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Analysing eGovernment Implementation in Developing Countries Using Actor-Network Theory

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Analysing eGovernment Implementation in Developing Countries Using Actor-Network Theory

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2006

Abstract

This paper addresses the value of information and communication technologies (ICTs) in supporting the "good governance" agenda of public sector reform programmes in developing countries. Within the overall spectrum of reform, there has been particular interest in improving the accountability and transparency of public finance. The paper presents actor-network theory (ANT), based particularly on Law and Callon's work, as a framework for understanding e-government for public finance reform. It applies this theory to a longitudinal study of public expenditure management information systems in Sri Lanka. Alongside specific findings about the global and local networks that have shaped this set of e-government applications, the paper also reflects on the value, applicability and operationalisation of actor-network theory in development informatics research.

A. eGovernment Investment as a Development Issue

A1. Public Sector Reform, Good Governance and ICT

The World Bank convened a Task Force in 1992 to explore the issue of governance. They defined governance as "the manner in which power is exercised in the management of a country's economic and social resources for development" and "good governance" in a developing country as synonymous with "sound development management" (World Bank, 1992). Four areas of interest were defined: public sector management, accountability, the legal framework for development and information, and transparency. Not surprisingly, these emphasise the aspects of government affecting economic development, in line with the World Bank's own charter.

The good governance concept has been broadened subsequently. Critics of the World Bank have argued that public sector reform projects based on their narrow interpretation of good governance often have little effect in the absence of deeper changes in the political context and in the incentives shaping behaviour. For example, it is contended that the leadership dimensions of government need to be reformed as well as the administration and that the private sector must be involved with a broader approach to good governance (Nelson and Eglinton, 1992).

The focus on good governance has continued over the last decade with the series of strategy documents, co-ordinated by the Organisation for Economic Co-operation and Development, that developed the international development targets negotiated and agreed at the United Nations conferences of the 1990s explicitly recognising the importance of effective governance. In 2001, the UK Department of International Development stated "the quality of governance is critical to the achievement of the Millennium Development Goals" and asserted that, where progress on achievement of the targets has been made, it reflects a parallel improvement in the quality of governance (DFID, 2001).

But there still remains today a conceptual ambiguity in the donor community on the measures to be advocated to improve governance. It is recognised that changes in institutions, procedures and attitudes inside and outside of government are needed in order to promote openness, accountability and predictability. There has also been a growing recognition that the Western rationality-based premises on which modern bureaucracy is founded may represent discontinuity with other cultural traditions. Martin (1991) states that there is "no standard formula for fostering an acceptable level of state management and good governance: the road to such a destination is mapped out by cultural factors that vary considerably from place to place and are in no way unalterable".

The question remains open as to whether it is possible to conceive of general standards of good governance acceptable to both external and internal political actors. Externally devised standard models for organizing government structures tied to the aid instruments of the international financing institutions (IFIs) cannot fully take into account specific state-society relations and may have a negative rather than positive effect.

The IFIs are currently focusing on the notion of institutional deficit as their primary area of interest under the good governance agenda. However, policy prescriptions for good governance attached to aid programmes need to be examined cautiously as, although they are bound to have an effect, it is difficult to predict the precise nature of this impact on the complex network of political and organisational processes within any government structure.

Let us turn now to consideration of one particular area of the public sector reform agenda being advocated by the IFIs. There is widespread acknowledgement that reforms of the fiscal system are required to improve the low level of accountability and transparency at state level in many developing countries. Best practice guidebooks on "how to do it" are published by the IFIs. These urge the establishment of national fiscal objectives and require the Ministry of Finance to:

> "Ensure ***aggregate fiscal discipline***. In the face of competing demands for limited financial resources, it is essential to be able to maintain controls over aggregate expenditure in the medium term.
> Facilitate ***strategic prioritisation*** of expenditures across programmes and projects. Within the overall resource availability, allocate resources in accordance with policy and social priorities.
> Encourage ***technical efficiency*** in the use of budget resources. Once allocated, ensure that resources are used effectively and efficiently." (DFID, 2001)

A sound financial management system allows a government to make the best use of available resources based on these three fiscal objectives but fiscal reform is usually approached in terms of technical measures such as a revised budget classification or computerisation and the results have "often been disappointing" (DFID, 2001). It has to be recognized that fiscal discipline needs political commitment: resource allocation is primarily a political process therefore any reform effort needs to strengthen government commitment by fostering collective responsibility for the budget and for its implementation.

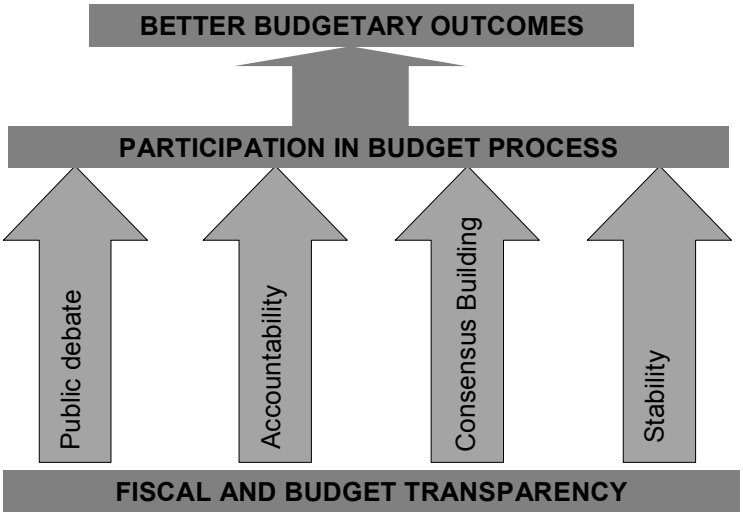
Collective decision-making needs good quality information: to prepare for decision-making by providing data and analysis, to accurately record the decisions taken and to ensure that the spending agencies act upon them. The need for a government-wide, integrated financial management information systems (IFMIS) has been identified as a core component of any fiscal reform programme (see, for example, the World Bank's case as put by Campos and Pradhan in 1996, that of the Asian Development Bank in Schavio-Campo and Tommasi in 1999, and that of the OECD in Allen and Tommasi, 2001).

The International Monetary Fund's Code of Good Practices on Fiscal Transparency (IMF, 1998) states that:

- budget preparation, execution and reporting should be undertaken in an open manner
- fiscal information should be subjected to independent assurances of integrity
- information on government activities should be provided to the public.

This emphasis on transparency and public debate can be translated into a fiscal reform agenda as summarised in Figure 1 that can be seen as placing information and communications technology (ICT) at the heart of the required changes.

Figure 1: The Rationale for Reform
Adapted from IMF Code of Good Practice by PricewaterhouseCoopers (2003)



A2. Failure of ICT Initiatives in Developing Countries

It is a well-known secret in the computer industry that information systems are more likely to fail than not. Surveys in industrialised countries suggest that less than one-third of projects are successfully delivered on time, to budget and fully meeting user requirements. The evidence base is not strong in developing countries but it all points towards even higher failure rates. We can estimate that perhaps one-third of such initiatives are total failures, and a further one-half are partial failures (Heeks 2001, Heeks 2003).

The most cited reason for failure in achieving economic benefits from ICT projects in developing countries is that the financial logic of ICT-based automation is typically based on Western cost/benefit calculations in which the cost of new technology is more than balanced by the benefit of labour cost savings. Whether such economic benefits are delivered by ICTs in Western economies is still a matter of much debate. In developing countries, though, we can be fairly certain that such calculations do not apply since technology costs are typically two-three times greater and labour costs up to ten times lower than in industrialised countries (Heeks and Kenny, 2002).

The failure of an information systems project in a developing country government is, however, a real and practical problem not only because of the opportunity cost of the investment, particularly the outlay of scarce resources of capital and skilled labour, but also because, where the IFIs are advocating an information systems project as part of a public sector reform programme, failure or partial failure has a negative effect on the image of the government implementing the initiative. Their credit rating with the

IFIs can be adversely affected and their reputation for good governance diminished. It is therefore vitally important to examine the reasons for failure of ICT initiatives.

To do this, we will first examine the performance targets being set on e-government programmes in developing countries. Are they different from those being established for similar programmes in the context of developed economies?

E-government is defined in many ways, but its definitions and the accompanying discourse provide us with insights into the limited sense in which e-government is conceived by many of the major stakeholders. We can illustrate this by reflecting on the discussion at the National E-Government Conference of Sri Lanka held in mid-2003 at which the guest speaker from the World Bank, in his keynote address that opened the proceedings, proposed adoption of the following definition of e-government, attributed to the Committee for the Modernisation of the State in Chile (2003):

> "E-government is a way of organizing public management in order to increase efficiency, transparency, accessibility and responsiveness to citizens through the intensive and strategic use of information and communication technologies in the inner management of the public sector (intra and inter governmental relations) as well as in its daily relations with citizens and users of public services."

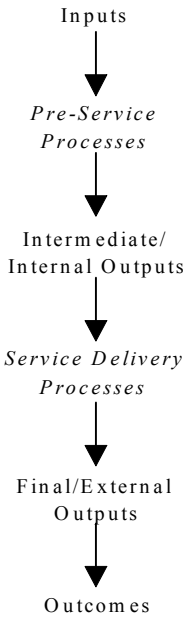
The emphasis on public sector reform and the "efficiency, transparency, accessibility and responsiveness to citizens" goals of good governance were summarily debated after his opening remarks. These issues were then effectively sidelined for the rest of the day as the delegates to the conference (politicians, civil servants, consultants and computer suppliers) engaged in a lengthy examination of the technology inputs to an e-government programme. Case studies were presented by ICT suppliers to illustrate that apparent "e-government best practice" can be followed by governments in both resource-rich and resource-poor environments, as long as the newest technologies are adopted and adapted to the environment. The success attributed to these projects (the output) was presented in quantitative terms only: the communication protocols adopted, the speed of connection, the number of ministry information websites, and the increase in use of the "one-stop" access points for citizen information.

The interplay of the various actors at that e-government conference will hold no surprises for those working within the ICT industry in developing countries. The parties enacting an e-government programme – the ministers sponsoring the initiative, the government IT department, the ICT suppliers, the consultants, the public sector users – currently regard the projects primarily in terms of technological achievement rather than application and function. A programme's success (or otherwise) is benchmarked in technical terms (UNDESA, 2003) throughout the world and little regard is given to the less tangible outputs of the programme, such as improvements in accountability and transparency, or to the societal outcomes incorporating notions of value to citizens.

A few voice their concerns that the substantial investment of public sector funds in e-government programmes in developing countries may not be achieving the return on investment that might be expected from comparable outlays in other areas. But what theories are they using to substantiate their stance? Can the success or failure of e-government projects be analysed in different ways?

To help address this question, we can examine the standard approach to the measurement of public sector performance, as shown in Figure 2 (adapted from Flynn, 2002). As can be seen from the discussion above, most of the debate about and measures of e-government focus on technical efficiency in terms of inputs (protocols adopted), processes (connection speed) or internal outputs (web sites, access points). Little emphasis is placed on the true areas of public value: the external outputs of e-government (such as public access to government information), let alone the broader outcomes of e-government on society.

Figure 2. Performance Measurement for the Public Sector



As we have previously ascertained, a successful information systems project is construed as one that is delivered on time, to budget and fully meeting user requirements. But the questions must be asked: "which users?" and "what requirements?" If the performance targets of an e-government programme are currently confined to those of technical efficiency then those that are satisfied with such outputs are likely be only a small sub-section of the potential users of the system.

To illustrate this point, we will examine, in Section C, a case study of public expenditure management (PEM) information systems. This particular area of the fiscal reform package is one of importance in ensuring sound development management as it concerns the transparent and accountable allocation and use of public resources. But were the external users who could potentially benefit from access to the budget information held in these PEM information systems involved in their design and implementation? Or was it just the technical efficiency gains within the Ministry of Finance that were considered in judging the success (or otherwise) of these systems?

B. Actor-Network Theory

B1. Outline of Actor-Network Theory

Heeks' work (2003) on the success and failure of ICT projects in developing countries places emphasis on the measure of organisational change that must take place in order to move from the current system (the reality) to the future system (the design). He shows that wider design-reality gaps occur, with a greater likelihood of failure, on projects in developing countries than on projects in developed countries due to generic differences in the two key human stakeholder groups (designers and users). The claims of technological determinism are negated and he lays stress on understanding the human dimensions of the intended organisational change. He therefore questions the postulated relationship between technology and the social.

Much of the information systems literature does not address such a core theoretical concept as it has a predictive and prescriptive character, aimed at influencing management behaviour. If ICT is "an enabler" of desirable organisational change, in the established jargon of the general literature, then such an effect will depend on the organisation's circumstances and, on the whole, the literature has avoided hypotheses of causality between ICT innovation and particular organisational or societal effects.

In order to address such a question, we will turn to the field of science and technology studies that has developed conceptual constructs to deal with the processes through which technologies are developed and influence societies. This is a multi-disciplinary field with a relatively short history but, unlike the field of information systems, the writers have devoted most of their endeavours to theoretical and explanatory studies, without assuming an intellectual responsibility for guiding professional practice.

In this paper, the framework for analysis is a well-known theory from within the science and technology field: Actor-Network Theory (ANT). This is selected for a number of reasons. First, it is well-established and there is an important hinterland of work explaining, critiquing, developing and applying the theory; including application to information systems in developing countries. Second, it has been comparatively stable, with later presentations building on the original theory, probably because the theory is "owned" by a particular group of writers. Third, it overcomes some important limitations of the "ICT as an enabler" perspective of the management literature that are based on technological determinism and can thus be presented as a complementary approach to information system studies.

Concepts

ANT will now be summarised. In presenting such work, it would be the norm to start with a definition of key terms. But ANT has a dense language that is an integral part of the theory and must be placed in context. We will therefore present the theory and the definitions together.

The "actor-network" as a concept was developed by Michel Callon, Bruno Latour and John Law during the course of the 1980s as a recognition that actors build networks

combining technical and social elements and that the elements of these networks, including those entrepreneurs who have engineered the network, are, at the same time, both constituted and shaped within those networks.

The position of machines in ANT is unique. It is recognized that technologies do not evolve under the impetus of scientific logic as technological determinism suggests: they are not possessed of an inherent momentum that allows them, as Latour (1987) describes it, to pass through a neutral social medium. In effect, "our technologies mirror our societies" (Bijker and Law, 1992, p.3) as they are continuously shaped and reshaped by the interplay of a range of heterogeneous forces within the networks. Machines are as much actors in the networks as are the humans.

ANT writers typically develop their arguments in an empirical context: the stories of Latour's hotel room key, Callon's electric car and Law's Portuguese sixteenth-century circumnavigators of the globe are particularly memorable. The tales tend to be heroic. Agency is a precarious achievement: many stories tell how it is that actors more or less, and for a period only, manage to constitute themselves and their networks. ANT treats the world as a set of related bits and pieces and there is no social order. There are only endless attempts at ordering through the formation and stabilisation of networks.

By telling stories and tracing histories rather than taking snapshots, ANT proves itself as "a pragmatic, recursive sociology of process with an interest in the uncertain processes that generate power and size" (Law, 1999). Understanding power relationships in ANT means describing the way in which actors are defined, associated and obliged to remain faithful to their alliances.

B2. Power and Translation

For Latour (1986), the problem of power is encapsulated in the following paradox: when you simply have power – *in potentia* – nothing happens and you are powerless; when you exert power – *in actu* – others are performing the action and not you. Power over something is a composition that is made by many – the primary mechanism – and attributed to one – the secondary mechanism. The amount of power exercised varies depending on the number of others who enter into the network. The notion of 'power' is a convenient way to summarise the consequence of a collective action but it cannot explain what holds the collective action in place. "This pliable and empty term" may be used as an effect, but never as a cause.

For Callon (1986), the analysis of stories in ANT leads to a better understanding of the establishment and the evolution of power relationships, because all the fluctuations that occur are preserved in these histories. The goal of the theorists is to show that the nature of society can be questioned at the same time as examining the actors and their networks: how they define their respective identities, their mutual margins of manoeuvre and how they identify the range of choices open to them.

In the diffusion model of power, a successful command moves under an impetus given to it by a central source. The ANT theorists contend that social scientists must

necessarily shift away from this model to understand power as a consequence and not as a cause of collective action. The translation model of power (Callon, 1986) presents a successful command as resulting from the actions of a chain of agents, each of whom translates or shapes it according to their own objectives. Those who are powerful are not those who hold power in principle but those who practically define or redefine what holds everyone together. This shift from principle to practice allows the vague notion of power to be treated not as a cause of people's behaviour but as a consequence of an intense activity of enrolling, convincing and enlisting.

In ANT, translation is the mechanism by which the networks progressively take form, resulting in a situation where certain entities control others. The repertoire of translation is not only designed to give a symmetrical description of a complex process that constantly mixes together a variety of human and non-human entities. It also permits an explanation of how a few obtain the right to express and to represent the many silent actors they have mobilised.

We will examine Callon's seminal paper on the history of the scallop fishermen of St Brieuc Bay (1986) as it presents in a concise form an approach to social analysis that has, according to Law, "hitherto been relatively inaccessible to English-speaking sociologists". Callon's translation model is claimed to outline a new approach to the study of power that emphasises the process of displacement and transformation. To translate is to displace but it is also to express in one's own language what others say and want: it is to establish oneself as a spokesperson.

In Callon's story, a scientific and economic controversy about the causes of the decline of scallops in St Brieuc Bay and the efforts of three marine biologists to develop a conservation strategy are described. The researchers sought to become indispensable by defining the problem and instituting a research programme of investigation. They successfully locked the other actors into their strategy, enrolled them and became their spokesperson.

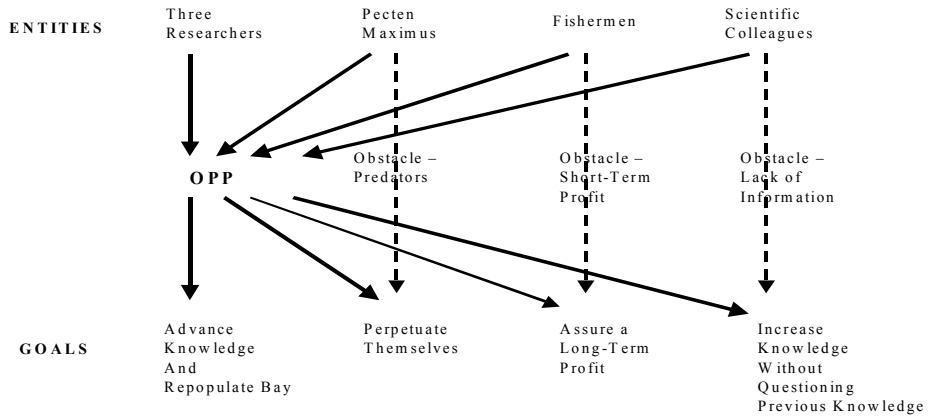
The four "moments of translation" in this story are:

- "problematisation" - the principal actors [the researchers] make themselves indispensable to others [fishermen, scientific community, scallops] by defining the nature of the problem and forcing the others to accept a way forward [the research programme]
- "interessement" – the principal actors lock the others into place by interposing themselves and defining the linkages between the others [the research programme becomes the recognised obligatory point of passage]
- "enrolment" - the principal actors define the roles that are to be played and the way in which the others will relate to one another within these networks
- "mobilisation" - the principal actors borrow the force of their passive agent allies and turn themselves into their representatives or spokespersons.

The researchers were able to construct a global network of relations between themselves and others – and between the others – that generated a space, a period of time and a set of resources in which innovation [the research programme] took place. Within the space provided by this global network, a local network of heterogeneous

actors dedicated themselves to the successful production of a working device [the construction of concrete pillars] to ensure the continued breeding of the scallops in St Brieuc Bay. The researchers established themselves as an obligatory point of passage (OPP) to control all transactions between the global and the local network, as illustrated in Figure 3.

Figure 3. Translation in Action (Callon, 1986)



Network Analysis

In their later work, Law and Callon (1992) suggest that the notions of context and content that are commonly used in socio-technology studies can be transcended if the analysis of the many heterogeneous actors in a network is treated as a balancing act where these various elements are juxtaposed. They analysed the balancing act between the heterogeneous actors that came together in global and local networks to design the TSR2 aircraft and, through this story, developed a network analysis and mapping of the technical change.

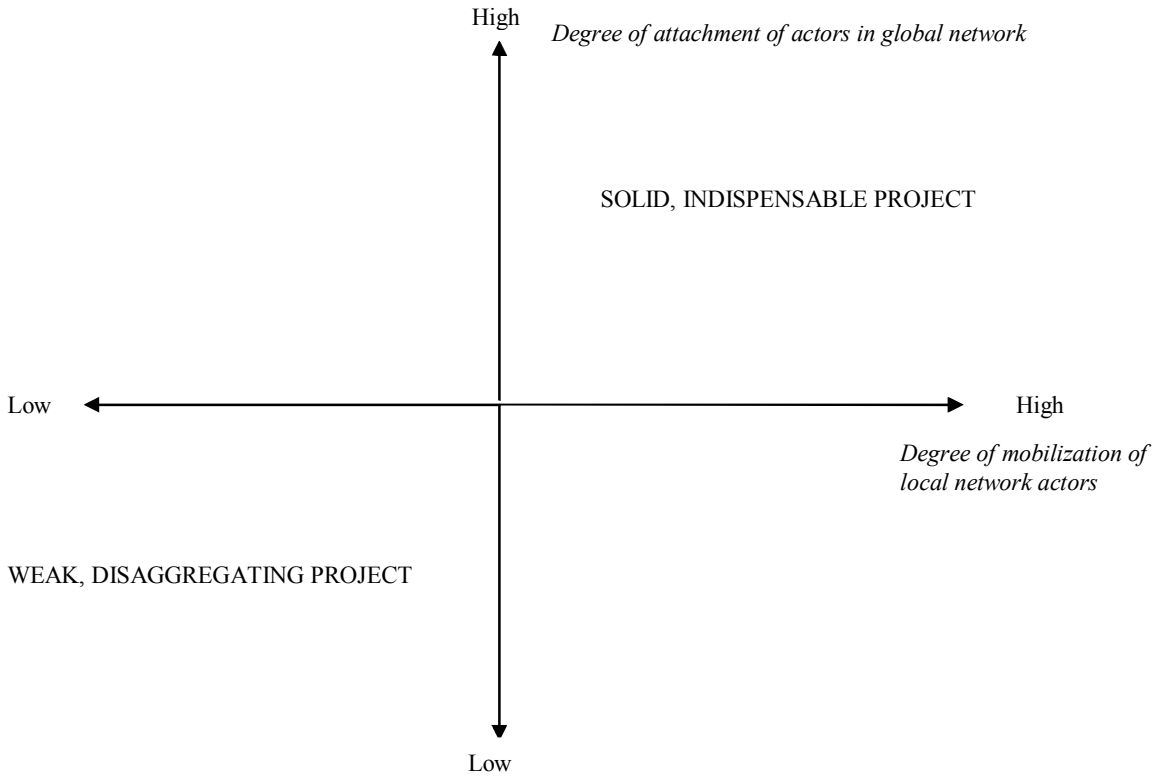
The history of the evolution (and eventual demise) of the TSR2 was told and the stance of each of the groups of human actors (the stakeholders) mapped against the evolving shape of the technical design(s). It was noted in the analysis that there was continual building and re-building of the two networks with seepage between the global and local networks at various stages in the project. Actors in the global network were able to interfere with the structure and shape of the local network when the obligatory point of passage was weakened, while those in the local networks were able to consult directly with actors in the global network.

The actors in the global network were heterogeneous: there were the institutional actors and a number of influential individuals but, in addition, there were, for example, geopolitical forces (the interest of political leaders), technology diffusions and civil society movements (anti-war protests). At the local network level too, the actors were heterogeneous: for example, private sector contractors, public sector officers, investments in computer hardware and software, design documents, reports.

Law and Callon contend that, if the elements that make up the networks are heterogeneous, then the extent to which a project can control its two networks and the way in which they relate are problematic. It is the degree and form of mobilization of the networks and the way in which they are connected that determines the success of a project in reaching its set goals. The obligatory point of passage is crucial in this regard.

It is possible to plot any project (Figure 4) on a two-dimensional graph where the x axis measures the degree of mobilization of local actors (control over the local network) and the y axis the extent to which global actors are linked (control over the global network) and thus to describe the translation trajectory. In this paper, we will apply this network analysis model to a case study of public expenditure management (PEM) information systems.

Figure 4. Mobilisation of Local and Global Networks (Law and Callon, 1992)



C. Implementation of Public Expenditure Management Information Systems in Sri Lanka from an Actor-Network Perspective

C1. Background to the Case Study

Having identified successful project implementation as an important analytical issue for e-government research and having identified the ANT network analysis model as a relevant theory for analysing how a project reaches its goals, we now move on to apply the model to a specific case study: the fiscal reform programme and the public expenditure management (PEM) information systems that were implemented in Sri Lanka.

The key groups of human stakeholders in the PEM information systems are shown in Table 1. It is to be noted that the system designer and ministry user groups are not the only interested parties in government financial information systems – politicians, the media, professional societies and the IFIs are also stakeholders.

Table 1: Classification by Function of the Key Human Stakeholder Groups

Group	Organisation	Department	Designer	User
Government of Sri Lanka	Ministry of Finance	Leadership	+	+
		State Accounts Department	+	+
		National Budget Department	+ (from 2001)	+
		Other Departments		+
	Other Ministries	Line Ministries		+
		Prime Minister's Office		+ (from 2002)
International Financing Institutions	Asian Development Bank	Head Office	+ (until 2001)	
		National Office		
	World Bank	Head Office	+	+
	Korean Aid Agency	Head Office	+	
Suppliers	International Accounting Firm	National Practice	+ (from 2001)	
		International Practice	+	
	UK Consultants	International Practice	+ (from 1998)	
	Korean Consultants	International Practice	+ (from 2002)	
	Korean ICT Supplier	Head Office	+	
		National Office	+	
Civil Society	Institute of Public Finance			+
	Media			+

The History of the Setting

1996 – 99: Implementing a Government-Wide Accounting System

The history of the public expenditure management information systems in Sri Lanka starts with a Financial Management Training Project that was funded by a grant from the ADB and implemented by the Ministry of Finance (MoF) from 1996 – 8. The project consisted of two components focused respectively on the establishment of a Government Financial Training Centre, together with the piloting of an accredited training syllabus, and on the preliminary design of a Government Accounting System. The first component did not progress as expected and project funds were re-allocated to the second. The international consultants' preliminary system design was "adapted to the environment" by the leader of the small IT group in the State Accounts Department (SAD). The direct result was the in-house development by an expanded system development team of the decentralized, government-wide Computerised Integrated Government Accounting System (CIGAS) to act as the data collection system for the central Treasury Accounting System, which had been operational in the SAD since the 1980s.

The internally developed CIGAS software was implemented at more than 2,000 locations throughout the country. Although basic in functionality, the IT group leader judges that "it has proven a useful step on the way to computerization". The low cost of the custom development by the in-house team, the ability to maintain the systems internally and the absence of incremental license costs have been important factors in the success of the CIGAS implementation. The ADB evaluation of the CIGAS component of the Financial Management Training Project provides important guidelines for the development of a sustainable model of public expenditure management information systems in Sri Lanka. The key elements of such a model include:

- "a dedicated unit in the State Accounts Department staffed by government officers with the required leadership, motivation and skills, together with the respect of the decentralized units where the systems were being deployed;
- a sustainable user training programme implemented through the Financial Training Centre;
- a recurrent cost structure comfortably within the means of government; and
- software that provided real assistance to its users so that they were motivated to use it, which is perhaps the most critical factor in the success of such information systems projects."

The ministry outsourced to the University of Kelanin (UOK) the development of a stand-alone budgeting system, using funds from a World Bank loan designed to combat the effects of the millennium bug (1997-99). This centralized system was for the use of the National Budget Department (NBD), with advice on the specification of the system being provided by British consultants. It is perhaps surprising that the NBD did not seek the assistance of their technical colleagues from the SAD IT team in this development rather than outsourcing it. The rational explanation given is that the funding was being allocated from the World Bank loan and the procurement procedures required the ministry to let an external contract. Informal sources within the NBD suggest that the department wished "to own" the UOK system.

The British consultants strongly recommended a locally-developed systems solution. "Despite their obvious advantages, our experience with packaged solutions has generally not been good. We have found that, with modern databases, systems can be developed relatively quickly which can meet the specific needs of individual countries. We have [specified] custom developed budget and accounting systems in Bangladesh, … and budget systems in Sri Lanka. These have been developed in Fox Pro and Microsoft Access and the [only] major problem is security" (Parry, 1997).

Despite being of limited functionality and simple design, the system was only partially implemented by the NBD. This failure was attributed to a lack of technical computing knowledge within the department.

2000 - 1: Designing an Integrated Financial Management Information System
Once first generation computerisation had been achieved, based on the simple stand alone cash accounting systems (CIGAS/TAS) deployed through all government agencies and supported by the ministry's technical unit, the ADB in the late 1990s urged the government to build upon this structure to implement a modern integrated financial management information system (IFMIS) covering all aspects of budgeting, accounting, treasury and debt management.

A consultancy report on the institutional modernisation of the MoF in 1999 identified five departments with 700 staff responsible for the key elements of public expenditure management and the ADB designed a cluster technical assistance project with each of the five inter-linked components targeted at one of the implementing departments. To link the departments, "a new computerised system will integrate all key financial management functions into a cohesive system on a common database" (ADB, 1999).

But the expectations of the organisational transformation to be achieved through the IFMIS were extraordinarily high.

"The Ministry has a vision of rebuilding itself into a high-performing organization. The vision is in part determined by the Permanent Secretary's previous job in the Central Bank, which is about to implement a re-organisation which will include a 50% cut-back on staff. A new implementation unit run according to private business practice will work with each department to help them re-organise around the new systems being designed, thus avoiding the risks and expense of customizing software. In the vision, the unit will grow larger and the ministry smaller over the long term. Such a model has been followed successfully in other finance ministries that have moved to integrated financial management systems, as a way to offer competitive compensation and an attractive working environment." (Wescott, 2001).

The ministry, with the assistance of consultants from an international accounting firm, undertook the Public Expenditure Management Systems project from 2000-3 under ADB grant funding. This was intended as the design and preparation phase of the IFMIS that would be implemented with the financial assistance of a follow-up loan from the ADB.

The ADB technical staff that designed the reform programme based it on the theory that technology-led change is an efficient implementation mechanism. However, a number of harsh realities emerged when the strategy for the IFMIS development was mapped out by the international consultants and reported to the MoF at the end of year one. The recommended IS strategy was to move quickly over a three year period to international best practice in public expenditure management, based on state-of-the-art ICT and a packaged software solution. An overall investment of $40 million was envisaged for the exercise with the recurrent cost for the maintenance of the IFMIS hardware and software estimated at over $2 million per annum.

The MoF departments that would implement the IFMIS were unsure of their role in and the incentives for them to adopt the procedural changes that would have to be made to accommodate these technology-led developments. The MoF leadership, advised by the in-house technical unit, judged the cost of the envisaged system to be prohibitive and requested an urgent review of the project.

A crisis ensued and a senior ADB delegation was dispatched to Sri Lanka. The project was extensively re-designed during their two-week mission. The remaining grant resources were re-targeted for the final two years of the project on introducing policy changes in the budgeting and accounting framework and the piloting of new and improved processes supported by less ambitious information systems. A strategy of improving the "functioning basics" rather than of implementing a "big bang" technology roll-out was adopted. Leadership of the project also changed: the ministry appointed a project director, the ADB task manager was replaced and the technical lead switched to the national office of the accounting firm.

2002 – 4: Improving Expenditure Management Policy, Procedures and Systems
During 2002 and 2003, the ministry progressively introduced a series of new budgeting and accounting policies and procedures. These were based on international best practice adapted to the Sri Lankan environment by three international advisers working with the national office of the accounting firm. They were supported by information systems developed by the accounting firm that built on rather than replaced the ministry's custom-developed systems. At the close of the Public Expenditure Management Systems project, a medium-term change programme was agreed to continue this reform effort that would progressively lead to the full adoption of International Accounting Standards. This was widely-publicised by the ministry and the Institute of Public Finance and endorsed by the international financing institutions. One of the elements of the improvement programme was to be an IFMIS.

So how did this re-instatement of the IFMIS as a key enabler of the good governance objectives of the government's fiscal reform programme take place?

A simple answer would be that the ministry officials were now more familiar with and at ease with the technology. During the latter phase of the project, as a direct result of advice by the national consultants during the re-design of the inputs, a local area network was implemented in the ministry and Internet access provided to 300 staff. A web-enabled Integrated Budget System (IBS) was built to support the new budget preparation and monitoring procedures and a government-wide training programme carried out. User-friendly evolutionary prototyping development techniques were

employed by the national consultants to win the support of the potential users and the NBD invested heavily in training its staff. Open source software was used, so creating "a low-cost but leading edge solution" (Senanayake, 2003).

The IBS was designed to interface with the CIGAS/TAS accounting systems and hence budget preparation and execution information was available to the MoF and line ministry users from one single source. A firm technology base for an IFMIS was thus put in place through the Public Expenditure Management Systems project.

A more complex answer to the question lies in the political environment in which the latter phase of the project was situated. A change of government in late 2001 brought to power a party with a neo-liberal economic reform agenda and a Prime Minister that saw "the future of Sri Lanka lay essentially in the service sector – in banking, finance, tourism, IT, call centres and so on" (Weerakoon, 2004). Eight Steering Committees were formed to guide the economic reforms, of which one had a direct mandate covering the development of ICT in the country. Membership of these committees was mixed: top civil servants, senior managers from the private sector and civil society representatives.

The ministry leadership was reconstituted with the change of government: a new ministerial team and a new Secretary Treasury. The latter shared his predecessor's view of the organisational transformation to be effected through the widespread use of ICT in the ministry. More crucially, he was a close colleague of the Prime Minister's and shared his vision of replicating in Sri Lanka "the path-breaking achievements in Andhra Pradesh where … a most efficient and people-oriented government [is] heavily assisted by information communication technology" (Weerakoon, 2004). He had a seat on the Steering Committee with ICT development responsibilities, together with the director of the national team of consultants working on the IBS development, and strongly upheld the Committee's objective of using the emerging E-Government programme to support growth in the national software industry.

The launch of the web-enabled IBS was engineered to coincide with both the first National E-Government Conference and an accounting conference organised by the Institute of Public Finance. When the Minister of Finance officially launched the website at a ceremony in May 2003, the Secretary referred to "the near revolutionary changes" that were occurring in financial management administration in the public sector through the use of ICT (Sri Lanka Financial Times, 2003) and shortly afterwards, at his opening address to the conference, he boasted that this application was the first and only example to date of an interactive e-government application in Sri Lanka.

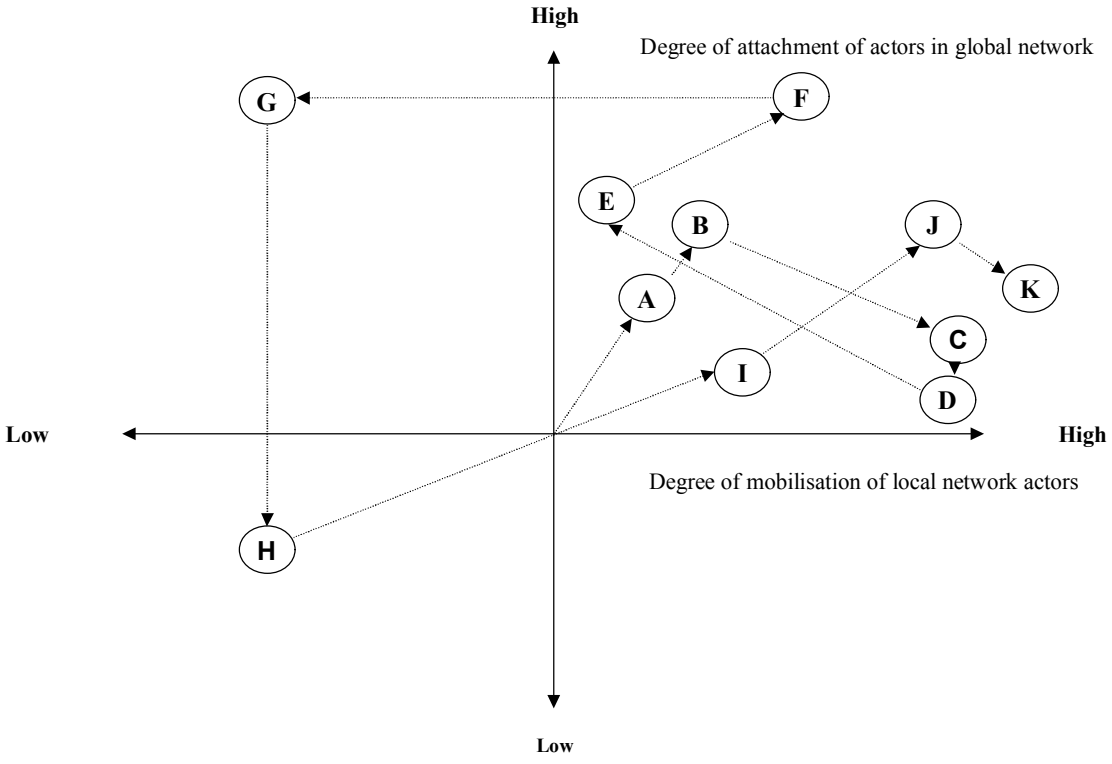
In 2002, the ADB commenced the design stage of a loan to continue the implementation of the streamlined budgeting and expenditure control procedures being piloted under the PEMS project, as well as substantive measures to improve the performance of the revenue administration. The design of this loan package, the Fiscal Management Reform Programme that became effective in early 2005, includes the key elements of the government's medium-term change programme for expenditure improvement. Crucially, the expenditure management component of the IFMIS is not covered by the ADB loan.

In a parallel move to the ADB loan negotiation, the ministry was discussing with the Korean bilateral aid programme their offer to assist in the financing of the development and implementation of an IFMIS. In late 2003, after the close of the ADB-funded project, a team of consultants from Korea moved into the ministry to undertake a design study under bilateral grant funding. The resulting recommendation was to tailor the IFMIS that had recently been built for the Korean Government to the requirements of the Sri Lankan Government. A bilateral credit line would be used to fund the necessary technical infrastructure, the tailoring of the software and a widespread training programme. The MoF leadership, drawing on technical advice from the World Bank, requested the consultants to pilot various of the modules in three line ministries during 2004 prior to a decision being made on whether to adopt the recommended strategy. To date, no decision has been taken.

C2. Application of Network Analysis

Applying Law and Callon's network analysis model to the Sri Lankan PEM information systems, the reform programme can be mapped (Figure 5).

Figure 5. PEMS Programme Network Analysis (based on Law and Callon, 1992)



The programme started in the centre of the diagram and climbed up the vertical axis as the MoF leadership and the IFIs agreed a mutually acceptable objective of improved public sector financial management based on international best practice (A).

This was broadly translated, in information system terms, into the need for an IFMIS to improve fiscal accountability and transparency (B) and a global network was formed to move this objective forward.

The formation of the local network that led to the development of CIGAS within the Financial Management Training project (C) effectively sidelined the global network. This movement down the vertical axis was strengthened with the wider support for the MoF's chosen custom development path provided by the World Bank loan-funded project (D), where the local network made the design decision on the UOK budget system.

The global network was re-constructed when the decision was taken by visionaries in the MoF leadership and the ADB to transform the ministry through technology-led change (E). A project was delineated and a team of international consultants versed in international best practice appointed (F).

Attempts to construct a local network were ineffective and the recommended IS strategy was not accepted (G). The removal of sponsorship of the project by the MoF leadership and the ADB led to a crisis (H) and a re-definition of the information system objectives.

A local network was formed (I) that developed the IBS. This symbol of success led to the formal adoption of a Financial Management Reform Programme by the MoF, with promised support from the international financing institutions (J). The IFMIS within the reform programme is planned to be a tailored version based on the Korean model and there is scepticism in the global network that this is an appropriate solution (K).

The translation process or trajectory of the reform programme is plotted graphically in Figure 6. It is useful to compare this against the technological trajectory of the programme provided in Table 2, which maps the stance of each of the groups of human actors against the evolving shape of the PEM information systems.

The categorisation of the actors as interested / hostile / neutral at each stage of the PEM information systems and the identification of the drivers behind their behaviour are based on the qualitative data collected by the author as part of her doctoral thesis research. The author's involvement in the Sri Lanka fiscal reform programme is active and recent. She is a visiting specialist adviser to the Government of Sri Lanka and was a member of the consultant team implementing one of the ADB-funded implementation projects from 2000 to 2003. As such, she was on-the-ground and able to record developments as they took place at one particular juncture in this reform programme. She has had direct access to the various stakeholder groups and to relevant documentary evidence through this practitioner role.

Table 2: The Shaping of the PEM Information Systems (adapted from Law and Callon, 1992)

TECHNOLOGICAL TRAJECTORY	INTERESTED ACTORS	HOSTILE ACTORS	NEUTRAL ACTORS
1. CIGAS/TAS + UOK • decentralized data collection • monthly centralized processing	SAD • central control • ownership Line ministries • incentives		NBD • lack of technical staff
2. Package IFMIS • standard solution • real-time processing • high-speed communication network • integrated systems	Secretary Treasury • organisational transformation ADB • e-government • good governance International suppliers • best practice solution	SAD [blocked] • loss of control • high recurrent costs Other MoF departments [blocked] • imposed from outside • unknown procedural changes	Line ministries
3. IBS/CIGAS/TAS • web-enabled data collection • centralized back-end processing • system interfaces	NBD • ownership • support to policy and procedural changes Local suppliers • high visibility system • "made here"	ADB • internal perceptions • reconfigure loan portfolio	SAD
4. Tailored IFMIS • real-time processing • high-speed communication network • tailored to GoSL requirements	MoF leadership • full system integration SAD and NBD • build on what is there Korean aid agency • e-government export International suppliers • sole source project	ADB and WB • fit to policy and procedural changes	

It can be seen that the technological trajectory of the reform programme evolved in a contingent manner as a direct result of the interplay of the human actors within the various networks that were formed. The behaviour of the human actors was influenced by the other elements within the networks, including the technology itself. The IBS, for example, became a symbol of success for the local network that developed it but also for the emerging Sri Lankan e-government programme and the national software industry. Without the IBS, which was a local improvisation measure and an unintended consequence for the global network, the Korean IFMIS might well have been adopted without any piloting programme or move to tailor the software to the specific needs of the Government of Sri Lanka.

C3. More Advanced Application of ANT

A more advanced level of analysis can be undertaken based on the translation model of power implicit within the network analysis of Law and Callon's work.

The network analysis model suggests that the success of each project in reaching the initial targets set for it (time, budget, output/innovation) crucially depends on the creation of an effective local network that operates independently of the global network. In the cases of the Financial Management Training Project and the Public Expenditure Management Systems Project, the local networks that formed produced outputs that differed from those in the original project design sanctioned by the global network. These outputs (namely, CIGAS and IBS) met the technical requirements of the users included in the local networks and the ministry officials judged each project as "successful".

But additional questions must be asked regarding:

- what public value resulted from this substantial investment of public sector funds in these e-government projects? and
- why were the external users who could have potentially benefited from access to the budget and accounting information held in these PEM information systems not involved in their design and implementation ?

The World Bank defined governance in 1992 as "the manner in which power is exercised in the management of a country's economic and social resources for development" and "good governance" as synonymous with "sound development management". Ten years later, the ADB summarised its stance on the strategic impact of ICT and e-government on good governance and wider development goals.

> "Improving the quality and efficiency of public and private sector governance is crucial to poverty reduction. Good governance is predicated on effective institutional arrangements that promote accountability, participation, predictability and transparency. Information-openness is critical to this process. ADB should foster appropriate targeted ICT applications that can facilitate stakeholders' participation in policy formulation and ensure transparent use of public funds. Timely and wide access to relevant information and data is the key to good governance. ICT can improve transparency and accountability in government and private sector operations." (ADB, 2002)

But, as one ADB technical adviser lamented, "ICTs' wonderful potential has been hardly used in most Asia Pacific countries to increase government accountability, transparency and participation" (Wescott, 2001). The answer lies outside the immediate sphere of technology, as we see from the Sri Lankan case study.

What power did the ADB have in ensuring that the public funds it was investing in the Sri Lankan fiscal reform programme were being used as intended to improve governance through the development of appropriate PEM information systems? The dictionary definition of "power" concentrates almost entirely on authority and its various permutations: the ability to exercise "power over". Location within the formal organisational hierarchy (particularly the bureaucracy of national and international government) provides certain stakeholder groups with their bases of

power. For others, it is their familiarity with the relevant technology and their ability to access – or block the access of others to – needed information. A rating for each group of the PEM IS human stakeholders of their "power over" the development of the PEM information systems is given in Table 3, based on their position in the bureaucracy and their knowledge of technology, as analysed in the author's research findings.

Table 3: Classification of the Key Stakeholder Groups by their "Power Over" the Development of the PEM Information Systems

Group	Organisation	Department	Bureaucracy Power Base	Technology Power Base
Government of Sri Lanka	Ministry of Finance	Leadership	+	
		State Accounts Department		+
		National Budget Department		+ (from 2001)
		Other Departments		
	Other Ministries	Line Ministries		
		Prime Minister's Office	+ (from 2001)	
International Financing Institutions	Asian Development Bank	Head Office	+	+
		National Office		(until 2001)
	World Bank	Head Office	+	
	Korean Aid Agency	Head Office	+ (from 2002)	
Suppliers	International Accounting Firm	National Practice		+ (from 2001)
		International Practice		+ (until 2001)
	UK Consultants	International Practice		+ (from 1998)
	Korean Consultants	International Practice		+ (from 2002)
	Korean ICT Supplier	Head Office		+
		National Office		+
Civil Society	Institute of Public Finance			
	Media			

The global network successively generated periods of time and sets of resources – the projects – in which the innovation took place. The success of each project crucially depended on the mobilization of a local network of actors, who produced information systems within the timescale and budget of the project. But the global network was unable to directly influence the shape of those PEM information systems: it had no "power over" the output.

As ANT so clearly shows, power is always in relation to something or someone else. Those who are powerful are not those who hold power in principle but those who practically define or redefine what holds the network together. The "power to" enact

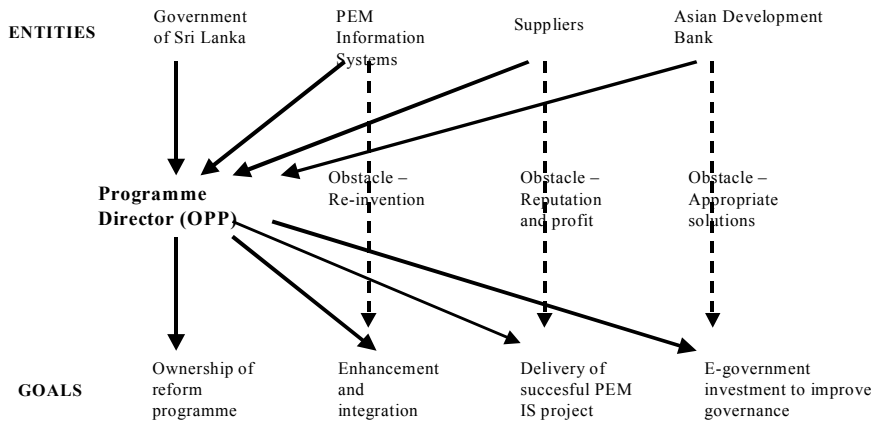
through others is a social power experienced in relationship with others and is based on an intense activity of enrolling, convincing and enlisting.

The goal of the ADB was to improve the level of governance through using ICT to facilitate the transparent and accountable allocation and use of public resources. But if the ability to get one's way in the face of opposition is at the heart of exercising power (Pfeffer, 1992) then the ADB was not a powerful stakeholder in the reform programme, despite its bureaucratic and technical power base.

The ADB was only one of a number of heterogeneous actors in the global network. There were the other institutional actors and a number of influential individuals, such as the Secretary Treasury, but, in addition, there were, for example, geopolitical forces (the presumed interest of the IFIs in the good governance of nation states is contended in various quarters), technology diffusions (such as the Internet) and civil society movements (freedom of information). At the local network level too, the actors were heterogeneous: for example, private sector contractors, public sector officers, investments that were already in place in computer hardware and software, professional allegiances, and reports.

On both the Financial Management Training Project and the Public Expenditure Management Systems Project, there was no recognised single point of control for transactions between the global and local network identified in the project design. During implementation, without a strong obligatory point of passage, the two networks operated separately from each other and came together in unplanned and unexpected ways. There was no on-going engineering of the networks that might have been carried out if, say, a well-respected and senior Programme Director had been appointed from within the ranks of government (as suggested in Figure 6).

Figure 6. Translation in Action on PEM IS Programme (based on Callon, 1986)



This is a more advanced application of ANT than Law and Callon's network analysis of technical change and requires specific research methods in order to develop it further. There are some interesting areas for research in the translation model: for example, the civil society groups have been identified as having no "power over" the shape of the systems but they certainly had "power to" influence when enlisted in the network.

The challenge must be met. The implementation of the modern methods of public sector financial management to support "good governance" as attempted in Sri Lanka is complex as the target of attention, the government ministries and agencies, typically do not have the institutional structure or the resources to support them. However, as Madon, Sahay and Sahay (2003) contend in their Indian case study of municipal revenue systems, while the process of implementing reform is complex, it nevertheless has to be engaged in, as such programmes have become "part of the existing contemporary reality of government the world over".

C4. Findings: the Contribution of Actor-Network Theory

In overall terms, analysis of the case study from an actor network perspective does seem to score relatively well on the obvious research tests. Firstly, one can ask whether it says anything new. It certainly puts previous ideas on the organisational change that must take place in order to move from the current to the future system into a new shape. The translation trajectory is mapped, together with the technological trajectory, thus indicating the socio-technical priorities that need to be addressed in a successful project. Second, one may ask if it says anything credible. Some questions about ANT will be raised in the next section but one advantage of using a well-known method and the accompanying vocabulary is that it does make complex results more convincing that the simple listing of factors found in other analyses. It also provides the basis for further argument and debate framed around the model rather than simple assertion vs. counter-assertion. Finally, does application of this model say anything useful? Although presented only briefly here, it does seem to. ANT is an appropriate perspective through which to analyse the dynamics of the power relationships that characterise IFI-funded reform programmes in developing countries that employ ICT as "an enabler" of change. The technology does not determine the outcome and neither does the social: the success of a project is dependent on the process of someone or something managing and controlling the various forces at play, both technical and social.

ANT permits an explanation of how a few can obtain the right to express and to represent the many. The case study material provides industry and policy practitioners with a clearer sense of the forces at play in e-government implementation in developing countries and, by explicitly recognising the inclusion or exclusion of various groups, it facilitates discussion on how the networks can be re-engineered to include potential users able to demand public value targets for e-government projects, such as increased public information and debate.

D. Reflection and Review

D1. Tractable Critiques of Actor-Network Theory

This section reflects on the ANT application just undertaken, plus evidence from other applications of the theory. The information systems literature on ANT is almost solely confined to case studies, which is not atypical of the ANT discourse where the theory is developed in relation to specific histories.

Semiotics and Methods

It is suggested by its critics that ANT has developed into a complex social theory with a dense vocabulary and that many case studies make rather an eclectic use of the conceptual vocabulary and, to a lesser extent, its methodology. Researchers tend to use elements of ANT selectively, as in this particular instance of the examination of the PEMS information systems in Sri Lanka, and there are few studies that take a comprehensive approach that works through all elements of the theory. Walsham (1997) criticises many information system studies using ANT as not being true to the theory.

In response, Law (1999) shows that ANT was intentionally developed as a way of being faithful to the insights of ethnomethodology where actors know what they do and researchers have to learn from them not only what they do, but how and why they do it. The ANT theorists recognise the need to keep their vocabulary in motion. Latour (1999) himself speaks of "the ridiculous poverty of the ANT vocabulary" that has proven a clear signal that no academic definitions can replace the rich vocabulary of the actor's own practice and states that "a great deal of our [ANT] vocabulary has contaminated our ability to let the actors build their own space".

Human and Non-Human Actors

An often-mentioned shortcoming of ANT is the inadequacy of the analysis it offers in respect to the actor (Lee and Brown, 1994). The theory assumes the radical indeterminacy of the actor and thus opens up the social sciences to non-humans. ANT makes no analytical difference between the social and the technical and this symmetry between humans and artefacts thus enables a sociology that accommodates both on the same terms. This indeterminacy supposedly entails a number of difficulties, including the frequently repeated accusation of relativism, and it is contended that it provides significant challenges in operationalising ANT for research purposes.

The critics acknowledge, however, that the concept of "heterogeneous networks" conveys with greater accuracy what the expression "information systems as social systems" was meant to convey in the information systems literature of the 1980s (Avgerou, 2002). Information systems cannot meaningfully be restricted to ICT within an independently delineated social environment and ICT innovation should be considered in interaction with the changes undergone or being pursued by the other

actors (people, institutions, other socio-technical objects) in an attempted organisational change.

The ANT theorists have robustly met this critique of indeterminacy. They contend that the technological actors in the network are intermediaries, embodying social intentions and the scripts of particular behaviours that are influenced by the socio-technical circumstances of the societies that created them. The process by which these properties are ascribed in practice can be potentially described (see, for example, Akrich's 1992 study of the photoelectric lighting kit which was designed in France but put to use in the Ivory Coast) but often it is not.

Emphasis on Power

ANT is often criticised for presenting actors guided by the quest for power and solely interested in spreading their influence through the manipulation of networks. Stories are only told when there is a crisis or drama involved and the managerial and engineering character of the principal actor is stressed as the central precept of the model. The hyphenated link between actor and network is frequently misunderstood as an agency/structure cliché.

In reply, Callon (1999) explains that heroic stories tend to involve actors with Machiavellian tendencies but that, in ANT, there are no model actors and a variety of possible configurations of action so, depending on the configuration, the principal actor can be both generous and altruistic (see, for example, Hennion, 1993). Latour (1999) points out that the theory was meant to concentrate attention on a fluid movement, a circulating entity with actor and network designating two faces of the same phenomenon, like waves and particles. As he so succinctly describes it: "There are four things that do not work with actor-network theory; the word actor, the word network, the word theory and the hyphen! Four nails in the coffin."

D2. More Challenging Critiques of Actor-Network Theory

This discussion ends with two further issues related to ANT which are less tractable and which, it is argued, require continuing modifications to the theory.

Social Theory

It has been contended by various critics (Collins and Yearley, 1992; Bloor, 1998; Descola and Palsson, 1996) that ANT has slowly drifted, in the last twenty years, in a directionless fashion from a sociology of science and technology into a social theory and onwards into yet another enquiry of modernity.

This contention is not surprising as it is made by social scientists with a radically different viewpoint on the nature of society from the ANT theorists. Within ANT, the necessary continuous definition and redefinition of what collective action is about in the network, as power is only obtained from those who are doing the action, means that society is being constructed in the present: it is being built by every actor and is in principle unknowable. This is the performative model and the ANT writers argue

that society is not what holds us together: it is what is held together (Strum and Latour, 1985). This is in direct contrast to the view of those social scientists that see society as existing and in principle knowable (the ostensive model).

Latour (1999) laments that "those who should have been most interested in our work, that is the social scientists, turned out to be its harshest critics" and lectures them: "Making society hang together with social elements alone is like trying to make a mayonnaise with neither eggs nor oil – that is, out of hot air." He contends that sociology should study "associations rather than society: social ties are not strong enough to link us all together, all the forces that are mobilised to link humans together and ensure that some orders are obeyed, and others are not, must be considered".

The advice to the social scientists provided by Latour in 1999 was not a new direction in ANT and was constructed carefully upon previous ideas. In 1986, Latour had argued that, as different actors define society in their own way, then non-social resources must be mobilised to enforce standard definitions if a stable society is to result. He saw this, in effect, as the same result as that obtained by Foucault (1977) when he dissolved the notion of a power held by the centre in favour of micro-powers diffused through the many technologies to discipline and keep in line. Latour expanded Foucault's notion to the many techniques employed in machines and the hard sciences that influence and control society.

After ANT

ANT as a sociology of science and technology may well have developed into a social theory. But this is to its advantage rather than its detriment as the current theoretical stance is grounded in the original concepts. The question is what happens next.

For Law (1999), "the desire for quick moves and quick solutions, the desire to know clearly what we are talking about, the desire to point and name, to turn what we now call ANT into 'a theory', all of these have done harm as well as good. 'Have theory, will travel'. Easy use of the term 'actor-network' has tended to defuse the tension originally and oxymoronically built into the expression. We have lost the capacity to comprehend complexity".

For Latour (1999), "should we limit ANT and tackle complexity and locality seriously and modestly? As with several of us, Law is somewhat terrified by the monster that we have begot. But once launched in this unplanned and uncharted experiment in collective philosophy, there is no way to retract and once again be modest. The only solution is to do what Victor Frankenstein did not do, that is, not to abandon the creature to its fate but continue all the way in developing its strange potential."

Perhaps Avgerou (2002) is right in contending that it is important not to see ANT as complete in itself and as a well-developed social theory with all its limits and delimitations – but as a theoretical position within the broader debate of the studies of the sociology of technology. Callon (1999) asserts, "we never claimed to create a theory. In ANT the T is too much. It is a gift from our colleagues. I fear our colleagues and their fascination for theory".

D3. Overall Conclusions About Actor-Network Theory and Development Informatics

This paper has argued that the successful implementation of e-government projects can make a contribution to development, particularly where the wider public value goals of public sector reform programmes, such as improvements in transparency and accountability, are being supported.

When questions arise about the success or failure of information systems projects then frameworks drawn from the literature on science and technology studies, such as ANT, can have a role to play. Specifically, this paper has made use of Law and Callon's theory of network analysis of technical change, based on the translation model of power, and has shown that it has a contribution to make in answering at least two types of research question:

- Is technology the major factor to be considered in the intended organisational change engendered by an information systems project?
- What can be done to strengthen the networks formed to design and implement information systems projects in developing countries?

It has been illustrated that technology is just one of a number of heterogeneous socio-technical elements that must be considered and managed in the design and implementation of a successful information systems project. Public sector information systems projects in developing countries funded by the IFIs pose a particular challenge in this regard and specific, culturally-sensitive solutions need to be identified at the design stage.

The contribution of the theory was demonstrated in relation to the story of the public finance reform programme in Sri Lanka and the resulting PEM information systems; an area that does have some particular features in its focus on transparency and accountability and its cultural setting. However, these features do not make any major difference to the applicability of the translation model of power, which has been used for the analysis of non-computer based information systems in other developing countries (e.g. Madon, 2004).

This paper has focused on the application of network analysis in information system design and implementation. This is only one element of ANT and the actor network perspective can be applied in various other ways to bring value to development informatics research: it can be used, for example, to analyse technology transfer between countries. It has potentially a wide area of application, which is summed up by Walsham (1997) when he acknowledges ANT as being "a promising theoretical vehicle for IS research". The challenge is now to produce useful research work in the field of development informatics that takes a comprehensive approach to ANT and is true to the theory.

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