

A FEDERATIVE VIEW FOR INFORMATION INFRASTRUCTURES IN DEVELOPING CONTEXTS

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Abstract: Large IT projects, usually managed by international organizations, often fail to get rooted in the variety of contexts they address. On the other hand, a frequent problem of local initiatives run by public administrations and NGOs is their fragmentation and lack of coordination. This paper aims at identifying a mid-range empirical area and a meso-level theoretical perspective in order to propose an infrastructural approach to IT-based efforts. Relying on studies of information infrastructure evolution, and experiences in fostering collaboration across a variety of IT based development efforts, we propose to practitioners and researchers to conceptualize existing systems as potential hubs of a possibly emerging information infrastructure, and suggestions to manage them accordingly. The proposed new step in that direction is the constitutions of ‘federation’ of socio-technical systems as a crystallization of ‘networks of action’. Selectively integrating running systems and coordinating existing organizations is a way to scale up while keeping the design locus as close as possible to where practical local knowledge is situated.

Keywords: Networks of action, information infrastructure, integration, socio-technical innovation, development, federation

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1. INTRODUCTION

For several years now, the idea of the “network society” has highlighted how the logic of networks has shaped contemporary world, with a specific emphasis on the role of IT. Large IT systems, here referred to as ‘information infrastructures’, are unevenly distributed and evolving. Organizational contexts have a central role in such unevenness. Such unbalanced situations are mostly evident in developing contexts - it is widely known that many approaches to implementing IT in developing contexts have been tried, some succeeded, and many failed to be sustainable. This paper proposes a view over ongoing successful projects as possible hubs of a broader infrastructure to be constituted by federating them, rather than as best practices to be replicated, as commonly suggested. Fragmentation of IT projects can be tackled, we suggest, by supporting coordination through the establishment of ‘federations’, in which technology has to be considered as a relevant actor.

We picked the term ‘federation’ from political science because it well expresses our proposal for agreements and shared power without constituting a unitary organization (as a state). Federalism combines autonomy for sub-central units with a central authority, whose power is constitutionally defined. This understanding of federalism resonates with the view we present about infrastructures as federations of existing information systems. Federations of socio-technical systems, we argue, can help in reducing the design/reality gap by linking locally rooted information systems with globally distributed information infrastructures, which do not depend on single transnational authorities. Integration of information systems, a crucial issue in information systems research, is conceived as part of federative efforts. Indeed, the purpose of this paper is to propose a view over ongoing successful IT projects as possible hubs of an information infrastructure. A central theme in the Information Infrastructure literature is how information technologies emerge and grow in use, in order to propose specific approaches for how appropriate applications can be adopted, scaled up, cultivated, sustained, and institutionalized over time. We aim at a contribution in this sense by considering the constitution of infrastructures as outcome of a federation of information systems, comprising both technical components (such as technologies and standards) and social and organizational elements (such as work practices, human resource issues, politics, as well as other institutional conditions).

The paper is organized as follows: first we problematize the issue of the ‘network society’ in developing contexts by bringing information infrastructures into the picture. Then, the design/reality gap is tackled both empirically (disconnection between plans and actual results) and theoretically (information infrastructures as possibly emergent). At this point, federations are proposed as a way to develop information infrastructures, avoiding the two opposite risks of grand projects (which fail in meeting local requirements, therefore in being used), and micro interventions (which hardly scale up). The federative approach is discussed in the final section.

NETWORKS AND INFRASTRUCTURES

A decade ago, Castells (1998), engaged by the United Nations Research Institute for Social Development Conference on Information Technologies and Social Development, wrote “The most critical distinction in this [network] organizational logic is to be or not to be — in the network. Be in the network, and you can share and, over time, increase your chances. Be out

of the network, or become switched off, and your chances vanish, since everything that counts is organized around a worldwide web of interacting networks.” The centrality of networks in the contemporary world is widely accepted, with their growth increasingly taking place not only geographically but also across disciplines and fields of activity (Benkler, 2006). Such networks do not emerge by and sustain themselves autonomously, they are in interplay (shaping and shaped) by information infrastructures, including organizational practices and institutions. The concept of information infrastructures contrasts with the traditional concept of information systems, which typically concerns independent or stand alone systems. IIs are large scale, complex, and networked technologies such as the Internet. Information infrastructures can improve dependability, quality of service, coherence, and affordability of services provided to people by supporting such networks.

An information infrastructure has been described as a “shared, evolving, heterogeneous, open and standardised installed base of IT-capabilities” (Hanseth and Lyytinen, 2004). Another widely accepted concept of information infrastructures comes from Bowker and Star (1999), who studied classification systems. The former view can help in pinpointing the heterogeneity of large information systems, and in conceptualizing them as in continuous interplay with other ones, and with their contexts. The latter, by focusing on classifications, intercepts a boundary between information management and interdisciplinary research. Both views on information infrastructures tend to contrast reductionist top-down approaches to integration and standardization by highlighting how infrastructures are the not-completely-planned outcome of long term evolution and contingencies. Integration efforts need to take this open-endedness into account.

In many developing countries social volatility and instability is accompanied by lack of capacity to make full use of the potential IT presents for development (Weber and Bussell 2005). Often, there is a mismatch between skills implied and required by IT, and those available locally. This reproduces the marginalization and exclusion that Castells warned about. IT projects in developing contexts suffer from both horizontal (local vs. global) and vertical (across initiatives) fragmentation. From a vertical view, IT projects are run by different organizations like local ministries, United Nations, World Health Organization, Organization for Economic Cooperation and Development, donors, national public agencies, non-governmental organizations, and consulting firms. These efforts are often uncoordinated, with the result that local organizations have to spend inordinate amounts of time and resources in dealing with separate –and sometimes conflictive- initiatives and actors. At the local level, poor focus on the development of expertise and tendencies of neglecting social and organizational issues are cited as major factors contributing to the problem of ineffective implementation of information systems. However, global implementation plans designed in presumably universally valid strategies also often prove problematic, as they easily clash with the large variety of contexts of implementation. From a horizontal view, we find fragmentation between IT programs. For many years, public administrations have become increasingly complex and dispersed, with programs operating as tightly controlled silos, resulting in an overall poor quality and ineffectual sharing of information, therefore lack of coordination.

Fostering coordination across IT programs, thus across organizations, also requires consideration of technological aspects, through inscribing cooperative tools, enabling information sharing and revising lines of accountability. We are aware that it is not a linear process because technology tends to freeze the contexts from which it originates, with the risk of obstructing its transfer. The dialectic between local specificities and global requirements, flexibility and standardization (Hanseth and Monteiro, 1997; Braa et al., 2007) is central in building information infrastructures. In order to find a balance between local specificity,

interoperability, and standardization (Rolland and Monteiro, 2002), open processes of continuous and long term negotiation are required. Engaging in “metadesign” to open up solution spaces, rather than offering complete solutions (Giaccardi and Fischer, 2008) is an interesting approach.

Our proposal has two starting points. The first is our participation, within a broad frame of action research, in a project which we refer to in this paper as Program for Health Information System (PHIS). This participation put us in contact with a wide variety of IT-projects in many developing contexts. The second is our participation in the Committee on Development Information (CODI) of the United Nations Economic Commission for Africa (UNECA) bi-annual meetings, which aim to provide technical and policy assistance to African nations to develop national geo-information infrastructures (NGII).

The PHIS network was initiated in 1994 as a health information project in South Africa, in collaboration with a Scandinavian university. From 2005, the European Commission funded this initiative by supporting the strengthening of collaboration links between the nodes of the network. These linkages consist in sharing experiences, skills, products, and processes between similar contexts. Indeed, the PHIS network comprises of international training programs and open source software development teams which have now expanded from South Africa to Ethiopia, India, Vietnam and other countries. Specifically, our involvement took place at all levels of PHIS activities, from global software development to local implementations in different countries, including capacity building initiatives.

The CODI conferences for national and supra-national geo-information infrastructures development in Africa was initiated in 1999 and has convened five times in bi-annual pan-African meetings. In contrast to PHIS, CODI conferences have produced documentary output (a series of documents and auxiliary reports) that discursively attempt to move Africa away from the deadlock of uncertain knowledge and contested values in NGII implementation, first by promoting implementation steps and later (when implementation steps failed to bear fruit) partnership with the prestigious national information and communication infrastructure (NICI) initiatives, thereby avoiding the design-reality gap empirically and theoretically.

3. Re-Framing the “Design – Reality Gap”

Much research examining the implementation of IT in developing contexts has reported on a wide range of cases where systems end up as total or partial failures. The gap between the design of information systems and use contexts has been found to be a key factor contributing to IT implementation failures (Heeks, 2006). Addressing these challenges is not merely a quest for increasingly sophisticated technical solutions, but an endeavor to identify and engage with approaches that take into consideration the complexity and heterogeneity of the socio-technical contexts that constitute and support information technologies.

Issues related to information systems integration are two-sided. On the one hand, they are about integration “out there”; about the complex interplay of datasets, protocols, standards, work practices, and institutional settings. The other side is about the “integration of our view” on such phenomena, which is fragmented in different theoretical traditions and disciplines. Our perspective on federating systems highlights the continuous redefinition of socio-technical arrangements. The “organizing” aspect is usually understudied, although crucial in understanding and managing the entangling of organizations and technology in integration efforts (Orlikowski, 2008). Therefore, we see organization as a possible result of successful integration, not its pre-requisite (Czarniwska, 2004).

A supranational sovereign authority, with the remit to regulate and coordinate IT-based efforts within and across countries, is unlikely to be established or even possible. At most, a supranational authority in Africa, such as the United Nations Economic Commission for Africa (UNECA) can play a role in helping build consensus around key African development challenges and in articulating common perspectives and positions, which then may form the basis for engagement with the international community. For instance, the UNECA has been instrumental in the inception of the African Information Society Initiative (AISI) and the implementation of NICIs with support from other United Nation agencies and bilateral donors. Lack of coordination leads to fragmentation and waste, as well as to unsustainable implementations, too weak to amass critical long term support. Therefore, the endorsement and development of transnational information infrastructures can only be bottom-up i.e. must find a basis through progressively federated ongoing projects. From such a starting point, our aim is to provide a framework to facilitate sustainability and scalability of a transnational information infrastructure. Concrete possibilities for coordination can be inscribed into the project guidelines and technologies. This paper presents an argument along this line by suggesting 'to infrastructure' ongoing IT projects.

Indeed, from a historical perspective, we can note that many infrastructures emerged through the integration of existing systems, with incremental standardization being a key element in their establishment. The scalability of infrastructures is not simply the outcome of interoperability and standards. Without considering organizational and political aspects of the actual contexts of implementation, integration of systems and scaling up of information infrastructures do not happen. This is the reason to call this process "federation", to avoid both technological reductionism and the tight technical coupling implied by "integration". Facilitation of interoperability among existing projects, as well as with new ones is our proposal for a first step in such direction.

Bowker (2000) argues that the integration of large datasets happens at the concrete level of database design as well as at the abstract one of negotiating relationships between disciplines, simultaneously. Therefore, the two faces of integration have to be contextualized (or "historicized") both as a guide for practical activities, and as a transdisciplinary research topic. On the political implications of categories and classifications, Suchman (1994), Star (1991) and Leuenberger (2007) respectively have explored the performative aspect of categorizations, the marginalization created by them, and the political relevance of their indirect enforcement. All these aspects are constitutive of both enacting and studying federations as means of growth of information infrastructures.

4. 'Infrastructuring' Needs a Federative Effort

Federating information systems to develop information infrastructure is a way to actively take into account legacy systems that not only represent inertia and obstacles for change, but also a tremendous resource, because they are part of existing activities and procedures. In other words, a globally scalable information infrastructure is of necessity "cosmopolitan", i.e. embedded in, and thus familiar with and at ease with a long range of organizational and societal cultures and settings.

Choosing appropriate integration strategies and technologies that balance needs for smooth information flow on the one hand, and stimulate and enable innovation, learning and improvement of organizational performance on the other, is crucial. Therefore, federation, rather than a late add-on option, should be seen as a first concern when considering the need for a new information system, incrementally leveraging existing infrastructural parts, re-arranging both technical and organizational pieces together, negotiating collaborations. Such

approach contrasts to a more traditional requirements engineering process of using established software libraries but otherwise more or less starting from scratch. It also runs fundamentally counter to the “not-invented-here syndrome”.

4.1. Networks of Action Crystallized in Federations

Various arguments have been raised by development studies to establish “South-South” collaborative networks. The sharing of resources can help the long-term sustainability of information systems implementations. It has been argued that it is important to develop “networks of action” within which groups and organizations in the South can share experiences and support each other in the effort to develop software that is matching with local requirements, sustainable on the long term, and globally scalable (Braa et al., 2004). Here we propose to consider how to crystallize such “networks of action” for the development of information infrastructures.

We encourage the revision of IT development strategies in order to conceive themselves as potential parts of larger networks, possibly included in or converging into a broader infrastructure. Design and implementations have to be organized accordingly: by thinking about ongoing information systems as dots to be connected for future information infrastructure. The base for our view lies in recognizing the importance of the “installed base”, of what is already in place and being done. Analytically, three layers of infrastructures can be identified, with relative issues – technical, organizational, and political:

Technical

At the basic level, this includes the technical artifacts involved, such as datasets, data warehouses, information flow schemes and protocols. Furthermore, it extends to technical processes and conceptualizations, i.e. software development and debugging procedures, architectural considerations, deployment platforms, programming tools.

Organizational

This includes both public sector institutions and private companies, facilities, procedures, responsibilities, as well as heterogeneity in the provision and access to information (often related conflicts of interest), and also the various levels of integration: syntactic, semantic, related responsibilities (Carlile, 2004). It also entails unintended side-effects such as increased complexity through coupling of previously separate elements.

Political

This pertains to local administrations, ministries, international organizations like UN, and importantly the range of powerful donors (USAID, Gates Foundation, World Bank etc). Political aspects include the re-ordering of relationships (re-distribution of burdens and benefits), and balancing (central) control versus (distributed) autonomy.

Furthermore, though it is useful to separate these issues analytically, they are closely intertwined from a practitioner point of view. For example, research on databases, human resource management, and IT governance refer to different disciplines, but these topics are hardly distinguishable in what people do on a daily basis, and in how technology changes and can be changed. Similarly, federations do not necessarily respect such an ordered analytical view. More likely, they cut across different levels. In order to account for this, research about federations needs to not only be interdisciplinary, but also reconsider assumptions about what

is empirically relevant, and how to approach the study. For instance, federating information systems for health monitoring and transnational health policy making requires the gradual dissolution of the current disjunction of disciplines (health informatics is also policy-making as a way of acting in the world, to paraphrase Bowker [2000]). So, services and applications impacting public health care (as other domains) need to be tied together to cross-fertilize each other; this is the reason for interoperability at the technical level (which includes the negotiation of definitions of standard protocols, tools, datasets etc.) and the establishment of coalitions at organizational and political levels.

Thus, instead of being seen as a monolithic system which regulates individual action, federative order comes to be seen as an upshot of concrete, communicative interaction, creating a broad meshwork to circulate and multiply innovations and dilute negative side effects. The establishment of an information infrastructure operates simultaneously at the concrete level of participatory design and implementation (e.g. fields in a database, capacity building, integration of datasets and organizational practice) and at a theoretical one (dealing with the relationships between information science, organization, and global software development, among others).

4.2. Co-evolution of Theory and Practice

Understanding which infrastructural elements can be translated into the heterogeneous public and private sector contexts in the South is a matter of development strategies. As it is a matter of federating existing and working IT projects, the possible nodes of an emerging infrastructure cannot be described 'a priori'. For instance, a teleradiology system can match well with an aggregated health data reporting system. Two databases about HIV and tuberculosis are difficult to integrate because they are based on different technologies and/or their administrators' responsibility lines diverge. This is why we claim that the federative attitude needs to be constitutive of IT efforts, rather than a later add-on: once self accountable systems are in place, it is difficult to change them in order to make them to contribute to new and broader functionalities, later. Indeed, creating, implementing, re-using information standards is difficult, expensive and often in partial conflict with the vested interests of some stakeholders.

As socio-technical federations can be used to affect -if not to manage- the installed base, we need to find a balance between the need to enable virtuous circles and avoiding the propagation of negative side effects across a growing network. Existing problems in particular systems should not propagate from the local to the infrastructural level, because risks will escalate as a consequence (Hanseth and Ciborra, 2007). Being more specific about the strategies for federating systems, we recommend a selective integration which identifies specific elements to integrate across systems and places. These strategies can be supported by focusing on the following incremental steps:

- Established initiatives should be documented to enable smooth handover
- Collaboratively and dynamically mapping and cataloging existing initiatives in developing countries
- The negotiation and provision of guidelines for those who are starting new initiatives, and want to avoid being locked out after some time in their activity development

- Actively fostering coordination of organizational and technical matters
- Facilitating the federation of complementary technologies and initiatives
- Establishing mixed public-private transnational consortia
- Aiming at an independent and authoritative forum for socio-technical negotiations

Such steps do not promise results in the short term, but constitute the base for long term efforts to be effective. In practical terms, this means that the initial hubs of emergent information infrastructures are likely to be found among ongoing initiatives on the ground: established projects -if connected as dots of an infrastructure- have already gone through the critical bootstrapping phase (Aanestad and Hanseth, 2003). Thus, ongoing IT efforts are the privileged loci of design, but interoperability needs to become a priority. Therefore we recommend building on top of what is already there, as this strategy re-orders and orients existing and other resources, does not clash with the local “installed bases”, is more likely to meet local needs, and allows the coordination of fragmented initiatives, improving results and saving resources.

4.3. Federations between Markets and Bureaucracies

Unlike the “one size fits all” innovation approach, the federating approach is flexible because it facilitates modular alliances. So, a federating approach helps scalability and requires active management of growth, balancing the tension between standardization and flexibility through gateways (Hanseth, 2001) and flexible standardizations (Braa et al., 2007). Thus, it implies a mid-long term view and support which goes beyond current fragmentation. Scaling up needs to address both “the what” and “the how” (Sahay and Walsham, 2006; Braa et al., 2006).

The complexity which emerges from the interplay within and between the previously introduced levels of federation suggests to position federations between the two ideal-typical poles of organized relations: market and bureaucracy, which can never be found in their pure forms.

	Bureaucracy	Market	Federalism
Achilles Heel	misplaced trust in authority and expertise coupled with high mobilization capacity	tendency to put self interest before collective interest	multiple accountabilities (what is right the procedure or the customers requirements?)
Is vulnerable to	dramatic collapse of ambitious think tank projects	failures stemming from lack of cooperation or individual corruption	propagation of side-effects
Stresses	expertise, forecasting, and management	individuals as self interested rational choosers	negotiations and consensus building
Blames	poor compliance with established procedures, lack of professional	faulty incentive structures through over collectivization	internal conflicts and slow implementation of decisions of public

	expertise	and lack of price signals	interest
Remedies	more expertise, tighter procedures, greater managerial 'grip'	market like mechanisms, competitions and leagues, information to support choice	appeal level
Watchwords	steering	self-interest	alliances

In the table above, the first two columns come from Christopher Hood (1998), who adapted them from Douglas and Wildavsky (1982), the third has been added by the authors. It presents the characteristics of federations in contrast to other organizational principles. Below we propose a list of federations which are classified along three infrastructural characteristics: accreditation (granting access), coalition (managing gateways), and standards. These three dimensions help in explaining the tension between flexibility and stability in federations.

Infrastructural Level	Ideal – Type (Top-down and bottom-up)	Characteristics	Examples
	Regulatory body/Authorities	Centralized, independent body	EU – 7 th Framework Programme Value Management Model
	Peer production	Community, distributed acceptance (like gift economy, or 'potluck', where status and legitimation are crucial) ¹	Wikipedia, FOSS, Geoserver, Mondrian
Coalition (gateways)	Joint ventures	Merging of organizational sub-parts for a negotiated task	WHO OpenHealth
	Networks of Action	Scaling of dispersed collaboration	PHIS
Standard	Franchising	Autonomy within the frame of controlling organization	Linux Standard Base, HMN, NHRM
	Sector Association	Body for negotiation and representation of interests	WITFOR WSIS IFIP 9.4 W3C ICANN

5. CONCLUSION

Relying on studies of information infrastructure evolution, and experiences in fostering collaboration across a variety of IT based development efforts, we propose to practitioners

1 Also refer to Ghosh (1998)

and researchers to conceptualize existing systems as potential hubs of an emerging information infrastructure, and to manage them accordingly: selectively federating running systems and existing organizational patterns is a way to move the design locus closer to where practical local knowledge is situated, and build on that basis. That is why we find a federative approach relevant to understand, design and implement information systems in developing contexts (and beyond).

To deliver sustainable benefits over their lifetime, infrastructures need to enable processes of experimentation, discovery and invention through trial and error. In coherence with our theoretical framework, technical and organizational aspects have to be considered at the same time for the establishment and maintenance of new networked and collaborative courses of activities. More precisely, the interplay between technology, work practices and organizational contexts within which such processes are expected to take place, makes these phenomena complex to understand, and to manage. So, analytical dimensions like layers (technical, organizational, political) and market-bureaucracy tension (in terms of accreditation, coalition, standardization) are proposed to conceptualize federations in a way which is accountable both to local needs, and scaling up requirements.

In her critical review of the contemporary literature about information systems in developing contexts, Avgerou (2007) identifies three discourses: 1) transfer and diffusion, 2) social embeddedness and 3) transformative. The third is rooted in the second, and both differ from the first, because they conceive target contexts not as passive recipients of IT, but as parties in the evolution of innovations. In Avgerou's view, the main difference between the last two discourses is that for "social embeddedness", information systems are locally constructed, whereas the "transformative discourse is explicitly concerned with the way IT is implicated in the dynamic of their change [of social, economic, and political relations in a developing country or the world at large]." (idem p.8). Avgerou states that the social embeddedness discourse is sensitive to local dynamics and situated meanings and actions. The transformative discourse introduces new elements beyond organizations and interorganizational links: institutions (intended as broad social models) implying power relations beyond specific organizational settings. Thus, the transformative discourse intercepts an empirical area situated at the meso-level, between global initiatives and discourses, and emphasis on specific implementations. At this level, we see a possible development of the "Networks of Action" strategy (Braa et al., 2004), to conceptualize and conduct each intervention as but one element in a larger network of action. The crystallization of that "infrastructuring" is seen metaphorically as 'snowflakes' by Staring and Titlestad (2008).

This strategy also requires substantial investment. Still, many of the building blocks of such an infrastructure can be taken from the frameworks underlying ongoing successful projects. In this way, rather than each project remaining isolated and autarchic, and thus fragile, federations of projects can be more sustainable, though they require the ceding of some control in the process of federating. By delegating common functionalities to an open or federatively managed infrastructure, each project gains the benefit of resources created by others, and at the same time is freed from shouldering the full cost of maintaining its own technological and informational platform (Nielsen and Aanestad 2005). Therefore, by creating loose or tight federations and pooling their elements, projects may be able to bootstrap an infrastructure.

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