

CONTEXTUALIZING ICT FOR SUSTAINABLE DEVELOPMENT: AN INSTITUTIONAL ACCOUNT OF THE AMAZON RAINFOREST MONITORING SYSTEM

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Abstract: This paper provides an analysis of the relationship between ICT artifacts and institutions in the context of the millennium development goals (MDG) for sustainable development. Based on Fligstein's (1990) idea of 'conceptions of control' (broad managerial paradigms) and on primary and secondary empirical data pertaining to the history of the governance of the Brazilian Amazon region and the role of the Brazilian Amazon monitoring systems, this paper argues that: (1) the process of institutional change (shifting of conceptions of control) is conflictual, emergent and contested; (2) the design and use of ICT artifacts tend to reflect the local dominant conceptions of control; (3) that ICT artifacts that emerge within a specific conception of control can be reconfigured to serve the interests of other conceptions of control over time. The paper concludes that it is essential to attain the spatial and temporal dimensions of ICT in order to understand how the local institutional forces shape the development and use of ICT in relation to the MDG. In this way, it might be possible to understand not only whether an ICT contributes to the MDG or not, but also why it is the case, and which social dimensions could help or hinder the future use of ICT for those aims.

Keywords: neoinstitutional theory, conceptions of control, millennium development goals, geographic information systems, environmentalism, Amazon rainforest

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1 INTRODUCTION

In September 2000, the 189 member states of the United Nations signed the United Nations Millennium Declaration. One of the most important parts of the declaration was the Millennium Development Goals (MDG), an eight-goal action-plan that the international community agreed to carry out in order to improve the life of humankind. These goals included the reduction of extreme poverty, combating aids and ensuring environmental sustainability. Different studies point out that information and communication technologies (ICT) could play an important role in helping countries develop and by doing so, contribute to the achievement of the MDG (e.g. Batchelor et al., 2003; Madon, 2005). Nevertheless, the overwhelming cases of failure of ICT projects in developing countries suggests that the challenges ahead are as daunting as the potential benefits (Baark & Heeks, 1999; Walsham & Sahay, 1999).

One of the main results emerging from the literature that reports on the possibilities of ICTs in developing countries has been the centrality of social and cultural dimensions in the success and failure of ICT projects (Avgerou & Walsham, 2001; Barrett, Sahay, & Walsham, 2001). Walsham and Sahay (1999), for example, showed that geographic information systems contain a series of “western” values embedded in them (e.g. use of maps to represent the territory), which may contrast with those values held across different developing countries. Studies such as this suggest that in order to increase the chances of success of ICT projects in developing countries, stakeholders ‘must improve their capacity to address specific contextual characteristics of the organisation, sector, country or region within which their work is located’ (Avgerou & Walsham, 2001: 2). Thus this literature has pointed to the importance of understanding the spatial dimension of development.

However, far fewer studies have also sufficiently attended to temporal dimension of ICT in developing countries (for exceptions see Madon & Sahay, 2001; Sahay, 1997; Walsham & Sahay, 1999). This study seeks to contribute to this limited literature by drawing upon neoinstitutional theory to inform our analysis of the case of the introduction and development of the Amazon monitoring system¹ over the last four decades. Our case will reveal that the differing uses of this ICT application can be explained by considering the ways in which the differing institutional values become

¹ Today the family of governmental monitoring systems of the Amazon rainforest are developed and maintained by INPE (Brazilian Institute for Space Research), the OEMAs (state-level organs for environment, such as SEMA from Mato Grosso), IBAMA (federal environmental protection agency) and SIPAM (system for the protection of the Amazon). Despite the number of actors and individual systems, it reasonable to reefer to this set of ICT applications as a single “Amazon monitoring system” given the fact that all systems are related in different regards to INPE’s PRODES (which maintains the leadership in the area) and draw upon the same raw data (Landsat, CBERS and MODIS satellite images).

dominant over time. In this context, we will argue that evaluating the Amazon monitoring system solely in relation to the goals of sustainable development as understood today in the developed countries would be a mistake, since this view implies an ahistorical or even a naïve understanding of ICT in developing countries. Furthermore, our paper will argue that the relationship between ICT and institutions should be conceptualized as conflictual, emergent and dialectical (Hayes, 2008), and further, that literature on institutional literature needs to better attend to the emergent and conflictual practices that shape and are shaped by information technology.

This paper is organized as follows. The next part provides the theoretical base of this paper and briefly reviews the information systems literature in this area. The third section outlines our methodological stance. The fourth section presents the empirical base of this article. This is followed by a discussion and conclusion where we discuss the case with regard to the relationship between ICT artifacts, their institutional context and the millennium development goals.

2 INSTITUTIONAL THEORY

Neoinstitutional theory in organizations emerged in the late 1970's and 1980's in response to a growing disenchantment with the explanatory power of traditional economic and rational administration theories underling many articles in literature at the time (Barley & Tolbert, 1997). Generally speaking, new institutionalism defines institutions as widely shared norms, rules and interpretive structures 'that constitute the nature of reality and the frames through which meaning is made' (Scott, 1995: 40).

Neil Fligstein (1990) offers a strong institutional analysis that presents clearly both a focus on the cognitive dimension of institutions and its identification as a phenomenon present at a broader social level that characterizes much of the neoinstitutionalism in organizations. His analysis, like DiMaggio and Powell's (1983), challenges the mainstream evolutionary economic theory that believes that the U.S. naturally created technological efficient firms by managing them according to an universal extemporal rationality. Fligstein shows through a longitudinal study of North American corporate history that USA's biggest companies have taken their current shape mainly due to a succession of dominant conceptions of control. Conceptions of control are institutionalized widespread 'totalizing world views that cause actors to interpret every situation from a given perspective' (1990: 10). They 'operate both as cultural templates for structuring new actions (i.e., what behavior make sense) and a set of structures limiting the possibilities of action (i.e., what others are doing, thereby structuring what reactions are possible)' (Fligstein & Brantley, 1992: 287). Conceptions of control can be understood as a sort of institutional logic since they provide 'sets of "material" practices and symbolic constructions' to individuals so as to make sense of their environment (Friedland & Alford, 1991: 248). However, while institutional logics provide the 'cognitive maps' to activities that range from bureaucracy to religion, conceptions of control are mostly related to managerial practices since they emerge from the need of individuals and organizations to control their environments. Examples of conceptions of control include the manufacturing conception that sees the organization as an engine that

must transform raw materials into finished products in the most efficient way, to the more recent financial conception, that sees organizations as a portfolio of assets that must obtain the highest return on investment.

The growing information systems literature that draws on ideas from neoinstitutional theory suggests that institutions interact with ICT artifacts mainly in two ways: (1) local institutional arrangements influence success/failure of ICT projects (2) the institutional field shapes the design and use of ICT in organizations.

First, different authors point out that the broader institutional context plays a key role in the establishment (or institutionalization) of ICT innovations. King et al. (1994) initially suggested that institutions, understood mainly in terms of early institutional theory (e.g. influential organizations such as government, professional associations and universities) can influence the success or failure of IT innovations. Later Swanson and Ramiller (1997), drawing on the neoinstitutional theory, propose that specific organizing visions (community-wide idea for the use of specific of ICT applications) are the main enabler of successful innovations. Building on this concept Currie (2004) analyzed the case of Application Services Provisioning (ASP), a business and technological model that delivers software over wide networks and argued that it was not established as originally conceived largely due to the incapacity of its supporters to generate a coherent community-wide organizing vision. Closer to the focus of this study, Humes and Reinhard (2007) emphasizes the role of coercive power in the institutionalization process of a public financial system in Brazil.

The second line of studies argue that the impact of ICT in organizations is not deterministic, but depends on specific institutional arrangements present at the organization prior to the introduction of new technologies such as values, roles and patterns of interaction (Avgerou, 2000; Barley & Tolbert, 1997; Currie & Guah, 2007; Fountain, 2001; Noir & Walsham, 2007; Orlikowski & Robey, 1991).

Even though neoinstitutional theory has been gaining an increasing number of supporters in the last few years, different authors point out to important limitations to the theory for the study of ICT in organizations (for a review see Yang, 2003). Lawson (2003) complains about the disappearance of the individual behaviour effect from the institutionalist framework, while Blackler and Regan (2006) argues that neoinstitutional theory downplays the role of conflicts, emergence and false starts in the process of institutional change. Hasselbladh and Kallinikos (2000) are even more acute in their critique, and affirm that the current mainstream version of the theory is 'too idealistic and broad to direct empirical research', and as such it 'needs to abandon the bird's eye view of the field, and come closer to the social and cognitive means and procedures underlying rationalized beliefs and schemes of action' (700).

Given the broad and longitudinal nature of this research it was not possible to abandon the view from above and to give due attention to the role of individual agency in the process of institutional change. Nevertheless, this study has drawn heavily in Blackler and Regan's (2006) concerns and has privileged theoretically the role of concurrent and

conflict conceptions of control. At the same time, by following Hasselbladh and Kallinikos (2000) this study has paid close attention to the ideals (e.g. broad intentions), discourses (e.g. norms and laws) and techniques of control (e.g. official statistics) concerning the development and use of the Amazon monitoring system during the data collection phase of this research.

3 RESEARCH METHODOLOGY

The case study that forms the empirical base of this article concerns the history of the Amazon monitoring system, a family of satellite-based remote sensing systems used by the Brazilian government to estimate deforestation rates in the Amazon rainforest. The primary data consists of sixteen interviews held between June and August 2007, in three different Brazilian states. The informants were thirteen government officers, two members from non-governmental organizations (NGOs) and one entrepreneur with business activities in the Amazon region. The government officers interviewed are individuals directly involved in the development and use of the Amazon monitoring system and the creation of the country's environmental policy, including two ex Ministers of the Environment, three congressmen, an influential scientist member of the IPCC (Intergovernmental Panel on Climate Change) and directors of different environmental and research bodies. Nine interviews were tape recorded and then transcribed and translated in English. In the other seven interviews the author judged more appropriate to take extensive notes and then, just after the encounter, reconstruct as accurately as possible the full conversation while translating it in English.

Secondary data sources have also played a key role for allowing the historical reconstruction of the case study and to offer initial topics to be discussed in detail during the interviews. These data sources include the Brazilian law, newspaper archives, reports from governmental agencies and NGOs, technical documentation concerning the Amazon monitoring system and academic papers about the economical, political and environmental history of the Amazon. The primary and secondary data was then analyzed using an interpretive stance in order to identify recurrent themes and shared interpretations of the Amazon rainforest and the role of the monitoring system (Walsham, 1993).

4 AN INSTITUTIONAL TALE OF THE JUNGLE

Based on the identification in the primary and secondary data of three main recurrent ways of interpreting the Amazon rainforest and the monitoring system, we argue that in the period under analysis (1964-2007) the Brazilian government has managed the Amazon region from three different conceptions (see Table 1). As we will see below, the trajectory of the Amazon monitoring system has been shaped by these three alternate and sometimes contradictory conceptions of control. The military conception of control represents the worldview usually held by the armed forces, and sees the nation as a territory that must be defended from all kinds of threats to its economical, political and territorial independence (see Page & Redclift, 2002).

Conception of control	Ideal	Aims
Military	An independent and strong nation-state	Protect the Amazonian region against threats to its economic and political sovereignty
Economic	A wealthy and prosperous Amazonian region	Develop the Amazonian region by expanding and modernizing its economy
Ecological	A sustainable and risk-free society	Preserve the Amazonian environment

Table 1 Ideals and focuses of the military, economic and ecological conceptions of control

The economic conception of control in general terms is concerned with the economic growth of the country, as defined by the achievement of certain numeric indicators (e.g. GDP, per capita income and budget surplus). The economic conception of control is closely related to the notion of developmentalism, namely, a set of ideologies that ‘regard development in the sense of economic growth and institutional modernization as a good in itself’ without questioning the fact that those models of modernity are a product of developed nations and that they often collaborate to the perpetuation of post-colonial forms of domination (Berger, Berger, & Kellner, 1974: 183; Escobar, 1988).

Finally, the ecological conception of control is primarily concerned with the long-term sustainability of human life on Earth. While the economic conception of control ‘downplay[s] discontinuities and crises, especially in the ecological arena’, the ecological conception recognizes the impact that human activities have on the environment and perceive risks – hazards generated by modernization – as management’s core problem (Shrivastava, 1995a: 119). According to this conception of control, the government should preserve the environment by adopting ‘ecologically sustainable organizational designs and practices’ (*ibid*: 127).

This section presents the case study from a neoinstitutional perspective, analyzing the evolution the Amazonian policy of the emergence of the Amazon monitoring in terms of these three conceptions of control. The analysis of the implications of the case study for the understanding of ICT and institutions more specifically will be left for the discussion section. For analytical clarity the discussion below separates the history of the Amazon in relation to three major events: the military coup d’état in 1964, the creation of the new democratic constitution in 1988, and the year 2001 in which the Amazon monitoring system has showed for the first time some effectiveness in reducing deforestation.

4.1 The birth of the Amazon monitoring system

Most of the Amazon forest is under the sovereignty of Brazil, and the “Legal Amazon”² by its turn, covers nearly half of the country’s territory. The region has gigantic

² Legal Amazon (Amazônia Legal) is the socio-geographic division established by the Brazilian government to indicate Amazon rainforest and areas of transition. It includes all seven states of the North Region (Acre, Amazonas, Amapá, Pará, Rondônia, Roraima and Tocantins), as well as Mato Grosso state

proportion: the area is 26 times bigger than England and nearly the size of the European Union. Until the 1960's the region was barely untouched, but following a military coup d'état in 1964 the region became a major priority for the government. During that period the government became increasingly concerned with the military security of the Amazon. At the time the government feared that American expansionist policy and the world's demographic growth might have led to the loss of sovereignty over the region (Reis, 1965). In order to fill the region's "demographic empty" (the main source of vulnerability) the government started a major internal colonization project that provides subsidies for agricultural activities – a set of measures that has initiated a process of large scale deforestation that continues to the present (Fearnside, 2005). This view has echoed clearly in the interview of a congresswoman from one of the Amazonian states:

During the 1970's the idea was to occupy and develop the region at any cost because of the imminent threat of the U.S to get the area. It was the period of the 'Mata por Pata' [trans. replacement of forest by cattle ...]

Parallel to the colonization of the Amazon the government has also started investing in satellite and airborne remote-sensing technology, becoming one of the pioneers in this technology (Biache, 1983). Different interviews state that the reason for this expenditure was twofold. First, there was the economic need to know more about the country's continental territory and to verify if the subsidies to convert the forest into 'productive land' were giving the expected results, instead of being drained out by illegal schemes. 'The SUDAM [Agency for the Development of the Amazon] wanted to know if all fiscal incentives were really being used to cut down trees' explains a senior scientist from INPE, the Brazilian space research institute. Second, the data provided by satellites was seen as crucial in the government's effort to maintain the sovereignty over the Amazon.

Towards the end of the Cold War the attention of the international community shifted from military to ecological concerns. And Brazil, that was in a process of transition from the military to the civil regimes suddenly found itself as global environmental villain due to its policy towards the Amazon. At first the Brazilian government resisted the international pressures. For instance, the country refused to participate in the International Environmental Conference where the preservation of the Amazon was one of the topics, on the grounds that the discussion of how Brazil manages its territory represents an attack on the country's sovereignty (McCleary, 1991). However, around 1988 pressures from high-profile members of the international community (including cuts of loans from the World Bank) and national social groups such as the rubber tappers' movement led by Chico Mendes (which was assassinated that year) forced the Brazilian government to review its policy towards the Amazon and adopt stricter environmental regulations (Espach, 2002; Kolk, 1998).

As part of the new environmental policy, the government created PRODES (Program for Calculating Amazon's deforestation), the first monitoring system to regularly provide data concerning the extent of deforestation in the Amazon region. Indeed, Brazil stills the

in the Center-West Region and most of Maranhão state in the Northeast Region. The Legal Amazon includes 59% of the Brazilian territory.

only country in the tropics to regularly provide reliable statistics about its forest coverage, even though Indonesian government have started developing a similar system (Fuller, 2006; World Bank, 2006). Based on the comparison of the most recent forest coverage as shown in the satellite images, with images from previous years, PRODES calculates through statistical techniques an estimate of the deforestation rate for that year (how much rainforest has been lost in km²) divided by state (see Figure 1).

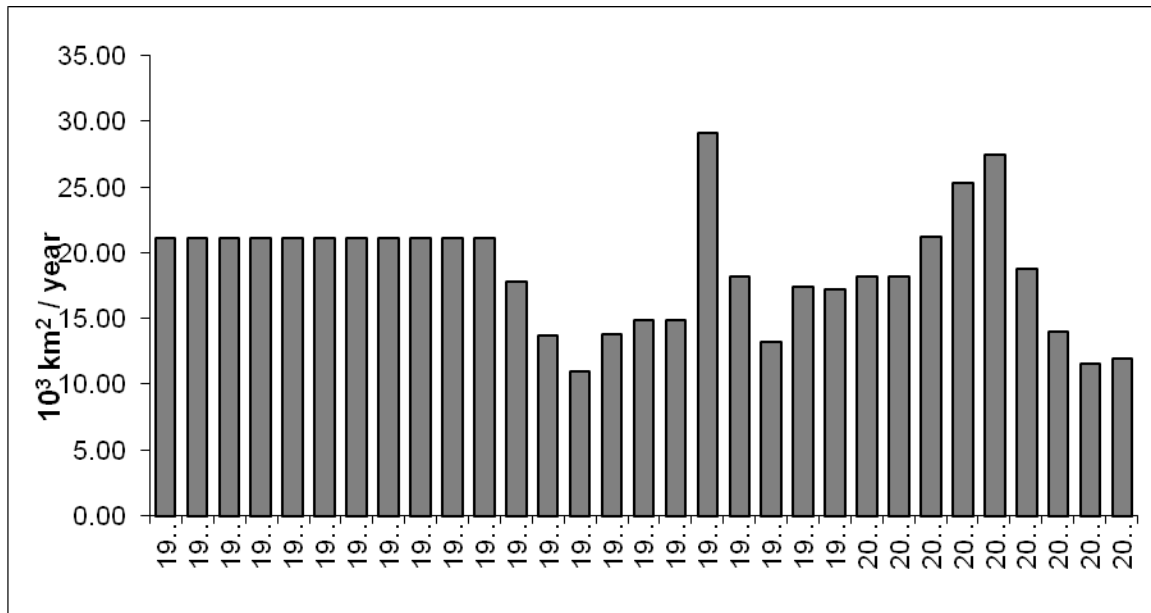


Figure 1 Deforestation rates of the Brazilian Amazon rainforest between 1978 and 2006 calculated using the Amazon monitoring system (Sources: Fearnside, 2005; INPE 2008).

Despite the official ‘greening’ of the Brazilian government, accounts from different interviewees and secondary data showing high deforestation rates during the 1990’s (see Figure 1) suggest that the change in the official discourse during the end of the 1980’s did not represent any significant change in the way the Brazilian government has seen and managed the Amazon rainforest. Indeed, a closer look at the meaning that some top Brazilian politicians give to the ‘environmental friendly’ actions describe above suggests that the decision to change the environmental law and to create the Amazon monitoring system was mainly an attempt to convince the international community that the Brazilian government had the right attitude towards the Amazon. When asked about the motivations behind the creation of IBAMA (the federal environmental agency) and PRODES, the Amazon’s most important monitoring system, a congressman and ex top member of the executive pointed out in an informal conversation that:

During the 1980’s the international community was concerned with the Amazon. I created the IBAMA by putting together different pre-existing bodies as an answer to this pressure. As a way to prove that we have the competence to manage the Amazon. The use of satellite images to monitor deforestation started under my government. [...] The

idea with this move was again to demonstrate to the international community our preoccupation with the environment.

The above suggests that around 1988 emerged a discourse (new environmental laws, and a constitution) and a technological artifact (PRODES) in clearly line with the ecological conception of control. However, despite the superficial alignment of the new laws and this ICT artifact with the ecological conception of control, the meaning attribute to it and the actual organizational outcomes (e.g. high deforestation) suggest that the Amazon monitoring system and the environmental laws were actually resources for the military conception of control aiming at reducing international pressure. Furthermore, judging by the continuation of many agricultural subsidies inherited from the military era and the continuous expansion of agriculture in the region it is possible to conclude that the economic conception of control (characteristic in the first uses of remote sensing in Brazil) was also present at full strength.

4.2 The ‘greening’ of the Brazilian government

After years of false starts and the dominance of the military there is indication of change the Brazilian government towards the ecological conception of control. In other words, the government seems to have started devising its policy towards the Amazon region aiming, amongst other things, at the actual environmental protection of the rainforest and the sustainable development of the region. Evidence of the rise of the ecological conception can be found in different places. For example, in 2007 the government proposed the creation of a new international fund to exchange avoided greenhouse emissions from deforestation for financial help. This action is particularly relevant because it indicates at the same time the strengthening of the ecological conception and the weakening of the military conception of control, since Brazil had so far always refused any mechanism linking international money to the preservation of the Amazon on the basis that this represents a threat to the country’s sovereignty. Most importantly, the notion that the Amazon rainforest should be preserved seemed to be taken-for-granted for all interviewees.

During the same period the arrival of a new generation of monitoring systems suggest that this family of ICT artifacts has been transformed from a resource of the military conception of control to one of the main tools to control deforestation. Different interviewees explained to us that, unlike PRODES that provides only yearly data, this new generation of monitoring system that includes DETER, SLAPR and SisCom is able to detect within 15 days new clearings in the Amazon rainforest and relate this data with the land registry, which allows the environmental protection bodies to intervene while illegal operations still under way and prosecute environmental crimes (Fearnside, 2003). As a consequence, different officials pointed out that the Amazon monitoring system has played a key role in the drastic drop in deforestation rates between 2004-2007 (see Figure 1). A Brazilian top scientist at a governmental research institute and member of United Nations Intergovernmental Panel on Climate Change (IPCCI) explained to us:

Today we can say that the tools we [INPE] have developed are the main environmental management tools for the [Brazilian] government. Thanks to this

constant monitoring of the Amazon that the public organs are able to act, so it has an essential role. Furthermore, a share of the reduction in deforestation is thanks the existence of those [monitoring] systems. It is true that if you don't have political willingness, you don't go anywhere. However, also without this monitoring system the illegal activities can go on and nobody will even know about it, or maybe know only afterwards [when it is too late].

Further still, a new use for the Amazon monitoring system closer to the economic conception of control is taking shape. The Amazon Fund, proposed by the government in 2007 and created in 2008 with a donation of \$300 million from Norway (with promises of donate up to \$1 billion in the following years), was only possible once the Brazilian government committed itself to reducing deforestation. Further current negotiations in the United Nations are seeking to link carbon credits with the avoidance of deforestation or REDD (reduced emissions from deforestation and degradation) in the global carbon credit market. In both cases, the Amazon monitoring system is due to become a tool to calculate carbon credits to Brazil based on the detected deforestation in the Amazon. This suggests the formation of a synergetic relation between the economic and the ecologic conceptions of control.

However, the strengthening of the ecological conception of control within the Brazilian government and the weakening of the military conception is not a smooth process, as it might seem in a first look, but the outcome of a process that involves the steady contestation from the military and the economic conceptions of control. First, the recent clashes between the government and the military over the creation of the indigenous reserve Raposa do Sol, near the country's borders shows that the institutional supporters of the military conception of control are reluctant to give up. According to environmental NGOs the surge in deforestation rates in the second half of 2007 (after three years of steady decline) was due to the increase in the price of soy beans and other agricultural commodities and the lack of capacity or political will of certain sectors of the government to counterbalance this market force. Furthermore, different officers suggested that the economic aspect of preservation hinders the full deployment of the ecological conception of control. A senior representative of the ministry of the Environment explains the issue:

The problem is that in order to adopt an environmental model the country will suffer an economical loss. Today half of the wealthy produced by the country comes from primary products which have environmental impact. The rich countries on the other hand do not want to answer if they want to pay the bill.

This suggests that even though the ecological conception of control has gained considerable force in the last ten years, it is inextricably interlinked with the economic conception of control and with a diminishing but still present military conception of control.

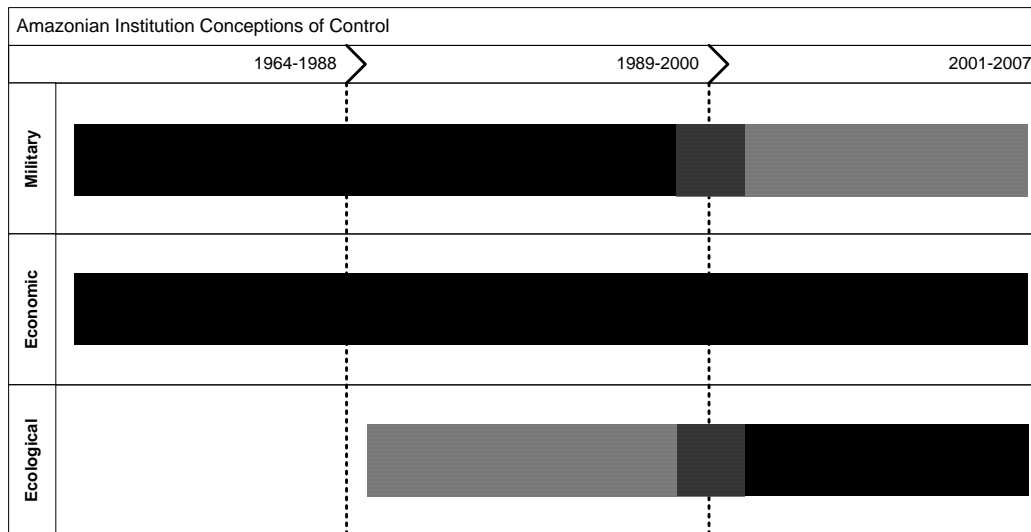


Figure 2 The different conceptions of control within the Brazilian government between 1964-2007

In summary, the institutional account of the history of the Amazon monitoring can be understood as a competition between different conceptions of control. At each period of the history of the Amazon, the three conceptions - military, developmental and environmental - were able to influence the meaning and use of the monitoring system with different levels of intensity. While the economic conception of control remained at full strength during the entire period under analysis, it was possible to verify the emergence of the ecologic and the recession of the military conceptions of control during the 1990's. Having presented the case from the lenses of institutional case, the next section discusses the implications of this analysis for the study of ICT in relation to the millennium development goals in developing countries.

5 DISCUSSION AND CONCLUSION

This discussion section argues that in order to evaluate ICTs in relation to the millennium development goals it is important to consider the historical trajectory of the broader macro societal context (Barley & Tolbert, 1997). Indeed understanding the relationship between the global and local context has been a concern for many eminent IS scholars for some time (Walsham, 2001). We draw primarily on Fligstein's (1990, 2001) work to understand the Amazonian monitoring system shifting trajectory of meaning and use, first as a legitimating symbol for militaristic purposes, and later as an environmental monitoring system in line with the MDG for the sustainable development. To do this we consider how broad institutional fields may shape and change the ways in which the Amazonian monitoring system was conceived of and framed, and the characteristics of this process.

Institutional change

In order to understand the history of the Amazon's monitoring system social context it is also necessary to understand how the different conceptions of control emerge and recede. Our case also highlights how dominant conceptions of control can become destabilized

when moments of crisis arise. Fligstein (1990) argues that moments of crisis offer an important opportunity for the rise of new conceptions of control. These are the moments in which ‘major groups are having difficulty reproducing their privilege as the rules that have governed interaction are no longer working’, the institutional fabric tears up and institutional change can happen (Fligstein, 2001: 118). During the end of the 1980’s and beginning of the 1990’s Brazil has faced two political crisis that are connected to changes in the Amazon monitoring system. First, during the end of the 1980’s the international pressure for the preservation of the Amazon rainforest culminated in cuts of international credit to major development projects located in the Amazon rainforest. This financial crisis forced the government to stop ignoring international preservationists pressures and to change its official environmental policy, a move that even though did not have immediate effects paved the way for further institutional change (a process that could also be understood in as the consequence of a coercive isomorphism from the rich countries (DiMaggio & Powell, 1983). Second, over the same period the military dictatorship went in crisis leading to a political transition from the military rule to a civil government aligned to the military (1985-1990), and finally to a government clearly distanced from the dictatorship (from 1990). At broader level, with the fall of the Berlin Wall and the official end of the Cold War the regional political instability was not as great during the 1990s as it had been previously. The new internal and the external political dynamics meant that the rationale for the monitoring system being in place to defend Brazil’s sovereignty over the Amazon was not strong enough to sustain this particular use. During that period Brazil was also marked by an institutional transformation that is outside Fligstein’s theory. Different interviewers pointed out that the Brazilian society (and consequently its government) become increasingly aware of the importance of their natural environment, and the risks of its destruction could bring to our health and quality of live. It is possible to identify a endogenous and a exogenous factor behind the strengthening of the ecologic conception of control. First, Brazil’s further urbanization and industrialization, could have led to the emergence of a risk averse society as described by the sociologist Ulrich Beck (1992). Second, it is possible to interpret Brazil’s ‘greening’ a the consequence of a north-south institutional isomorphism (DiMaggio & Powell, 1983), a phenomenon already extensively described in other terms in the development literature (Adams, 2003; Banerjee, 2003; Escobar, 1988). As a consequence of these processes and despite its false starts and obstacles, today the Brazilian government sees the Amazon rainforest mainly as a national treasure that must be preserved, even though governmental practices towards the region are not always coherent with this view. Nevertheless, this conception is quite different to the view prevalent in the 1970s and much of the 1980s when it was conceived of as a green desert, an unproductive land covered with rainforest that must cleared to give way to the country’s development.

Institutionalization as a longitudinal process

Similar to Fligstein’s (1990) account of USA corporate history in the last century, the Brazilian government has also been dominated by a succession of different conceptions of control in the last four decades. In this context, the notion of conception of control has allowed us to understand why organizations such as the Brazilian government or a major US corporation have adopted certain practices that might seem absurd by today’s

standard, such as subsidizing large scale deforestation of the ‘world’s lungs’ and adopting predatory pricing to push competitors out of the market, respectively.

The case study of the Amazon monitoring system also contains empirical findings that extend Fligstein’s (1990) notion of conception of control. While Fligstein (1990) suggests that a certain institutional field is usually dominated by a single major conception of control, our case has shown that two conceptions of control can coexist in symbiosis or conflict for significant periods of time. This was evident in the synergy between the pressures for military sovereign control and economic development that framed the colonization of the region during the 1970’s, as well in the current conflict between the military and the ecologic conceptions of control over the indigenous reserve Raposa Serra do Sol. Currently such contestation is most evident with regard to the competition for dominance between the ecological and the economic conceptions of control. While the idea that the Amazon should be preserved is taken-for-granted, the actual governmental practices towards the Amazon are still an arena of contestation between the economic and the ecological conceptions of control. This is in constant negotiation and as such the trajectory of conceptions of control are best viewed as being emergent political outcomes (Blackler & Regan, 2006).

Aligning artifacts and institutions

Conceptions of control not only offer a way to conceptualize the relationship between specific organizational practices (e.g. subsidies for destruction) and broader social phenomena (e.g. the cold war) but also provide a theoretical lens to understand the process whereby the institutional context shapes the design and use of ICT artifacts. The case shows the presence of a degree of alignment between dominant conceptions of control (and institutional values) and ICT artifacts, confirming similar studies carried out in developed (Currie & Guah, 2007; Hayes, 2008) and developing countries (Humes & Reinhard, 2007). The novelty of this study is the finding that the relation between ICT artifacts and conceptions of control is neither static nor predictable. Indeed, the case study suggests that ICT artifacts can emerge in accordance with a certain conception of control (e.g. military) and later be reconfigured to reflect a succeeding conception of control (e.g. ecological). The recognition of this phenomenon has two implications for the understanding of ICT in institutions.

First, this suggests that it is wrong to analyze the history of ICT artifacts as simply an evolution from a ‘worse’ to a ‘better’ system. Since the evaluation of what is better is usually framed according to the contemporary dominant conception of control, this kind of analysis can easily lead to presentisms or cultural imperialism, namely, judgments based on values different from the time period or place of the ICT artifact (Noir & Walsham, 2007). So, for instance, it would be wrong to evaluate historically the Amazon monitoring system simply in terms of their efficacy in attaining the sustainable development advocated by the MDGs by reducing deforestation rates since it is a notion that is clearly linked to the ecological conception of control that only emerged in the developing countries in recent years.

Second, the analysis of the trajectory of ICT artifacts in relation to conceptions of control can help us to understand what might appear to be an arbitrary drift. Ciborra (2000) points out that ICT artifacts, such as information infrastructures, tend to drift, namely, 'they deviate from their planned purposes for a variety of reasons often outside anyone's influence' (4). He explains that technology intrinsically tends to drift due to some force from inside that manifests itself when its put to use, '[t]hus, the idea emerges of technology with a certain degree of autonomy and inner dynamics; of technology both as a drifting system and as a organism to be cultivated' (*ibid*: 32). In this context, the case above suggests that the Amazon monitoring system's transformation from a militaristic symbol of competence to an ICT that helps to attain the sustainable development MDG was actually not a random drift outside the government's influence due to the ICT's inner force, but instead it was an realignment of the technology with the aims coming from a new emergent ecological conception of control.

In this context, the assessment of the linkage between ICT and the millennium development goals shouldn't stop at the evaluation of the current outcomes of these applications. Instead, researchers should better conceptualise and investigate the spatial and temporal dimensions in order to understand the local institutional forces that over time shape the development and use of ICT. In this way, it might be possible to understand not only whether an ICT contributes to the MDG or not, but also why it is the case, and which social dimensions could help or hinder the future use of ICT for those aims. Hopefully, armed with this understanding, research on ICTs in developing countries can continue expanding its concern from the ICT *per se* to the social aspects that enable productive uses of technology for the sustainability of the world's resources.

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