to ‘stretch the mind’ in order to imagine and to grasp the meaning of new ways of working. The sessions were designed with a novel tool called Value-Attribute Analysis\textsuperscript{16} (see Box 8.2), which is based on soft modelling. It proved a strong tool to align different perceptions of goals to use ICT, to align expectations and to set priorities. It resulted in a pre-white paper on an ICT policy for education.

The different fore-mentioned interventions resulted in the development and adoption of an ICT policy for education in 2007. This ICT policy is a rather comprehensive addressing some of the persistent problems in the domain. ICT is used as a tool for learner centred and active teaching methods, with the teacher in a role of facilitator. For the development of e-contents, the Ministry opts for a facilitating role. Software choices are open and ‘open source’ is seriously considered. NGOs were acknowledged as service providers in the ICT policy for education. Another step was the consistent deployment of a behavioural participative approach around ICT development, which contributed to a more regular participation of stakeholders as the Ministry included a formal statement on the need for stakeholder consultations in their policy. Hence, the acceptance of incremental and moderately radical innovations opens the possibilities for a gradual trajectory of change. Therefore, ICT can act as a catalyst for social change (Sørensen, 2002) and an entry point for development. With ICT being integrated in

\textsuperscript{15} By the Commission on Science and Technology (COSTECH) and the International Institute for Communication and Development (IICD).

\textsuperscript{16} It is a novel use of the Innovation Suite developed by Inpaqt (http://www.inpaqt.nl/).
the specific regimes related to the domain studied, the ICT applications were scaled up and replicated also in the public sector. So the interventions were effective and the RT process resulted in the integration of the technology in the domain.

In line with the theoretical framework, we analyse the properties of the ICT applications in terms of extendibility and the diffusion theory of Rogers (1971, last reprint 1995) as preconditions to integration in the socio-technical regime. Thereafter, we analyse both interventions and autonomous developments that made the process of scaling successful.

### 8.5 The properties for scalability of the pilots

The ICT prototypes were designed for operation at full scale, e.g. websites to serve the entire nation, or with the purpose of full scaling in mind e.g. not serving only the highest classes but the entire school. Therefore properties for extendibility can be considered no (substantial) blockage to scalability. Also issues of standardisation and interoperability were less relevant except for the management information system. There was only an incidental and aborted effort of a large software company to dominate the market.

How about the properties for scalability as advanced by Rogers? The highly participatory methodology for generating the ICT prototypes and the decision making on priorities
with more or less consensus, suggest that most properties for diffusion are filled in positively by the participants. The perceived relative advantage, triability and observability were clearly fulfilled. There was also compatibility with cultural values, but less with behaviour patterns and organizational structure. The different degrees of change invoked in terms of value propositions and routines for different stakeholders led to resistance, especially for a number of teachers and staff in the administration. They perceived ICT as disrupting the routines, and/or opposed financial interests (e.g. by reducing tuition fees), and/or as a threat since it required re-defining their identity in their job positions. The limited level of empowerment experienced also reflected this point. It was largely due to two cases. First, frustration by teachers who were trained on how to make best use of ICT in teaching, but subsequently could not implement it in their schools, not only due to a lack of infrastructure, but due to resistance to change by peers. Secondly, there was a mismatch between the knowledge offered and the expectations. Related to the third aspect, simplicity, the web applications were experienced as relatively easy. But ICT applications in combination with learning tools were not overtly simple and training, examples and advice helped out. However, the main constraint is again the changes required in other parts in the school system, to make it effective. In conclusion the ICT prototypes responded favorably to three out of five properties for scalability according to the diffusion theory of Rogers. For two properties – compatibility and simplicity – this largely depended on the perception of advantage, the willingness and ability to change.

Most ICT applications were rather incremental innovations and were easily accommodated. More radical innovations were not rejected as long as they developed step wise; a typical ‘fit-stretch’ pattern. This is illustrated by the following examples. ICT in teaching training courses was initially opposed. Then the idea was accepted that it might be good to expose future teachers to ICT. This implied little change as education depended on the teacher; a safe and familiar solution. When ICT was well embedded in the teacher training colleges, bolder change was envisioned and some started to experiment with student-centred approaches. Therefore change as such did not seem an obstacle. But the ability to change depends on the wider embedding and the ‘room of manoeuvre’ for the actor involved.

The favourable properties for scalability were also reflected in the rather quick integration in the user-market and the socio-cultural regime. As mentioned, the main resistance came from the educational policy regime (policy makers) and the established way of teaching and learning (teachers). For a better understanding, it is useful to trace the impact of the ICT applications on the three analytical dimensions presented in

17 It should be noted that two third of the interviewees perceived ICT as important to improve their standard of living. However costs of connectivity and access remained a hindrance, though prices for connectivity lowered substantially as of 2003.
section 8.2 (Figure 8.2). The ICT applications particularly impacted on:

- The socio-technical system (resources used for ICT, including infrastructure, software and support services; cheaper access to learning resources e.g. electronic books, chemical experiments; reduced transaction costs e.g. to access exam results or possibilities for scholarships).

- The position of the actors and social groups, because the speed of communication and the increase in transparency of actions and results. For example school performances are easily compared. Also the use of ICT in the teaching and learning process requires the teacher to expose his knowledge and to make the process, including marking, more transparent, which is a substantial change.

- On the ‘rules’ in a more indirect way through increased knowledge and raised expectations on the education system as the websites make this information available that was hitherto not easily accessible.

For the private schools ICT meant an economic opportunity. It further reinforced their position in the educational field. Possible resistance to change by teachers in the private sector was quickly eliminated as ICT skills meant a higher pay and a necessity for the school to satisfy the demand for ICT by parents and students.

The conclusions to be drawn from the events as summarised in Table 8.2 indicate; imposition by a narrow top, lack of support from lower echelons in the Ministry, implementation problems, and a fear for criticism from a part of the public related to improper use of ICT by accessing morally not accepted contents. Over time, ICT was more and more integrated in the user-market and the socio-cultural regime, at least in the urban areas. Also the growing recognition of the importance of ICT for the economy provided some legitimization for the technology. The science regime became interested as some actors were involved as consultants. Also the costs of ICT were gradually going down. Nevertheless this seemed insufficient to put ICT on the agenda of the policy makers. Interesting to know is which interventions were helpful to integrate ICT in the specific policy and the established way of teaching?

8.6 Processes and interventions for integration of ICT in the educational policy regime

Our analysis points to the following processes and interventions relevant for the integration of ICT in the educational policy regime.

---

18 Consultants were involved in interactive policy making and made spontaneously presentations on the approach to interactive policy-making in Nigeria and Japan, during travel for other purposes.
Sense making involves “the ongoing retrospective development of plausible images that rationalize what people are doing” (Weick, 1999, p. 42). This was stimulated by the demonstrations of the ICT prototypes. This generally impressed policy makers and headmasters. But sense making mainly occurred during participatory multi stakeholder workshops\(^{19}\) and the interactive policy sessions that provided ample opportunities to explore the technology with others.

The build-up of local knowledge provided the trust that the application of ICT is do-able that risk is limited and without creating major external dependency. This knowledge was built up through the development of the ICT prototypes and by exchanging between the teams working on the ICT applications, seminars-workshops and in a later phase by integrating the knowledge in the development of the e-school programme. This became a rather large group of knowledgeable national experts. Learning by doing and peer learning were the most important methods to build up the local knowledge. A weak point was limited codification of the knowledge.

Construction of congruent meaning and re-alignment; stakeholders use action theories. These are ‘frames of mind’ held by an actor and shared in a professional community as related to the definition of (i) problems, (ii) solutions, (iii) the underlying empirical and normative background theories and (iv) insight in preferences related to identity and relationships (Grin & van de Graaf, 1996; Grin & van Staveren, 2007). Based on learning, congruent meaning can be constructed; i.e. pursuing similar goals based on different considerations and not based on shared meaning, but congruent meaning. This allows the build up of new value propositions related to the technology. Important is the way congruent meaning comes about. It has to be discovered not through abstract discussions, but through specific debates around the shared object of action (Grin & van de Graaf, 1996). This can be facilitated by a carefully conditioned learning process, without a priori impositions. The exchange between participants contributed to congruent meaning and alignment, which resulted in a reduction of uncertainty and initiatives for collaborative actions. Though all this pointed to the need to integrate the technology and to regulate it, it did not happen yet.

Coalition building i.e. the ability to carve out a partnership with some leading donors enabled the niche to secure its own resources for scaling.\(^{20}\) The niche of ICT in teacher training colleges had a high level of ownership amongst the principals. ICT was perceived to make work easier and to provide skills that were recognized and paid for in the market. Together with the capacity of the responsible director at the Ministry to remain under the lee of internal politics, a scaling-up programme could be developed, although the official approval by the Ministry took a long time due to internal obstacles.

---

19 The ICT Round Table (back in 2002) and the Future search works of the e-School programme in 2005.
20 This applied to the support provided by SIDA to Tanedhu and the student website till the programme officer changed and the implementation of the e-School programme was more and more delayed.
This demonstrated that *funding is helpful, but not decisive*. For example the perspective of donor financing for the e-school programme helped to put the issue on the agenda, but in itself, was an insufficient argument to initiate policy-making.

**The build up of pressure** on the education policy regime contributed to scalability. But it did not come about easily. The passing away of the initial *champion* shows the vulnerability of heavy reliance on one strong person.\(^21\) Efforts were made to spot *political entrepreneurs* and to involve them. These were initially unsuccessful. Only in 2006 an active supporter of the RT process was nominated deputy minister of education and boosted the process. A potential important intervention could have been *peer shaming*. In this case exposure between different countries during a workshop in Botswana\(^22\) offered an occasion for peer learning that resulted in a cognitive and emotional awareness that ‘we are far behind.’ Within the Ministry a small group was set up to take up ICT in education. Due to a lack of strong follow up, the ambition ebbed away. Apparently internal constraints frustrate such a process. Also the facilitators missed an opportunity here. Other efforts that were less useful included (1) a lobbying sessions with members of parliament that did not translate in action on their side and (2) special sessions with headmasters during their annual conference contributed to awareness, but did not spark a pressure for change. Very helpful was *openness by the ‘top’*, the new ‘top’ of the Ministry, appointed early 2006, was more open to ICT due to their background in science. This openness is essential to the integration of the technology.

**Changes in the socio-technical landscape** enabled the acceptance of the technology. Besides the general trend of a wider use of ICT, it was especially *political pressure* from higher levels that played a role. Election time approached and in society there was a growing pressure to increase the enrolment of secondary students drastically and to educate more and better qualified teachers rapidly. This challenge created openness to change current practices.

Important to note is that *modulation occurred* i.e. the reinforcement of developments at the three levels. This made the integration of ICT in the socio-technical regime possible. The new practises at niche level were as such not rejected by the educational policy regime. This became clear through coping of the ICT applications in the niches, through ICT training and discussions with staff of the Ministry and through discussion with the overall management of the Ministry. Yet the spark was still missing.

**Synchronisation** turned out to be important. The trigger to take policy making and implementation of ICT in education seriously was the question “How do we handle these ICT activities?” when the e-school programme intended to spend a part of their

\(^{21}\) Also a change agent in whom was heavily invested was discouraged further to take up ICT in education due to a change in conditions for promotion in the Public Administration.

\(^{22}\) Organized by the Common Wealth of Learning (Vancouver) and the International Institute for Communication and Development (The Hague).
funds through parties other than the Ministry, which was perceived as conflictive. Partly coincidental, partly conscious, but essential was that the pre-white paper from the interactive policy-making project was presented in the morning and the e-school programme in the afternoon. Now, the conclusion was evident: an ICT policy for education was urgently needed as it would define actors and resources. This showed that it was important to exploit conflict constructively and to be prepared and able to act quickly on the windows of opportunity that are presented.

*Process facilitation* played an important role in this case study. Some important aspects of this process turned out to be the following. *Legitimacy* to conduct the interactive policy sessions was derived from the acknowledged position of the local facilitator (COSTECH) and from the national ICT policy, even though the policy was not actively implemented. A *continuous pressure* was required to keep the policy making process going. Some financial resources were at hand in order to be *flexible* in organising events, etc. – because it was not written into the existing budget lines – and alertness/flexibility is important to make use of opportunities. *Deploy hands* or in other words to use consultants was required to add capacity and knowledge for the formulation of the policy. The caveat of consultants is that they may dilute ownership and take the lead in content formulation. This erodes both understanding and commitment of the decision-makers. The importance of facilitation and of a regime project like the interactive policy process to bring about transitions is recognised in literature (Grin & van Staveren, 2007).

A question is whether the integration of ICT in the specific policy regime would have taken place without the interventions. The case study does not suggest this, for example the model school (#5) struggled initially to get extra resources to support the ICT infrastructure. Only when ICT policy making started in the Ministry, the management of the school dared to use public funds to sustain the activity. The policy facilitated the actual allocation of resources by the Ministry to ICT in schools. Sectoral ICT policies were still very rare in Tanzania by early 2009. Also in another social service sector like health, ICT is not integrated (Nielinger, 2006), nor is a policy formulated. Therefore we conclude that scalability is brought about through these interventions with a particular role for the interactive policy process as the formal mechanism for integration.

Another question is whether the RT process that generated the ICT applications created blockages to integration? We suppose this has been the case as this bottom up...

---

23 Nielinger (2006) also stated that in other sectors, such as governance and health, the use of ICT is limited too. For example, a survey in the health sector revealed that ICT started to serve as a tool for communication and administration for the main central offices and research centres (COSTECH, 2007). More development-oriented initiatives with ICT were very limited. Only the Health Information System Programme (HISP) in Zanzibar, but it had little success on the mainland yet.
process, which is inclusive and empowering stakeholders, might be a less attractive value proposition for the dominant actors involved in the specific policy regime as compared to well-financed, donor-driven, top-down initiatives. However, many top-down approaches might seem faster, more efficient etc, but in reality they are slower, more expensive and mostly fail.  

8.7 Discussion

In this section we first relate the findings to IS research and secondly to the further operationalisation of the concepts for the theory and practice of IS research. The value of the discourse of socio-technical systems is acknowledged in IS research (Pipek & Wulf, 2009). This study shows that scalability of ICT is not only a matter of: (a) assessing the actual demand for the technology, (b) how usable ICT is in the everyday activity of the user and (c) the availability of support services (Mursu et al., 2005). But that is also a matter of multiple influences and modulation, learning and institutionalization (Miscione & Sahay, 2007) and is intrinsically a political process. Literature underwrites that ICT is a driver of change in power structures and processes, but also that stakeholders use their power to affect the new socio-technical system emerging (Jasperson et al., 2002). An example of the political struggle related to the properties of ICT applications is vividly described by Sahay et al. (2009). Therefore Unwin’s (2009, p. 365) suggestion that “truly delivering people’s need in a cost effective way” and hence they will pay for it, is far too simple and optimistic. The reality is that ICT-based innovations that are designed with and targeted at the poor and the vulnerable, do not emerge by themselves, but rather tend to be suppressed. Hence deliberate efforts are required. This is not only about affordability and access to resources, but about shifts in knowledge, control and power. Besides, the nature of ICT with its rather unique aspects of versatility and reflexivity (Pipek & Wulf, 2009) can make coherent and complementary sets of ICT applications that are attractive to innovate in sectoral governance and development like in the case study on education. Therefore a wider perspective is required to understand scalability.

Scalability implies that potential users, other actors and the socio-technical landscape in general, allow embedding of the ICT application into existing practices and at the same time the construction and enacting of new work practices (Miscione & Sahay, 2007). The case demonstrates the interplay between the properties and the process of development and scaling of an ICT application. The case suggests a further

---

24 An example in Tanzania is the effort to establish an electronic management information system. The failure of these top-down approaches is demonstrated both in education and health.

25 The ICT application is health management software (DHIS2) that could function in the example of Braa (2007) as the flexible standard that attenuates the negative aspects of fragmented health financing.
differentiation of the term ‘scalability’ according to the level of re-alignment of the socio-technical regime required. The following four dimensions of scalability can be distinguished:

- **Functional extendibility** in terms of load factor, geographical spread and/or the administrative capacity of serving more organizational units for accepted functionalities. This dimension is rather technical in nature and independent of the socio-technical regime. It covers the technical and functional aspects that determine the potential for expansion of the application (Braa et al., 2007).

- **User acceptance**, the relevant features of the ICT application that make it attractive to the user. It covers the aspects of perceived advantage, simplicity and triability of the diffusion theory. This dimension is dynamic and can be shaped in specific multi-stakeholder processes.

- **Market extendibility** in terms of conversance with (upcoming) standards, interoperability and other requirements to be able to gain a market share beyond the niche. This dimension relates less to integration in the socio-technical regime, but most to the shaping of business models and actor games within a stable or evolving socio-technical regime.

- **Perceived degree of regime change.** At the meso level and in the socio-technical landscape, where power and vested interests play important roles, actors judge ICT applications, apart from their functionality, also from their effect(s) on the socio-technical regime from their own perspective. It makes a difference if the application is perceived as leading to an incremental regime change, or if it is perceived as requiring a radical regime change, meaning that both the integration of the technology, the changes induced in social practices and functions, are rather radical as of the onset. This dimension is dynamic. It depends on the anticipated effects of regime change as perceived by each of the actors as well as on the ongoing instabilities in the existing socio-technical regime. It can be influenced using specific interventions across system levels, based on knowledge of the regimes involved. This dimension of perceived degree of regime change is particularly important, as in development co-operation quite a number of ICT applications imply radical regime changes.

In practise addressing persistent problems constitute a real challenge, also for IS research. An example from literature is the introduction of national management information systems for health that enable better planning, but create shifts in transparency and power between bureaucrats, politicians and donors. Their development and scaling proved very hard in Tanzania (Kimaro, 2006; Smith et al., 2007). To understand problems in the process of scaling, it is worthwhile to analyse in an early stage persistent problems that are the outcome of ‘weaving errors’ in the system the ICT application addresses. This analysis allows to adapt the design of the ICT application and to develop
strategies for scaling that better cope with persistent problems. In the example on health, a flexible standard for the monitoring of health data (Braa et al., 2007) is suggested as a property of an ICT solution to reduce some negative effects of the persistent problem of ‘competing’ programmes due to fragmented financing in health (see section 8.2). Some suggestions for the scaling of ICT applications that address persistent problems from the case study on education for strategies are: (a) a stronger involvement of would be implementers in the field, (b) developing ICT strategies for each main organization in the domain concerned (or type of organization like a teacher training college) and (c) identifying antagonistic interests at an early stage and searching for solutions through reframing, negotiation or redefining boundaries.

8.8 Conclusions and implications for development co-operation

The approach of socio-technical transitions provides a framework for understanding scalability. Its grounding in the social shaping of technology and structuration theory, makes it attractive for further development in IS research. In descriptive terms, it yields a set of four dimensions of ‘scalability’ that can be used for the a priori or a posteriori analysis of application development and implementation processes. In prescriptive terms, it yields a participatory methodology for ICT design, including involvement of actors at higher levels in the system. Refining the concept of scalability enables IS architecture and interactive design processes to better define the requirements, to target interventions more precisely and to anticipate obstacles. This study was explorative and more research is required to deepen understanding and to develop heuristics.

A few practical lessons can be drawn from the case study for IS design, for technology management and for development cooperation.

First, in IS design, the different properties for scalability and the way they come about, help to explain why top-down policy making and planning, as well as sector-wide blue-print ICT architectures are less, if ever, successful. The RT process is a promising alternative for the design of ICT for development. The translation of the RT process in planning approaches could be as follows. A bottom-up approach is desirable for idea generation and innovation (Janszen, 2000). During this process a vision is developed that could be the recurrent and dominant theme for reflexive learning and its progressing objectives a guidance in a process-network approach (Raven, 2005) that facilitates alignment and agenda setting. The core of the process-network approach is (a) the exchange and codification of the knowledge acquired through piloting novel ICT-based practices; (b) the implication of relevant specific regimes through active co-construction, and (c) interactive policy-making. Implementation and change management are to a large extent bottom-up processes, but a top-down backing is needed for conflict resolution, resource allocation, standardization and
control of implementation.

Secondly, in technology management, the literature assumes that the breakthrough of the technology largely depends on modulation and landscape changes (Geels, 2005). Raven and Verbong (2006) put up the question “how actor behaviour at the niche level contributes to or results in system innovations or transitions” as existing literature rather emphasizes a 'top-down' perspective. This study describes the bottom-up dynamics and the ability of niches to bring about regime change. In general, ICT implementation in any organization (in industrialized or developing countries, in companies or government) is a process where technology and the social system interact. The concepts of SST may give a general framework to better understand phenomena now described as ‘culture’, ‘resistance’ or ‘change management’ and guide interventions that contribute to the scalability of innovations that emerge in niches.

Thirdly, this study might also provide lessons for development cooperation. Presently donors tend to intervene from ‘outside-in’ and at one level only, such as:

- macro level, for example by structural adjustment and budget support;
- meso level through policy discussions and sector budget support in the so-called sector wide approaches, somehow assuming that policy discussions lead to implementation of change, which is problematic (Moulton et al., 2002);
- micro level, through pilot projects with main problems to become scalable and sustainable, often as they are driven by a narrow technological or social focus, or larger-scale programmes with often an equal narrow focus, which come to a stand still if external finance dries up.

This study shows why the emphasis on support at one level only and from ‘outside-in’ is less effective. Quick and external ‘fixes’ that lack the scalability properties of inside-out innovations are not scalable and a waste of resources. It seems to be better to stimulate change from ‘inside-out’, in an approach like the RT process that relates grass root and meso developments and offers a way for institutional renewal from ‘inside-out’. Moreover, it is well to remember that most innovations are generated by the private sector and NGOs and therefore their active inclusion is essential.