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EXPLORING CHARACTERISTICS OF GIS ADOPTION DECISIONS AND TYPE OF INDUCED CHANGES IN DEVELOPING COUNTRIES: THE CASE OF ETHIOPIA

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ABSTRACT

The adoption of geographic information system (GIS) in developing countries is limited due to contextual impediments. Despite this, there are examples in developing countries where GIS is being adopted through various projects, initiatives and incentives. One such example concerns the municipal utility sector in Addis Ababa, Ethiopia. The sector is largely under the control of public authorities with limited funds, yet it has been investing in GIS. Our article explores what have been the characteristics of the adoption decisions and type of induced changes, with the purpose to explore what could explain the GIS adoption process. The aim of this exploration is to find general characteristics of what would make GIS adoption successful in a developing countries context. We hypothesized that actual GIS adoption decision and induced changes depend on the overall organizational interests and strategic opportunities, which in turn depend on contextual factors. The results indicated that there were some circumstances which fused GIS adoption decisions with a certain degree of opportunism. GIS was adopted especially when it served other strategic purposes, such as structural adjustments to maintain organizational control. Furthermore, we found that higher level organizational changes, such as changes in power structure and communication lines, would not directly occur only because GIS adoption required so. These characteristics may be more profound in developing countries than in developed countries.

Keywords: Adoption decisions; organizational changes; GIS; GIS communications

1. INTRODUCTION

Technology adoption is a process which can follow if organizations have at least a basic capacity to access the technology. This basic condition constitutes often the main difference between organizations in developed and those in developing countries. Several studies have highlighted that in developing countries contextual determinants related to economic, technological, legal, and financial infrastructure are major impediments of technology access, and hence to technology adoption. With regards to information and communication technology (ICT) adoption this is no different, as several studies point out (Huang and Palvia, 2001; Molla and Licker, 2005; Oyelaran-Oyeyinka and Lal, 2005). Moreover, Bunker (2001) argues that only "*if we understand the cultural context in which a tool is made then we will understand the skills to transfer and use such tools in an effective manner.* The impact of such differences we can examine best by finding a case where most of the factors are similar, yet few are dissimilar.

The municipality of Addis Ababa in Ethiopia is in the unique situation (for an organization in a developing country) that it has gained considerable (economic and financial) access to technology as a result of a variety of both donor-driven (Urban Local government development project 2008-2014; Addis Ababa Urban development project 1990-1999) and

government funded projects (Addis Ababa Water Supply Project 1994-1999; Urban Information Development Project 1996-1998, River Basin Studies). One of the sectors where this is most prominent concerns the infrastructure and utility management sector, including the power, telecommunication, water, sewerage and drainage management organizations. As the sector largely depends on spatial information of the physical infrastructures and relative location of customers, effective management of the information is crucial. As a result, these utility organisations have a history of investing in information technologies. One type of such information technologies is that of geographic information systems (GIS). GIS technology utilizes geospatial references to link and analyse different types of data. The technological capability of GIS in the context of utility management is to spatially locate and select best routes, to review the area and adjacent facilities, and to manage utility data such as pipelines geographically. GISs potentially allow users to better access to information for operations and planning and decision making (Campbell and Masser, 1995; Pickering et al., 1993). As such managers of utility organizations would possibly be motivated to adopt GISs, and to re-organize their operations accordingly (Dunn et al., 1997; Pickering et al., 1993). In practice, however, the direct link between such organizational changes and GIS adoption decisions are not obvious.

GIS adoption has both technological and organisational dimensions. This is because, in most cases, adopting GIS requires integrating new working practices into existing ones, which induces organisational changes. As a result, actual GIS adoption decision and induced changes supposed to depend on the overall organizational interests and strategic opportunities, which in turn depend on contextual factors. Despite the fact that the purpose and complexity vary with contextual factors, GIS inception and implementation processes are instances through which technology and organisational changes are transmitted to the members of the organization (Budic and Godschalk, 1994; Campbell and Masser, 1995). This implies that the relationships between GIS adoption decision and induced changes may be visible through these instances of GIS diffusion process.

Therefore, we aimed to explore the characteristics of GIS adoption decisions and type of induced changes as dependent on factors that influence GIS adoption decision and implementation processes. The municipal organizations of Addis Ababa, Ethiopia provided a specific context to observe the issues against the assumptions which are usually generated from researches in western countries.

The structure of the article is as follows: First we provide a theoretical foundation on how to view organizational changes in relation to GIS adoption decisions. This leads to three questions deliberated to explore characteristics of adoption decisions, type of induced changes and the implications. Next, we explain the methodology of data collection, followed by a summary of results and an interpretative analysis of these results. Finally, we give conclusions.

2. THEORETICAL FRAMEWORK

Despite the wide spread use of GIS in developing countries, the actual decision to start using GIS does not gain much attention in current GIS research. This decision would however be crucial in the understanding why and how GIS gets adopted in certain organizations and not adopted in other. Concepts such as ‘adoption’ and ‘diffusion’ link the implementation of technology with the organizational consequences. These concepts have proven useful to assess how a technological innovation emerges or disappears within the organizational context in which it is developed and adopted. Empirical research from various authors has combined identified several determinant factors for organizations to adopt GIS (Campbell and Masser, 1995; de Man and van den Toorn, 2002; Masser et al., 1996), including:

1. internal and external pressures,
2. organizational readiness,
3. internal communication,
4. perceived benefits of technology,
5. exposure to ICT and/or GIS, and
6. feelings towards GIS related changes.

While the first three of these factors mainly refer to the organization as a whole, the second set of three factors refers to attitudes and behavior of individual persons, who are part of the organization. Adoption is thus the direct link between both. The focus of this research was therefore to investigate the organizational changes that occur as a result of decisions of individuals to adopt GIS, or that occur alongside decisions of individuals to adopt GIS. Some of these links between attitudes of individuals and organizational issues are known.

First of all, attitude changes of individuals are influenced by how organizations organize internal communication on GIS. Rogers (1983) argued that technology diffusion is an innovation process which depends on how the intended innovation is communicated among staff members through certain channels over time. The communication channels could be formal and informal. Any communication takes place through specific organizational formal relations between staff and functional tasks, and through informal relations between individuals. In either case, the diffusion through such channels creates a situation in which individual members of organizations get exposure to GIS. The exposures might create a perception that precedes changes in work behavior, and changes in the relationship between the person and the work environment. The changes might affect the situation in which an individual accomplishes his or her activities (Hersey et al., 2001). As a consequence, an individual exposed to GIS develops an attitude towards GIS, which can change a specific work behavior. Such an attitude change may lead to the decision to use or not use GIS. The formal communication strategy usually follows from strategic plans on GIS implementation, which determine how to organize, plan and manage GIS technology and its components (Masser et al., 1996). Also, Tomlinson (2003) stressed the need for structured and formal internal communication of such skills prior to, during and after GIS implementation process. The informal communication is more visible from an organizational learning perspective, as addressed by (Fichman and Kemerer, 1997). Organizations learn through individuals negotiating on organizational decisions. In this negotiation process a particular view on GIS may become dominant, and as a consequence individual staff will tend to communicate a particular view on whether or not to adopt GIS in a particular way. In such a case, informal communication channels are driving an overall organizational adoption decision.

Secondly, internal management changes are influenced by perceived benefit and internal pressures (e.g. performance enhancement). As noted by Campbell and Masser (1995), the motivation for the adoption of GIS by organizations stems from the desire to enhance efficiency of organizational functions such as planning, operation, management and decision making. In addition Masser et al. (1996) and Obermeyer and Pinto (2008) added that GIS can only be adopted by an organization, and successfully implemented, if this process involves a minimum of change, and if the change is accepted by all decision making work units within the organization. This type of change is directly caused by perceived benefits and internal pressures. Consequently, individuals and organizations make changes in the way they do business (Campbell and Masser, 1995). The implication is that attitude changes towards GIS adoption decisions and the need to improve organizational performance through GIS implementation stimulate technological and organizational adjustments that may have an impact on the structure and design of an organization (Campbell and Masser, 1995; de Man, 2002; Rogers, 1983). Following Bradley (2006) and Huxhold and Levinsohn (1995), these

induced changes might be reflected through changes such as activity patterns, procedures, processes, organization, roles and responsibilities. Furthermore, Huxhold and Levinsohn (1995) indicated the creation or change of power structures and communication lines. Also, they indicated incorporation of induced changes depends on an organization's readiness (i.e., if there is sufficiently trained staff and availability of appropriate technologies and funds). Therefore, although there are no explicit instances and predetermined type and pattern of the changes in relation to adoption decision, in any context, the organizational changes as a consequence of GIS adoption are inevitable.

Even though Hanna et al. (1995) note that developing countries can learn from the diffusion paths of developed countries, in their own report they also based their arguments on what they refer to as '*tacit knowledge of the designers and implementers of national policies and programs to establish key rules-of-thumb for future programs*'. However, de Man (2002) substantiates that there are no globally applicable conditions for the introduction and implementation of GIS. There could be transformation of the very concept of innovations inception and implementation while it travels from industrialized countries to developing countries (Georgiadou and Homburg, 2008). Such diversity of views and the context in developing countries potentially evoke expectations of varying meanings of GIS adoption decision factors and type of induced changes from developed countries. Furthermore, one can take a position that the characteristics of some of the adoption decisions and the type of induced changes could be different in organizational context of developing countries.

Given this need to study GIS adoption in the context where its inception and implementation is assumed being evolved, we focused on GIS diffusion instances (initiation and implementation) in specific setting of Ethiopia, with the objective to explore: the characteristics of GIS adoption decision in developing countries. The GIS communications effect on adoption decisions and induced changes. Furthermore, we looked at contextual implications for the adopters and implementers in developing countries.

To address the focus of the study, in the specific setting, we formulated three main questions:

1. What are communication channels of GIS and how do these influence GIS adoption decisions of individuals?
2. What type of GIS organizational changes occur and how much can do these changes be contributed to individual adoption decisions?
3. What are the implications of GIS adoption and implementation in developing countries?

3. METHODOLOGY

The questions were operationalised based on the following assumptions:

We viewed organizations as socio-technical systems that exist in the context of both an internal and external environment of interdependent relationships. Any internal or external factors that interfere with the organization's ability to produce and provide services may become a force of change. The changes either improve or hinder its functions, processes and actions (Harigopal, 2006). GIS adoption decisions and induced changes in a particular organization depend on such a dual context in which both external and internal processes and interests develop.

In order to observe the factors and discuss the characteristics, we focused on the key phases of the Rogers (1983) GIS diffusion process in which each phase has decision moments to accept or reject GIS. He explained initiation as the phase at which organizations become aware of the technology while Obermeyer and Pinto (1994) specified it as a phase at which organizations evaluate needs and benefits of the GIS technology. The implementation phase

stated as the engagement of the organization in the activities such as database development, system maintenance and utilization of the technology which requires significant technological and organizational adjustment.

As the instances of adoption decisions and the induced changes are interdependent but most likely time distinct observable facts, therefore, we considered initiation phase as an instance of GIS adoption decisions and implementation phase as instance of induced changes. Yet, we analyzed causal relationships between the adoption decisions and induced changes as an unbroken process. Therefore, for the purpose of this research, initiation phase descriptions were mapped with adoption decision factors such as exposure to GIS, GIS communications, internal pressure and perceived benefit. The implementation phase portrayals also mapped with attitude towards GIS related changes and organization readiness. In doing so we attempted to identify characteristics of the factors influencing GIS adoption decisions and pattern of induced changes.

The data collection focused on the three above questions in relation to the GIS adoption occurrence and induced changes. We restricted the occurrence of GIS adoption to the utility sector in Addis Ababa for two main reasons.

Firstly, the context of the utility sector provides a good example where GIS is assumed to be introduced in a similar fashion in both developed and developing countries, namely as a subcomponent of a larger infrastructural investment (Masser et al., 1996). This characteristic is different than GIS adoption in other sectors, such as land administration, for example. For this sector Rajabifard et al. (2007) and Steudler et al. (1997) notice that there is still a considerable difference between developed and developing countries in the role of GIS technology for the maintenance of cadastral records. Secondly, the utility sector in Addis Ababa operates entirely under the control of the public sector. This characteristic makes the cases of organizations comparable, even though each of these organizations has a different organizational and GIS application context.

Empirical data collection focused on seven organizations having an influence in the utility service provision in the Addis Ababa. Four of these are directly dealing with providing utility services, such as water & sewerage, telecom, power and storm water drainage services. These are:

1. Addis Ababa Water & Sewerage Authority (AAWSA),
2. Addis Ababa Construction of Roads Authority (AACRA),
3. Ethiopian Telecommunication Corporation (ETC), and
4. Ethiopian Electric Power Corporation (EEPCo).

The other three organizations are directly or indirectly thought to influence GIS adoption by the utility organizations. The category may directly influence decisions on GIS adoption (by prescribing it) or indirectly influence it (by allowing it, or encouraging it). These are:

1. Addis Ababa Infrastructure Construction Authority (AAICA),
2. Urban Information Development Department (UIDD), and
3. Ministry of Water Resources (MoWR).

The organizations can be grouped based on their institutional control levels, based on to their proximity to the city council (c.q. local government) as shown in Fig. 1. Although the differentiation between such levels seems somewhat arbitrary at first site, (Omran and van Etten, 2007) argue that social networks and closeness to technology related decisions make a large difference in how technology is adopted and accepted. We used this distinction between

levels as an indicator for the freedom each organization may have in the organizational decisions to adopt GIS. Moreover, these may provide an indication of the influence of GIS communications in an institutional arrangement.

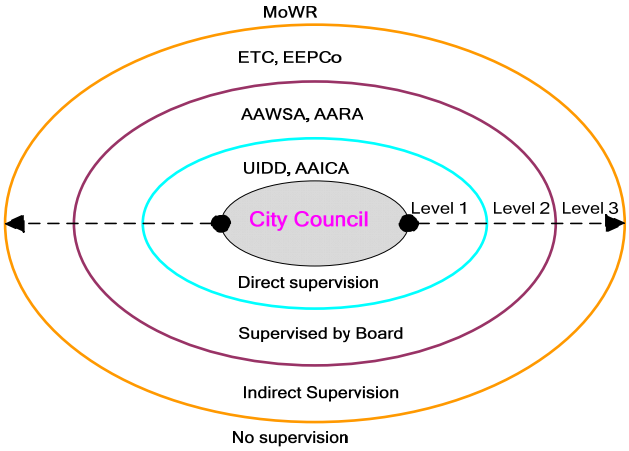

Figure 1. Institutional Control Level

The methods employed for the data collection (apart from document collection, including strategic documents, technical reports and project progress reports) were semi-structured interviews. These were supplemented by personal observations. Out of twenty seven respondents selected, twenty two agreed to have the interviews recorded; the remaining five preferred to give responses in writing. Out of the 27 respondents, 42% were direct users, 39% were potential users and 19% were indirect users. After a selection of respondents through shorter interviews, formal interviews were organized. The final interviews lasted on average one hour. Each interview focused on the identification of the factors described in subsection 2 (adoption decision, organizational changes, organizations' capacity, communication networks, perceived benefits, and attitude towards induced changes). In general, the methods and questions were deliberated to gather information on experiences, cases and factors contributed for the adoption decision and diffusion process (introduction and dissemination) and induced changes (organizational and attitudinal) which are observed through the perception and attitude of the respondents.

While the sample size of respondents as compared to the complete number of staff in the sector seems limited in hindsight, we also note that the respondents were selected iteratively and purposefully. The actual number of staff who has had any experience with GIS or with GIS related staff is still relatively limited (even worldwide). To find therefore some of the respondents had been working for more than one GIS related project was therefore difficult. The sample of respondents included key informants who have been working in the organizations since the first introduction of GIS. As such we believe that they could provide the required information. While incorporating respondents from top, middle and operational management levels, the selection was based on the criteria for the use of GIS. That is direct, indirect and potential users (Budic and Godschalk, 1994; Campbell and Masser, 1995). As a result those who were involved in the projects, worked in the organizations as drafts person for long years, who were junior engineers during the project and promoted to department head and deputy general manager level, who joined an organization as GIS expert recently, those who were drafts women before the projects and later promoted to GIS technician job positions, planners and economists with long year experience in the organizations and junior engineers were among the selected respondents.

4. SUMMARY OF RESULTS

The fieldwork generated results on GIS communication, GIS adoption decisions and induced changes.

4.1 GIS Communication and Adoption Decisions

Except for UIDP, it appeared that all GIS related projects were implemented by foreign companies. Respondents referred to two distinct projects implemented by AAWSA in 1994 and 1996 as the main external reason to start introducing GIS and GI related software (such as AutoCAD) into the municipal organizations. The Addis Ababa Water Supply Study Project introduced AutoCAD software to produce a large scale digital line map of the city while the water leakage reduction and control project used InFoCAD GIS to collect, store and analyze the water pipe network system. This incidence stimulated the municipality (city administration) to launch Urban Information Development Project (UIDP) in 1996. The project was implemented to upgrade the manual land information system to a computerized system and hence improve the revenue collection, land registration, land transaction and other related activities. Initially, the project made full use of AutoCAD software and the digital line map to collect land parcel data. Later on GIS software was introduced with the aim to link the descriptive information collected with the graphic information. Following its establishment as an authority in 2002, AACRA has implemented the pavement management system study project which used the digital line map in the GIS environment to collect, store and analyze the road network system information. The power distribution rehabilitation project, which is under implementation by EEPCo since 2005, is using AutoCAD and Microsoft Access to collect and store the power network information with main objective of changing the overhead power cables to underground. Also, the project is introducing GIS for same purpose and plus. Access Network Planning Division of ETC is converting the paper telephone cable network maps in to digital format using AutoCAD. It is mainly with the aim to facilitate the planning and operational tasks and there was a plan to acquire and use GIS to transfer the data from AutoCAD. Regarding MoWR, it appeared that GIS is introduced as a result of the simultaneous River Basin Study Projects. During the projects GIS was used to collect, store and analyze various relevant information.

We observed variations in the initiation of GIS introduction, organizational decisions and funding the acquisitions and GIS communications. The decision to introduce GIS was to improve the perceived data handling and management performance gaps in each organization based on the perception of GIS technological capabilities as communicated by software vendors, the project consultants and NGOs through short term trainings, workshops and demonstrations. Except that the initiation and decision made by the city mayor and the group of engineers to introduce GIS in UIDP and access network department of ETC respectively, the initiation and decision to use GIS in the rest of the organizations was made by the project consultants. Evidently, the decision was based on the consent of the organizations' work units. These work units usually were counterpart project offices rather than regular work units. However, we understood that upon completion of the projects some GIS acquisitions (through purchasing, training donations and from friends) were made based on the motivation of specific work units and individuals.

The starting date of GIS introduction and the actual GIS system varied per organization. Table 1 provides a summary of GIS introduction in each of the respective organizations. It shows an overview of the software type, the year in which GIS was introduced and which project introduced the software. In addition, the last column indicates the intensity of current use. AcrView, ArcInfo and Mapinfo are typically considered GIS software types, produced and distributed by corporate vendors, whereas AutoCAD and InfoCAD are often more considered an engineering, c.q. design, type of corporate software,

even though they can store and analyze geographic data. At certain locations there were additional software packages which were of the GIS type but not from a corporate vendor. We made a distinction between "in use" and "occasionally used" based on the perceived active number of instances of employment of the software. If all respondents within an organization could mention at least a number of recent instances of use we considered it in use, if only a few respondents could do so, we considered it occasionally used, if none could do so, we considered it not in use. In five instances we were not able to trace the year in which particular software was purchased. In particular the introduction of the ArcView software seemed rather ad hoc and related to individual contributions c.q. donations. Moreover, the funding and initiation of the introduction varies in relation to the institutional arrangement. Furthermore, although attempts of various organizations to acquire more GIS software types might indicate further intentions to adopt GIS, most organizations indicated primarily aiming at purchasing necessary basic hardware.

Table 1: Summary of GIS Introductions per Organization.

Organization	Software Type	Year Introduced	Obtained through	Project Consultant	Degree of use
UIDD	AutoCAD	1995	Project	Local	In use
	ArcInfo	1996	Project	Local	In use
	ArcView 3.0	Not known	Purchase	-	In use
AAICA	AutoCAD	2003	UIDD	-	In use
	Arc Info	2003	UIDD	-	In use
	ArcView 3.2	Not known	Training	-	In use
AAWSA	AutoCAD	1994	Project	Foreign	In use
	InFoCAD	1996	Project	Foreign	Obsolete
	ArcView 3.x	2003	Training	-	Occasionally used
	ArcView 9.1 ArcEditor 9.1	2006	Purchase	-	Not in use
AACRA	AutoCAD	2002	-	Foreign	In use
	MapInfo	2002	Project	Foreign	In use
ETC	AutoCAD	Not known	-	-	In use
	GIS	Not yet	-	-	Plan to purchase
EEPCo	AutoCAD	2001	-	-	-
	Integra1	Not known	Not known	-	In use
	GIS	Not yet	Project	Foreign	Plan to purchase
MoWR	AutoCAD	Not known	-	-	In use
	ArcInfo	1992	Project	Foreign	In use
	ArcView 9.2	Not known	Training	-	In use
	ArcView 3.x	Not known	Training	-	In use

We noticed that the local government reform program of 2002 was an active stimulus to start using GIS for those organizations in the first and second level of the institutional arrangements. This program actively promoted GIS dissemination among municipal organizations, for example. It appeared that this GIS dissemination strategy was given the importance by the management, given their reports on GIS and their increase of available data. The management of these organizations systematically described GIS as a core element

in support of the duties of the organizations. As an example, the decision that prescribed GIS use for the Urban Information Documentation Department and AAICA was followed by active dissemination of data from the urban information development project. Also, staff trained by the project was directly assigned in different departments. We learned that these intentional strategies to apply GIS produced additional opportunities for dissemination of GIS. Social interactions on GIS lead to increased awareness on GIS terminologies and capabilities. Furthermore, we found that in all organizations (including ETC) there were planned training sessions, supported by the management, and dedicated for those specifically assigned to work on GIS. We found that in AAWSA there was an effort made by individuals to disseminate the use of GIS in different work units. Initially, there was a training within a department which later on (after two years) management supported training was arranged for staffs in departments other than where GIS is located.

We would say that these types of activities had a direct impact on how GIS was communicated internally. The management orders to disseminate GIS followed the 2002 reform program. While at first only those organizations in the inner ring would provide such orders, later in 2003 AAICA communicated that introducing GIS for street addressing project would be an integrated solution to solve problems, such as unorganized infrastructure management (specifically water, road, telecom and power infrastructures). But, reports and responses indicated that in all organizations there were no training programs designed for various management levels. For example, the respondents in ETC mentioned that they have been motivated to propose to use GIS through various trainings and resources obtained from internet than learning from the early adopters. This is noticeable from the time difference in GIS introduction relative to the other organizations. The respondents from EEPCo and MoWR indicated that there was no a support or a push from level one or two organizations or the city council to introduce GIS. Also, except ETC and EEPCo, the respondents in other organizations indicated their participation on GIS skill trainings and workshops were organized by GTZ, JICA or UNECA.

4.2 GIS Adoption Induced Changes

We found two types of organizational changes associated to GIS adoption: changes in structure and changes in behavior. We noticed that the organizational changes vary among the organizations which might influenced the status of GIS functionality observed during the data collection. Table 2 presents a summary of the observed organizational changes in structure.

Concerning the attitude changes, we noticed a shift in what GIS represented as a technology in comparison to other similar technologies. This was evident in the responses from those respondents who use GIS and those who neither used nor trained on it. Also they compared GIS with other technologies previously they used to work with and they expressed their intentions and reasons to shift to use GIS. In most cases GIS was contrasted against AutoCAD. One respondent explained that *"…I know about AutoCAD and GIS…AutoCAD does not give geographically referenced objects like position of infrastructures, buildings…"*. Staff members who had been using GIS valued the potential of GIS, thereby hinting to specific technical capabilities of GIS in comparison to CAD (such as incorporation of attribute data management, getting geo-referenced positions of objects). Some respondents had a feeling that due to the high rate of dissemination of GIS and its importance to the tasks of the organizations, sooner or later changing the way they have been performing their tasks would be inevitable.

Table 2: Summary of Organizational Changes

Organisations	Introduction of GIS	Observed Changes	Current Status of GIS
UIDD	Project	New Work unit and Job positions opened	Functional
AAWSA	Project	Incorporated to a work unit, change of job assignment	Not functional; *(the trained staff left the organization)*
AACRA	Project	Incorporated to a work unit, new job positions opened.	Not fully functional ; *(the trained staff left the organization)*
AAICA	Disseminated from UIDD/Project	Incorporated to a work unit, new job positions opened.	Not fully functional. *(the assigned staff is not fully engaged on GIS activities)*
ETC	Individuals initiation	Change of job assignment	Just starting.
EEPCo	Project	Change of job assignment	Just starting
MoWR	Projects	New work unit and job positions opened	Functional.

To cope with such a situation they felt however in need for the knowledge and skill of the technology such that they can easily switch from existing practices to the new one. The interest and use of GIS was mostly found among particular professional staff, including drafts persons, planners, geographers and engineers. Such interests was also confirmed by the responses from more senior level managers, who noted that they had shifted some GIS work to engineers and suggested that it would be better to train the engineers on GIS. It appeared that the views were mostly constructed based on formal and informal communications such as professional interactions and particular workshops, short term training and software vendors' agents or consultants demonstrations sessions. Most of the respondents came to know about the technological capabilities of GIS through short term trainings, workshops, projects and friends who use GIS. We noticed individuals' interactions both within and across organizations on the basis of professional activities found significant in influencing the perception of organizational members. Despite all that perceived changes, we found the surveyors in sub municipal level AAICA sustained AutoCAD. Also during the data collection in AAWSA we learned that the intention of water engineers to use WaterCAD dominated over those intended to use GIS.

We viewed some of the rhetoric used in number of responses in two ways. One, it may underline an intention of GIS vision. The other is inducing changes through IT or GIS may be seen as an opportunity for strengthened autonomy of an organization. The indicative responses are given below:

> *"Generally, we are in the process of modernizing the organization. In my opinion my organization has a firm stand to implement GIS and have intention to use this project as a means for technology transfer to internalize such technologies ; organize in to regular work units…we are trying to identify the number and type of staff we need to engage on GIS works in regional and district offices."*

> *"…by the time the … management system study project completed, in 2002, there was organizational restructuring…we used that opportunity to incorporate GIS in to the organization…we want our staff to use it in a networked environment…"*

> *"There was no strong unit to disseminate it to other work units, first we must have strong central unit that can show the importance of GIS"*

Regardless of its limited use and low benefit, in general, all respondents referred the respective organizations' management intentions to implement GIS as one of major information systems implying that GIS will be core technology to manage various operational problems.

5. DISCUSSION AND ANALYSIS

Question 1: *What are communication channels of GIS and how do these influence GIS adoption decisions of individuals?*

In spite of the diverse application contexts and institutional arrangements, the introduction of GIS was initiated, in most cases, by projects designed for specific purposes. The projects demonstrated the GIS technological capabilities and that GIS could be relevant in solving performance gaps. This relevance for performance increase dominated the organizations deliberations. Any better mechanisms to collect, store and use vast spatial data were the motives for the increased intentions for adoption. Noticeably, the trends of attempts to introduce and use GIS softwares (see Table 1) indicate that the adoption decision is becoming part of the organizations' decisions. The perception on digital spatial information became increasingly interlinked with problem solving, such as water leakage, poor land administration, inefficient revenue collection, unorganized utility infrastructures planning/management and lack of organized rivers basin data. Various types of images on GIS were the causes for the development of the perceptions. GIS workshops, short-term trainings, demonstrations and social interactions have been the dominant communication channels for these images. Software vendors' agents (consultants), NGOs and professional groups dominate the network field. The majority of professionals involving in the social interactions were town planners and engineers. The social interactions, often, were bounded within the work units and professionals those were involved in to the projects. Mostly, the focus of the communications and interactions were on GIS capabilities and relevance. However, the key words like "modernization", "restructuring" and "central unit" may indicate the evolution of other views. This could be perceived as the formative stage of GIS vision development fused with implementing GIS as means of strengthening the public sector control (Harrison, 2002). Furthermore, although most organizations introduced GIS through projects, the introduction time difference observed between organizations could indicate the influence of institutional arrangement on GIS communications.

Consequently, where Campbell and Masser (1995) indicated that organizations and their individual members, respectively, can be motivated to employ technologies such as GIS to solve specific operational problems and tasks, in reality, the adoption decisions were bounded by GIS communication types which focus on the relevance of GIS capabilities to improve a perceived performance gap. Furthermore, contrary to Tomlinson (2003), the communication practices were not uniform, nor continuous and structured, but followed paths

relevant to project deadlines. As a result, diverging from the suggestions of Chan and Williamson (1999) the adoption decisions tended to be project prescriptive rather than focusing on aligning GIS with the organization. As a result, in line with Hersey et al. (2001), individuals or groups of professionals having upper hand in GIS exposure is driving the GIS prescription. This prescription result in a transformation of activity which is not parallel to organizational transformation as indicated by Avgerou (2000). Evidence is that the organizations hardly conducted cost/benefit analyses to assess how much various organizational costs would reduce when adopting GIS. This indicates that the adoption of GIS was to accomplish project objectives designed for specific purpose or specific work group's task rather than to support overall organizational functions.

We conclude that the internal communication which is driving the adoption decisions seems to be primarily related to the interests of external actors of projects, including the software vendors, NGOs and networks of professionals advising on projects. These often prescribe GIS for identified specific problems, based on the technological capabilities and less based on specific task relevance. As a result, internal organizational relevance is critically underexposed in the communication, and as a consequence in the adoption decisions.

Question 2: *What type of GIS organizational changes occur and how much can do these changes be contributed to individual adoption decisions?*

Even when GIS remained in its inception phase of specific projects, dedicated to specific technical tasks, none of the respondents indicated to discontinue the GIS activities after the completion of the projects. In most cases, after the completion of the projects GIS has been disseminated either because some work units found keeping the works of the projects is important for their tasks or the intention of individuals to use/sustain GIS. For example, initiating a comparison of GIS with other technologies could be an indication of an individual attitude change to prefer the use of GIS over other types of software. Furthermore, all organizations incorporated GIS into the realm of existing work units or even established specific GIS work units.

Still, the variety in type of organizational changes as displayed in Table 2 indicates however that GIS activities have not led to separate organizational processes. This was evident because GIS had not been supporting all organizational functions, and also benefits obtained at organizational levels are reported as very low. Although this would imply that the GIS implementation and dissemination processes were felt as ad hoc, there were still different types of organizational changes that have occurred in all the organizations. The results demonstrate that the induced changes were opening of new GIS work units, the incorporation of GIS into other existing work units, the creation of new job positions and changes in task assignments. These changes were different from organization to organization. In some cases GIS induced a work unit with defined job descriptions, responsibilities and roles with respective job positions. In other cases GIS job positions were incorporated in an existing work unit (other than GIS) without any clearly defined GIS related job descriptions, responsibilities and roles. Also, there are GIS induced job assignments without any newly defined job description and responsibilities.

Corresponding to the empirical results of Masser et al. (1996), GIS adoption induced organizational changes. However, the observed changes were different among organizations. In most cases, partly in common with Bradley (2006) and Huxhold and Levinsohn (1995), the induced changes constitute newly defined GIS related activities, roles and responsibilities. For instance, in an organization where new GIS work unit opened, it appeared that there were new job descriptions defining roles and responsibilities, procedures, processes and

organization. In organizations where only new GIS job positions opened, it appeared that role and responsibilities of individuals changed. In organizations where previous job assignment is changed to GIS task assignment, only responsibilities were changed. We viewed these differences in induced changes with respect to attitude changes in different organizational levels. In organizations where the top management has a leading role in the adoption of GIS there could be establishment of GIS work units, while in organization where the adoption is driven by motivation of operational level professionals the top management may endorse GIS related job role and responsibility changes.

Differing from Chan and Williamson (1999) and Huxhold and Levinsohn (1995)**,** in none of the organizations a GIS dominant aligned vision or existing power structures and communication lines changed as a result of GIS adoption. Yet, the relationship between the adoption decisions and organizational changes is visible from the rhetoric within the responses. The first response links GIS adoption to "modernization". Harrison (2002) argues that "modernization" in the cultural context of Ethiopian public sector essentially means readdressing the hierarchical control by the public sector. In other words, GIS could be a means to gain more autonomy as an organization. The second quote above re-confirms this need for change in control. The term "opportunity" (to incorporate GIS) is directly linked to the opportunity to restructure (responsibilities and authorities). GIS is thus may be seen as a means to change command and control structures. At the same time, the "natural" reaction to modernization and restructuring (as a process of redefining hierarchical control) is re-gaining strong public sector influence in the process. The third quote makes a link between GIS and importance of central control. Apparently, the perception is that the establishment of a central unit will enhance the importance, thus the GIS adoption. Thus, referring to the above analysis and the link between GIS and solving operational problems, one could certainly associate GIS adoption decision with both operational and administration reforms in the public sector.

We inferred therefore that the extent and type of induced changes as a result of the observed GIS adoption decision levels are: **(1)** top management lead adoption decisions could induce organizational changes to a level of incorporating GIS work units but not necessarily induce change in power structures and communication lines, **(2)** increased individual organization's members motivations to use GIS and adoption by counter part organizations could force the top management to decide on incorporation of new job positions with defined roles and responsibilities , and **(3)** altered attitude of few individuals in an organization could increase the intention of others to use GIS but not necessarily bring organizational changes. However, we argue that depending on culture of the public sector, the adoption decisions and associated changes may possibly be amalgamated with the interest of public sector control or other strategic opportunities of an organization or leader ship. In this sense, the changes induced by the adoption of GIS possibly evolve to creation or change of power structures and communication line.

Question 3: *What are the implications for GIS adoption and implementation in developing countries?*

The case in Ethiopia has shown that introduction and use of GIS for specific operational problems may not ensure integration of GIS within existing organizational practices and may not necessarily enhance efficiency of organizational functions. Many of the GIS work units were established in isolation of the overall organizational processes, which is common in most developing countries (Georgiadou et al., 2007). Still, the increasing interests to implement GIS, regardless of the immediate benefit obtained, indicates an increased level of attitude changes, which are also relevant in a developing country context. Specific for many donor driven projects is however the focus on immediate technological

capabilities, which affects the way internal staff communicates about GIS. As a result, one can question the feasibility of successful implementation and obtaining perceived benefits in an organizational setting. As GIS needs new practices, to be effectively used, its adoption decision and the consequences must not be seen in isolation with overall organizational phenomena. This means that in developing countries more emphasis should be given on implementing GIS technologies in view of the culture of the organizations, their institutional arrangement and the interests of the system as a whole. In this case, the usual focus of GIS communications focus on technological capabilities need to be fused with organizational aspects communication. The implication is that organisations' members attitude change and GIS adoption intentions need to be shaped through structured communications that focuses on an organization operational, internal and external institutional interactions and culture to bring about aligned GIS adoption interest. There by increasing the utilization level of GIS.

6. CONCLUSION

In addition to the conventionally reported factors which influence GIS adoption decisions, our research is indicating that in a developing country, which is typically at the early stages of acquiring and diffusing new technologies, internal communication and increased organizational willingness are characteristics that help to understand the GIS diffusion process. These characteristics might be evaluated based on the nature of instances of adoption, the way in which staff communicates about GIS, the specific problems that individual staff perceives and organization culture that exists. Attitude and organizations change as a result of these factors. In the specific context of the utility sector in Addis Ababa, certain staff could decide to adopt GIS, which resulted in attitude changes throughout the organization. One could conclude, therefore, that such contextual circumstances, dependent on individual staff, one can build up a certain degree of opportunism towards the adoption of GIS. GIS could be adopted especially when staff views such changes as enabling their own strategic objectives. In some cases this meant for upper level staff structural adjustments that maintained control. This may raise a dilemma whether the extent of changes (GIS dominant vision and power structure changes) would be driven by technological views or motivation for performance improvement or to reform the public sector control. Therefore, we argue that the characteristics of GIS adoption decisions could be dictated by organizational culture and focus of GIS communications. As such, in a specific context, depending on the dynamics of the elements, the GIS induced changes may have relative extent and type.

Finally, on the question whether adoption theories may be different for developed versus developing countries, we conclude that the case study at least highlighted the prominent relevance of understanding the characteristics of GIS adoption decision in a specific developing country context. Although the study aimed at exploring the link between GIS adoption decisions and organizational changes, we find that the GIS adoption process is part of a larger process of ICT adoption. The GIS software, for example, would not be able to function without basic ICT availability and functionality. Further research could however evaluate whether the issues discussed for GIS adoption decisions and type of induced changes also occurred in other sectors and ICT subsets. This may help to find more general conclusions on the specifics of technology diffusion and adoption in developing countries.

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