Using Institutional Theory and Dynamic Simulation to Understand Complex E-Government Phenomena

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Abstract

Governments around the world have developed e-government programs hoping to obtain important benefits. However, many e-government projects fail to deliver their promises. Some of such failures are the result of a lack of understanding about the relationships among technologies, information use, organizational factors, institutional arrangements, and socio-economic contexts involved in the selection, implementation, and use of information and communication technologies (ICT), producing mismatches and unintended consequences. The paper proposes the use of institutional theory and dynamic simulation, particularly System Dynamics, as an integrated and comprehensive approach to understand e-government phenomena. The paper draws on the case of the e-Mexico program, particularly in the strategy to create web-based content to the citizen in the areas of education, health, economy and government. Using the same technological infrastructure and under the leadership of the same Federal Ministry, four different networks of government and non-government organizations engaged in the creation of Internet portals to create relevant content in these areas. Differences in institutional arrangements and organizational factors resulted on different technology enactments.

Keywords

Institutional Theory, Technology Enactment Framework, System Dynamics, Mexico.

Introduction

Electronic government (e-government) has been recognized as a powerful strategy for government transformation. In the last ten years, governments around the world have

developed e-government programs hoping to obtain important benefits such as cost savings, improved service quality, increased accountability, and more public participation, among others. However, many e-government projects fail to deliver their promises. Some of such failures are the result of a lack of understanding about the relationships among technologies, information use, organizational factors, institutional arrangements, and socio-economic contexts involved in the selection, implementation, and use of information and communication technologies (ICT), producing mismatches and unintended consequences.

Therefore, it seems necessary to develop analytic approaches that combine sound theoretical basis with innovative and sophisticated research methods. Within the last decade, several researchers around the world have been exploring such approaches. This paper illustrates research in progress intended to illustrate one of these approaches, which has already proven to be useful and promise to be distinctively powerful in the near future given the complex and emergent nature of new ICTs and e-government initiatives. The paper proposes the use of institutional theory and dynamic simulation, particularly System Dynamics, as an integrated and comprehensive approach to understand e-government phenomena. Institutionalism is a powerful theory that helps to understand the intertwined and complex nature of the relationships among technology, organizational factors, institutional arrangements, and the socio-economic context in which they are embedded. System Dynamics has also been an effective research method to understand complexity and time trends in e-government and other ICT related domains. Together they demonstrate the great explanatory power of sound theories and computer simulation as an integrated research approach.

The paper draws on the case of the e-Mexico program, particularly in the strategy to create web-based content to the citizen in the areas of education, health, economy and government. Using the same technological infrastructure and under the leadership of the same Federal Ministry, four different networks of government and non-government organizations engaged in the creation of Internet portals to create relevant content in these areas. The case is interesting because it illustrates the ways in which differences in institutional arrangements and organizational factors result on different technology enactments.

In this way, the paper is organized in five more sections after this brief introduction. The next section includes a brief review of Institutional Theory and the ways in which we believe is connected with System Dynamics. The third section includes the data gathering and analysis methods. The fourth section is a description of the e-Mexico program, particularly its strategy on Internet-based content creation. The fifth section describes a preliminary model based in the case, including some simulation experiments. Finally, the last section includes some conclusions and final remarks.

Literature Review

We suggest that institutional theory in general and the technology enactment framework in particular represent an alternative to explain specific Information Technology impacts (productivity, life style, etc.) for specific organizations or individuals and allow to understand the relationships between information technologies, organizational characteristics, institutional arrangements, and environmental conditions (Fountain, 2001; Gil-Garcia, 2005). Dynamic simulation, on the other hand, provides the appropriate methodological tool to get a better understanding of those relationships, results and unintended consequences (Richardson and Pugh, 1981; Sterman, 2000). Following, we briefly describe institutional theory, showing

how the technology enactment framework has integrated technology into an institutional perspective, and briefly describe an approach of dynamic simulation.

Institutional Theory

Researchers are increasingly realizing that complex interplays exist between ICT and the social context in which they are selected, developed, implemented, and used (Kling, 2000; Orlikowski, 2000; Fountain, 2001; Orlikowski and Iacono, 2001). Studies with this view propose that there is a recursive and complex relationship between information technologies and social structures and, as a consequence, the results of ICT projects are highly uncertain and cannot be easily predicted. In addition, these studies argue that ICT are not only the technological artifacts, but also the social and organizational aspects around those artifacts (Orlikowski and Iacono, 2001). Institutional theory is one of these more integrative approaches that recognize the importance of the context in which ICT are embedded and help to understand the influences of various factors on their selection, design, implementation, and use (Gil-Garcia, 2005; Fountain and Gil-Garcia, 2006).

Throughout the development of institutional theory, institutions have been conceptualized in many different ways. They are thought as guidelines for human action or appropriate behavior in society (March and Olsen, 1989). These guidelines are historically produced and reproduced and, therefore, are taken for granted and not questioned (Zucker, 1977). Berger and Luckman (1966) define institutions as mechanisms that are perceived as objective and constrain the behavior of individuals. They have been also conceptualized as ways to reduce uncertainty and increase cooperation in the political arena (Moe, 1984). Therefore, institutions are seen as rules of behavior based on various important foundations, from culture and mental models to legislation and from social norms to political structures. Scott (2001) summarizes these different conceptualizations and foundations in three pillars that according to him represent or support institutions: cultural-cognitive, normative, and regulative.

Selznick (1949) shows how organizations are affected over time by the values of their members and the environment in which they are embedded. This results in organizations developing a character of their own that is not necessarily consistent or compatible with their formal goals (Selznick, 1949). Later, Meyer and Rowan (1977) argue that organizations act according to symbolic and rational logics. They contend that in many cases organizations adopt certain practices not because they improve performance, but because they provide legitimacy, showing the importance of institutions. DiMaggio and Powel (1983) further develop these ideas and identify three mechanisms by which institutions affect organizations in various organizational fields: coercive, mimetic, and normative.

Institutional theory has also been applied to the study of ICT in government settings and these studies have drawn on previous disciplinary efforts particularly from sociology, economics, and political science (2007). Following, we describe a recent institutional framework that integrates technology as a critical component of the analysis: the technology enactment framework.

Fountain (1995; 2001) proposes a theoretical framework rooted in institutional theory, Technology Enactment (see Figure 1). She says that the technology enactment focuses on the intersections between institutions, bureaucratic structures, and information technologies. The basic logic of this framework is that “objective technologies” are shaped by organizational forms and institutional arrangements to become “enacted technologies.” Similarly,

organizational forms and institutional arrangement are affected by the selection, design and use of ICT. Fountain (2001) explains that the enacted technology can be understood as the perception, design, and use of objective technologies such as the Internet and different pieces of hardware and software. Puron-Cid and Gil-Garcia (2004) propose that at the organizational level enacted technologies can be characterized as the features of the technology that are actually in place (they are included in the existing information system or systems) in contrast to all the features that could be potentially included (objective technology), but were not selected. The enacted technology produces certain organizational results or outcomes in terms of efficiency, effectiveness, and transparency, among others.

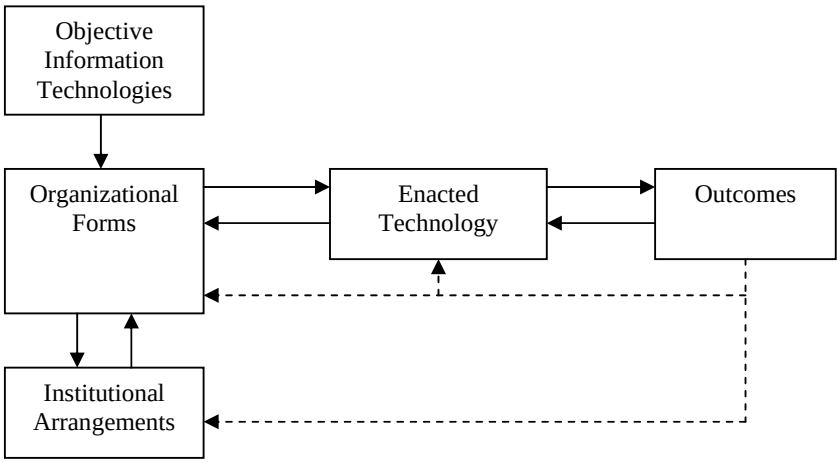


Figure 1. Technology Enactment Framework (Fountain, 2001).

Organizational forms include structural characteristics such as centralization, formalization and communication channels (Gil-Garcia, 2005). Other bureaucratic characteristics of the organizations are also included in this construct (Fountain, 2001). In contrast, institutional arrangements are laws, regulations, and other cognitive, cultural, or socio-structural constraints found in government contexts (Fountain, 2001). The enacted technology and the subsequent organizational results have also an impact on the organizational forms and the institutional arrangements (Fountain, 1995; Fountain, 2001). Therefore, the technology enactment framework acknowledges the recursive nature of the relationships between organizations, institutions, and ICT.

Dynamic Simulation

System dynamics is a method for studying and managing complex feedback systems (Forrester, 1961; Richardson and Pugh, 1981; Roberts *et al.*, 1981; Sterman, 2000). One of the basic principles of System Dynamics is that a system's performance over time is closely linked to an underlying structure of endogenous feedback processes. That is to say, patterns of behavior in the system are explained mainly by endogenous processes, not by exogenous factors. The processes of modeling and simulation are mainly intended to learn about how the world works, helping policy makers to improve their way of thinking (Senge, 1990). Usually, a computer model is needed because of human limitations to predict and manage the behavior of these complex structures (Forrester, 1971). In this way, the modeling process becomes a formal way of developing and testing hypothesis about the impact of feedback processes on specific problematic behaviors in a system.

System Dynamics practitioners have described the modeling process as a series of steps going from problem understanding to model validation and use (Randers, 1980; Richardson and Pugh, 1981; Roberts *et al.*, 1981; Sterman, 2000). The modeling process involves analysis of problem dynamics and problem structure. In this way, a system dynamics computer model is the result of an iterative process of comparing and contrasting a set of assumptions about the system structure and the known behaviors of it. In fact, system dynamics is best suited for problems that show dynamic behaviors, particularly when the pattern can be explained by actors' decisions and actions, as endogenous, recursive relationships represented by feedback loops.

A closed path of causal links constitutes a feedback loop. "A feedback loop exists when decisions change the state of the system, changing the conditions and information that influence future decisions" (Richardson, 2000). A *reinforcing loop* (or positive loop) represents a changing process where the characteristic is growing, decaying, destabilizing, or accelerating. A *counterbalancing loop* (negative or balancing) represents a process implying resistance to change, goal seeking or stabilizing behavior.

A common structural representation of System Dynamics simulation models are stock-and-flow diagrams (see Figure 2). Stocks (or state variables) represent accumulations in the system, and are increased or decreased only by inflows or outflows, which represent activities in the system. The "clouds" at the origin of the inflows in the figure represent conceptual boundaries of the system. That is to say, things flow from somewhere outside the representation of the problem. This view has been successfully applied in the Public Sector. Many examples can be drawn particularly from the System Dynamics Group at the University at Albany, who applies system dynamics to understand public policy problems with groups of managers since 1987 (Richardson *et al.*, 2004).

This graphical representation is, from our point of view, very consistent with the basic assumptions of Institutional Theory and the Enactment Framework (Luna-Reyes, 2006; Luna-Reyes *et al.*, 2007). As shown in the figure, the Institutional Framework constrains or enables organizational activity oriented to the development of a particular Technology Enactment. As shown in the figure, organizational activity can be represented as a combination of actors' effort and actors' effectiveness. We can think that institutions – cognitive, normative or regulative— constrain or improve any of these two components of activity. Technological artifacts accumulated in the stock of Technology Enactment are just software components, processes or documentation with no particular characteristic at all. However, technological characteristics are co-created along with these artifacts as shown in the figure. It is reasonable to expect that in this co-creation process, different artifacts have different levels of any characteristic such as quality. Subsequently, needs that emerge from the average characteristic of a particular technological development can potentially create pressures to modify the institutional framework. The feedback loop in the figure represents the recursive interactions among variables or the process of enacting technology.

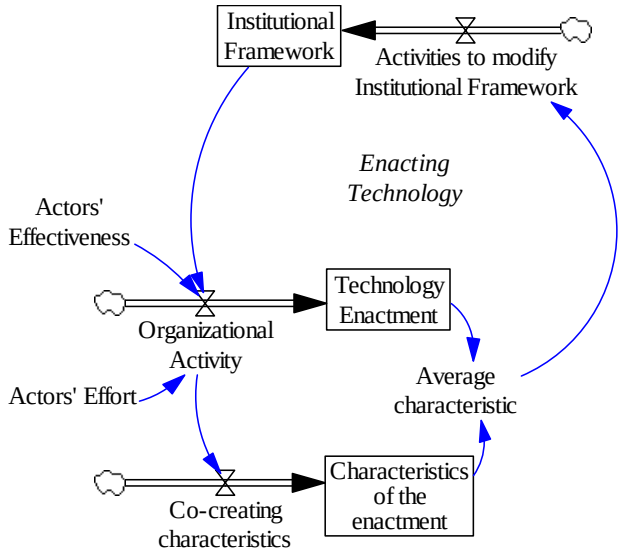


Figure 2. A System Dynamics Stock-and Flow Diagram.

Methods

This study is part of a research project that adopts a multi-method approach. It uses semi-structured interviews of project leaders and participants of more than 15 digital government initiatives in Mexico, a survey to project participants, and three in-depth case studies (Creswell, 2003; Yin, 2003). The objective of this design is to understand the mechanisms and results of collaborative digital government in Latin American contexts. It will also provide some evidence of the similarities and differences regarding collaboration and information sharing in government settings between Latin American and other countries.

This paper reports on the findings from interviews and document analysis of four initiatives of content creation in the areas of government (e-Government), health (e-Health), education (e-Learning) and economy (e-Economy). the E-Learning pillar, which are part of the e-Mexico initiative. Specifically, the results reported here are based on analysis of documentation and semi-structured interviews with public managers involved in the implementation of these programs at the ministry of Communications and Transportation, the ministry of Labor, the ministry of Social Development, the Latin American Institute for Educational Communication (ILCE), the ministry of Health, the ministry of Public Administration, and the ministry of Economy. The ministry of Communications and Transportation played a shared leadership role with leaders on each of the four areas.

Interviewees were asked about the characteristics of their projects, the institutional environment, project's costs and benefits, their perceptions of project success, collaboration, and networking. The research team analyzed the interviews, looking for specific themes and categories, but also for topics that emerged from the data. A prominent finding in the analysis is related to the different enactments and results of the four portals created in collaboration with different project participants. For example, e-Government portal, coordinated by the ministry of Public Administration is significantly different than the portal coordinated by the ministry of Economy. The research team then looked for specific examples of the impact of

institutional and organizational factors on the characteristics of each portal and collaboration processes among organizations involved.

Document analysis was used to enrich the contextual description and triangulate findings from the interviews. Documents such as the "National Plan for Development", the "Good Government Agenda", the e-Mexico strategy, and other documents describing the projects were collected and analyzed. Relevant themes for each topic are outlined as a preliminary conceptual map of a simulation model.

E-Mexico Case

President Fox started in 2000 a very ambitious program to promote the Mexican Digital Society and the use of ICT to improve government services. One important component of the program oriented mainly to promote a digital society was called the e-Mexico system, and was housed at the Ministry of Communications and Transportation. The e-Mexico system is an "umbrella" initiative at the center of the Mexican strategy to develop government services and applications for all member of the society. The mission of e-Mexico is to "be an agent of change in the country, integrating efforts from diverse public and private actors in the elimination of the digital divide and other socio-economic differences among Mexicans, through a system with technical and social components to offer basic services on education, health, commercial interchange, and government services, being at the same time leaders in Mexican technological development" (e-México, 2003b). The e-Mexico system was conceived as a way to provide universal access to information, knowledge and government services as a strategy to create a more democratic and participative society where economic and social benefits were better distributed (e-México, 2003b).

The main rationale of e-Mexico was the wide-accepted belief that ICT offer national economies with opportunities to grow, to develop, and to create sustainable competitive advantages. Moreover, ICT use in government is associated with benefits such as cost savings, better programs, more transparency and accountability, and improved democracy (Dawes, 1996; 6, 2001; OECD, 2003). E-Mexico objectives were developed on the basis of information collected from three main sources: a diagnosis of the ICT situation in Federal Government agencies, current practices research looking for e-Gov experiences in Latin America and the rest of the world, and a public forum conducted in 2001 involving more than 900 participants from academia, public administration, private sector, and non-profit organizations. The forum produced more than 140 different documents and proposals, which were considered together with the current practices and the given status of ICT in the Mexican government to develop the e-Mexico strategy.

The proposed goals were ambitious. The goal was not only to reduce the digital divide, but to create social and economic impacts through the access to information and public services. Moreover, the project was intended to contribute to knowledge creation through the creation of a main portal and several sub-portals based upon particular interests of diverse Mexican communities, reaching 80% of the Mexican population through the 20% higher-impact services (e-México, 2003a).

E-Mexico strategy was organized around three main "axes" or lines of action, and with a value-oriented and collaboration focus. The three main axes were (1) to create infrastructure that allows citizens to connecting to the Internet, (2) to produce relevant content, and (3) to develop a technical architecture for government. The focus on value creation and

collaboration was reflected in the coordination nature of e-Mexico. The following paragrpahs include a brief description of each of the three action streams, and the collaborations in the process.

The first line of work of e-Mexico was related to the creation of a connectivity infrastructure to cover most of the country. E-Mexico representatives have been working together with telecommunication companies to promote investment in the communications infrastructure in the country, increasing in this way the number of phone lines in the country. Additionally, e-Mexico system has worked in the deployment of 7,200 Digital Community Centers (DCC), following models that they found operational from experiences in Brazil and Peru, but also following previous successful experiences in the country with educational programs using satellite communications.

One known problem about information on the Internet is the fact that an important proportion of it is in English. In this way, the second main line of work in e-Mexico involved the creation of relevant contents for people to access. Initially, they worked in the development of the main e-Mexico Portal, and four sub-portals, e-Learning, e-Health, e-Economy, and e-Government. The portal project involved a collaboration process with the State Ministries associated to each of the four main "pillars," as people in e-Mexico calls each content area. In fact, there is a contact person in each one of the related Ministries that works together with e-Mexico in the Ministry of Communications and Transportation to coordinate content creation or the integration of currently existing content into the portals.

The last main strategy from e-Mexico was the creation of systems. The first and more visible system was the e-Mexico portal itself. One of the interesting design features of the portal was its orientation to the Mexican citizen, and how it was organized around people's life, home, family, taxes, education, health, etc. The less visible, but not less important system, is conformed by an architecture to facilitate government interoperability and services development.

On the following sections we will focus on the content strategy and the four content portals developed as part of the e-Mexico strategy. The four portals were designed to support the main objectives of the e-Mexico System. The e-Learning portal has the objective to offer new options to access education and training, promoting education for everyone as a way to personal development. E-Health portal intends to increase public health by eliminating barriers to access well-being information and services such as social security. E-Economy portal has the goal to promote the development of the digital economy in Mexico, particularly oriented to the micro, small and medium enterprises (mSMEs), as well as to promote a digital culture among consumers. Finally, e-Government portal is a medium to offer government information and services (e-México, 2003b).

E-Mexico staff collaborated with government agencies in content creation and integration, leaving the final responsibility of content management to the Ministry of Education, Health, Economy, or Public Administration who are actually the content owners. However, although there is one main content owner, many organizations are involved in each sub-portal. As one of the participants commented,

"…of course learning is coordinated by the Ministry of Education, but e-Learning goes beyond schools… education, training and culture. You have to include the Ministry of Education, you have to include the state education authorities, the National Council for Science and Technology (CONACYT), the National Council for Culture and Arts

(CONACULTA), public and private universities, the poet associations, the National Council for Educational Promotion (CONAFE)… This is important, it is very important to understand that the Ministry of Education only provides services to towns with a population greater than 500. Unfortunately, most of the 200,000+ towns in the country have less than 500 habitants. In those places operates a strategy from the National Council for Educational Promotion (CONAFE). They do not have any school; they are not organized in grades… They use a model for literacy based on a multi-grade approach."

In this way, e-Mexico staff collaborated with each of the "sector heads" to invite all other relevant organizations to participate in the creation of each of the four portals. Both processes and results were different on each pillar, and we believe that differences were associated with institutional and organizational factors as we will briefly describe in the following paragraphs.

The e-Health Portal

Maybe the most successful experience in content creation was the e-Health Portal. The Ministry of Health appointed the Director of the National Center for Technological Excellence in Health (CENETEC) as the head of the Sector in this effort. CENETEC was head of an already created network of health-related organizations such as the Mexican Institute for Social Security (IMSS), the Institute for Security and Social Security for State Employees (ISSSTE), several private universities and its own health centers network and other areas in the Ministry of Health. This network of organizations was already involved in conversations related to the use of IT in Health such as telemedicine, electronic health records, and publishing preventive health information. In this way, the e-Health portal initiative was in concordance the goals of this network, and provided them with the technical infrastructure to make it possible.

Figure 3. The e-Health Portal.

According to participants in this collaborative work, e-Mexico coordination and CENETEC played a very effective leadership role in the process. The network of organizations involved in the process developed a formal process to develop and organize content from different sources based on mental maps and a content management process. The contact person at the e-Mexico coordination had an education as a nurse, which helped her to have a more

effective communication with the representatives of the organizations involved. The process lead to a first version of a nicely integrated portal offering health information from all organizations involved. The current version of the portal is shown in Figure 3.

The e-Learning Portal

One important network of organizations was lead by the Ministry of Education and the e-Mexico coordination to create the e-Learning Portal (see Figure 4). Some of the organizations involved were the Public Library System, the Public Education System, CONAFE, the Ministry of Labor (in the area of training), the Ministry of Social Development, and the Latin American Institute for Educational Communication (ILCE). In fact, the Ministry of Education delegated to ILCE the coordination of the Content initiative that was closely mixed with the development of DCC in the country.

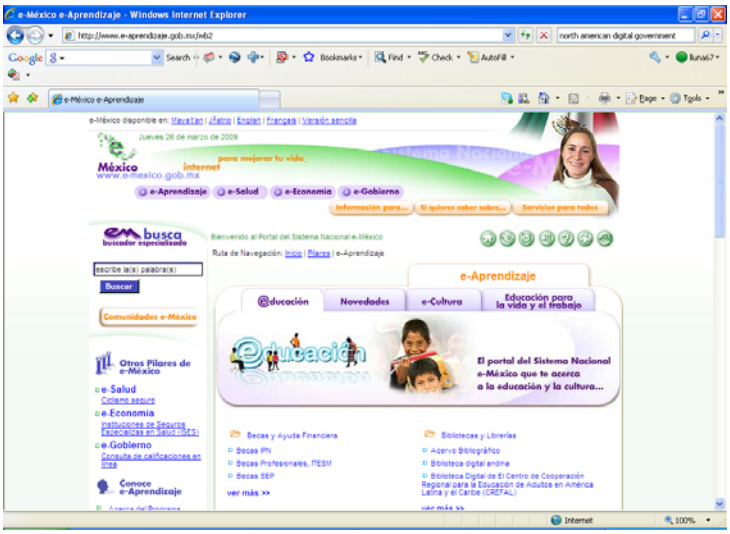


Figure 4. The e-Learning Portal.

Public Education system in Mexico is a huge decentralized system that responds very slowly to any request. Although organizations in this sector are used to work together, they usually move at their own pace. Federal proposals have to move to the State level, and then to the Regional level, and then to the Zone level, and then to the School level, where they have to be discussed and agreed to go back to step-by-step to the Federal level. Moreover, the basic education system has a different bureaucracy than the medium levels, and there are also several modalities of higher education, all with their own unions and rules. Moving all this system took ILCE most of his energy, leaving aside at least at the beginning many of the other actors with the exception of the Public Library System.

The Central Culture of the Ministry of Transportation (where the e-Mexico coordination was hosted) created some initial disagreements. However, given the importance on size of the education system, it has enough bargaining power to be part of the effort, and the e-Mexico coordination accepted the slow progress in the area. The content development formal process created through the e-Mexico experience with other portals did not echoed with ILCE, which is well-recognized nationally and internationally as a leader in the production of electronic media. In this way, the e-Mexico coordination worked with some of the partners that were not directly associated with ILCE in the creation of a portal that was more like a collection of

links to learning and training materials. Almost three years later, ILCE finished the education portal which is currently linked to the original e-Learning portal as shown in Figure 4.

The e-Economy Portal

The e-Economy portal effort was lead by the Ministry of Economy and the e-Mexico Coordination. The Ministry of Economy was until 2000 the Ministry for Industrial Development, and the Minister appointed his Director for Digital Economy as the leader of the sector to work in combination with the e-Mexico Coordination. Because of his focus on industry until 2000, the Ministry of Economy was much interested in promoting a particular strategy to develop the IT industry in Mexico. This effort was coordinated with the main IT industry associations in Mexico through the PROSOFT program. According to some participants in the process from the e-Mexico coordination, this perspective was quite limited because e-Economy should include many other organizations related to individual and small and medium enterprises economy. In this way, the e-Mexico coordination pushed for a more wide perspective looking for alliances with other financial and economic institutions, while the Ministry of Economy worked on its own projects involving his main partners in the process.

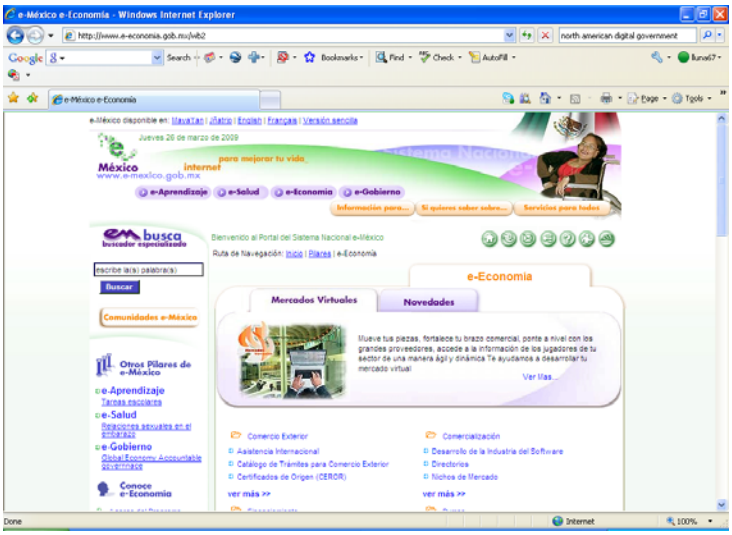


Figure 5. The e-Economy Portal.

As a result of this lack of alignment in goals, two different portals emerged from the process. The e-Economy Portal (see Figure 5), was hosted in the e-Mexico servers, and included mainly a list of organized links to content and interactive tools in organizations such as the Bank for International Commerce, the Small and Medium Enterprise program at the Ministry of Economy, the Ministry of Labor, or the National Commission for the Defence of Users of Financial Services (CONDUSEF). The Direction of Digital Economy at the Ministry of Economy, worked with its industry partners in the development of an alternate portal related to the software and IT industry in Mexico (see Figure 6). The e-Mexico processes developed from other portal development efforts had an impact on their own collection of relevant links, but they had no impact on the development of the PROSOFT portal, which was developed following the processes chosen by the actors involved in such development.

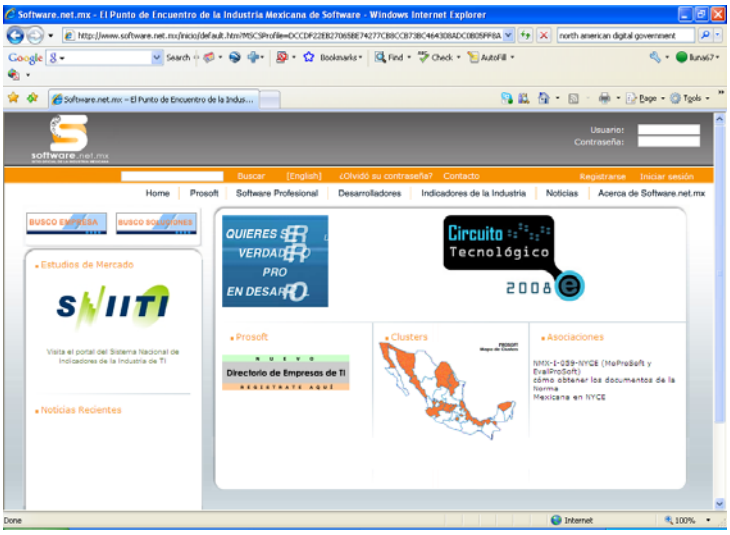


Figure 6. The Prosoft Portal.

The e-Government Portal

Maybe the more complicated relationship among the four networks was the one involved in the development of the e-Government portal. In this project, the Ministry of Public Administration appointed the Director of the Digital Government Unit inside the same ministry as the head of the sector. This Unit had an explicit mandate to coordinate e-Government efforts at the Federal level based on the "Good Government Agenda" from President Fox. This mandate had a lot of intersections with the Presidential Mandate to create the e-Mexico system, promoting goal conflicts and overlaps between both organizations. In fact, two very similar portals (similar in content) were created by each of these two organizations, the e-Government portal by the e-Mexico coordination (see Figure 7), and the Citizen portal created by the Ministry of Public Administration (see Figure 8).

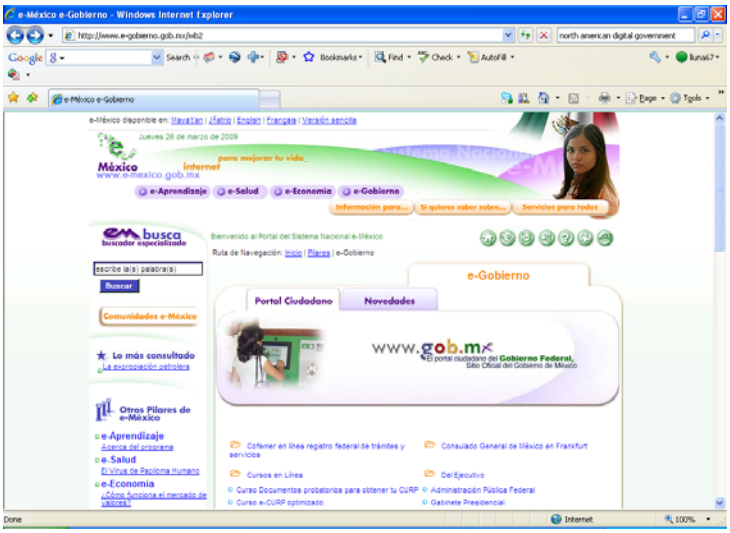


Figure 7. The e-Government Portal.

Similarly to the e-Economy case, the formal processes developed by the e-Mexico Coordination were important in the development of their own e-Government portal, but the Ministry of Public Administration has developed its own processes and standards to develop the citizen portal. Most of the relationship between the two Ministries has been devoted to the delimitation of responsibilities. Currently, the Ministry of Public Administration is in Charge of the e-Government Agenda, related mainly to the provision of government information and services using IT, and the e-Mexico Coordination is in charge of the more ample strategy of promoting the development of the Mexican information society. In fact, the e-Mexico Coordination just changed its name to become the National Coordination for the Information and Knowledge Society. The Ministry of Public Administration has taken over the leaderships of the e-Government Pillar, and the Portal shown in Figure 7 has just disappeared to be completely substituted by the portal in Figure 8.

Figure 8. The citizen portal gob.mx.

Model

We have developed a preliminary System Dynamics Model that represents a theory of how institutional, organizational and technology elements interact among them to produce different technology enactments. In this case, the model is able to reproduce four reasonable scenarios for each of the different content portals involved in the e-Mexico initiative. The section is organized in two subsections. The first subsection is a description of the model structure, and the second part contains several experiments conducted with the model.

Model Structure

Figure 9 represents the main structure in the model ENACTMENT1. The model in its current version includes three main sectors. The Portal Development sector consists of a simplified project structure where members of a network of organizations produced Portal Contents, and these Contents are enacted with different levels of integration. As we described in the case description, organizations involved in these projects also create formal processes with different levels of legitimacy for each network on the Process Formalization Sector. Effort to

develop contents and to develop formal processes is provided by organizations joining the project in the Collaboration Sector. Although organizations joining the network bring with them different levels of engagement and understanding of the project, these understanding and engagement levels are increased by the work developing contents collaboratively or figuring out forms of collaboration in the project through formal processes. Understanding makes their efforts more effective. The existence of the formal processes, increase the effectiveness of the efforts in developing contents, and its legitimacy contributes to the integration of these contents.

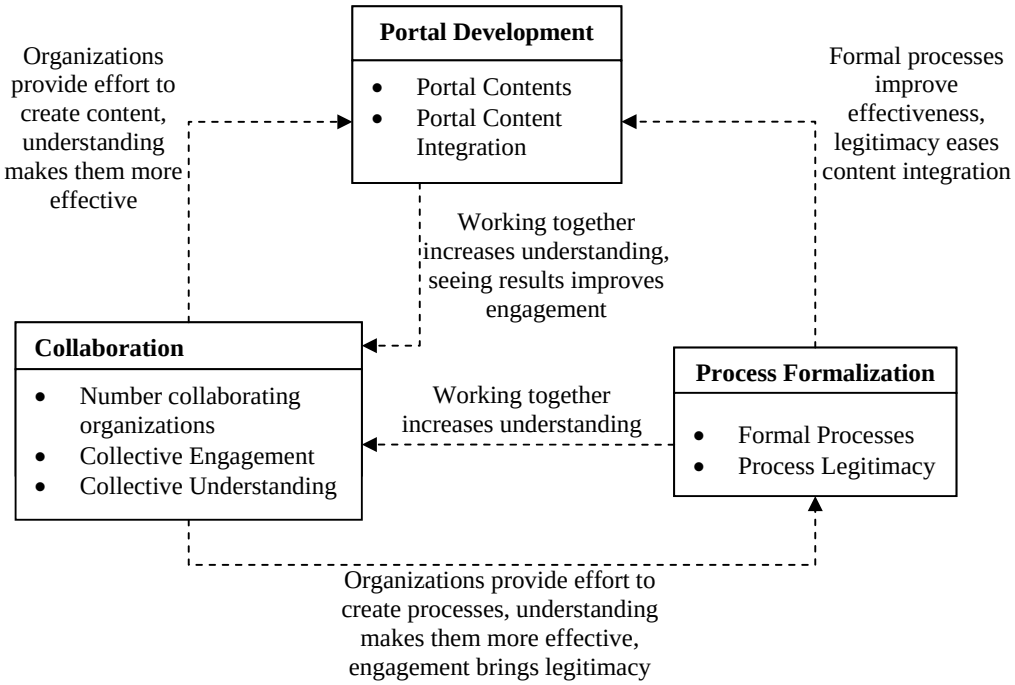


Figure 9. Overview of Model Sectors and Structure.

As shown in Figure 10, organizations joining the project of content creation are modeled as a diffusion model inspired in Bass classical model. The process has two components, and exogenous component related to efforts convincing them to join (represented in the upper part of the figure), and also an endogenous process of word of mouth (in the lower part of the figure). As shown in the figure, organizations can also leave the project according to an attrition rate.

Engagement and understanding are represented as two co-flow structures (see Figure 11). As mentioned above, organizations bring with them initial levels of understanding and engagement, which are modeled as variables with values between 0 and 1. Through their participation in the project, organizations levels of engagement and understanding increase. It is also important to note that total effort from the organizations network is a function of the level of engagement of the organizations in the project. Figure 11 shows the co-flow structure for engagement only, but there is a very similar structure to represent organizations understanding of the project.

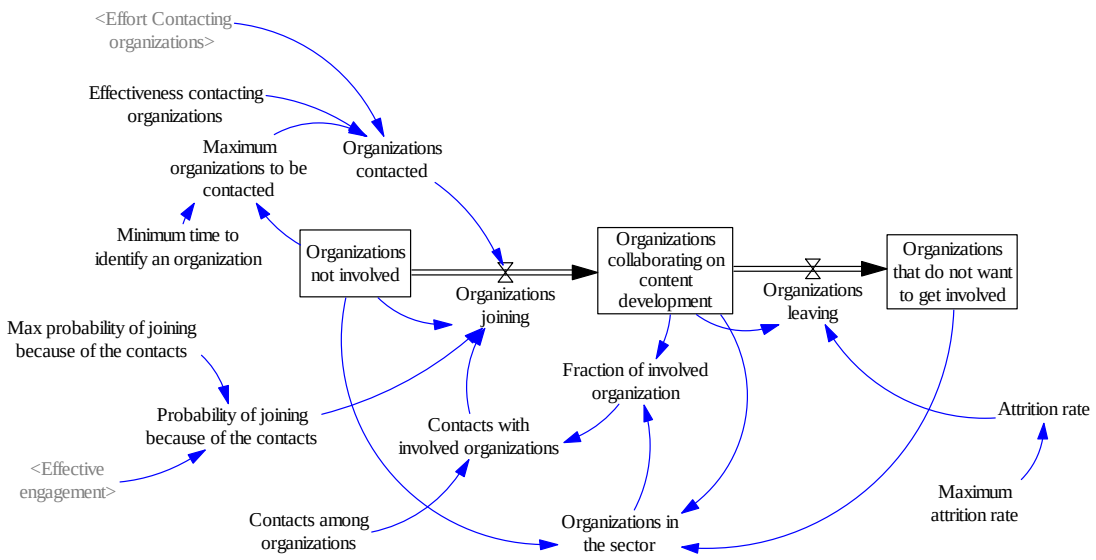


Figure 10. Contacting organizations for the project.

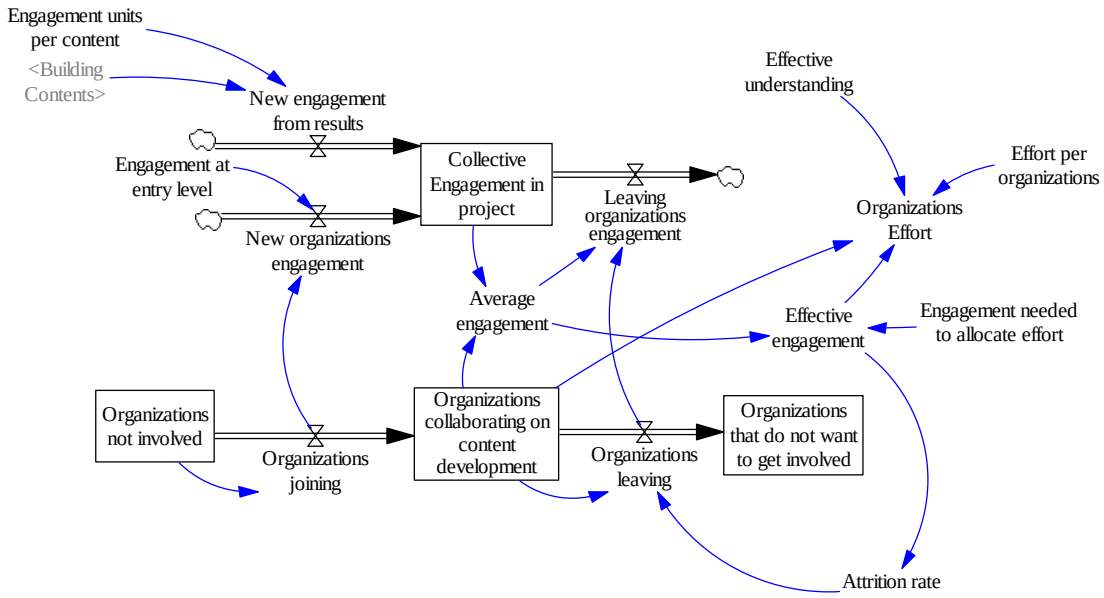


Figure 11. Engaging in the project.

Figure 12 represents the simplified project structure in the current version of the model. In this project, organizations bring effort to content creation with different levels of effectiveness. Effort depends on their level of engagement, and effectiveness depends of their level of understanding. As it is shown in the Figure, content integration is modeled as another co-flow structure. Integration is again a variable that can take any value between zero and 1, and is a function of engagement, understanding and the perceived legitimacy of the formal processes in place.

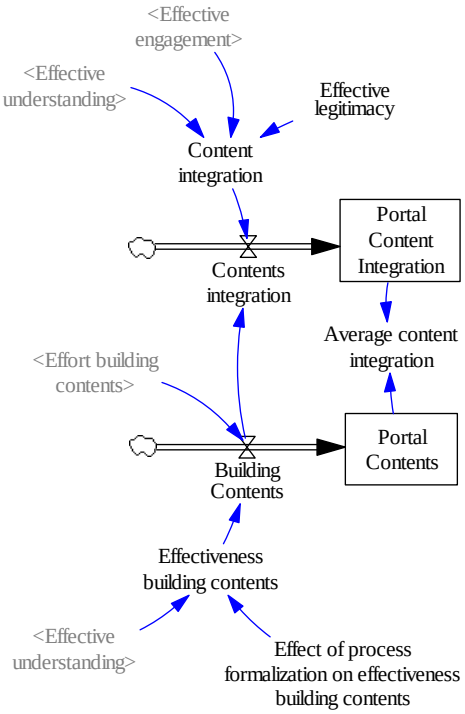


Figure 12. Building Portal Contents.

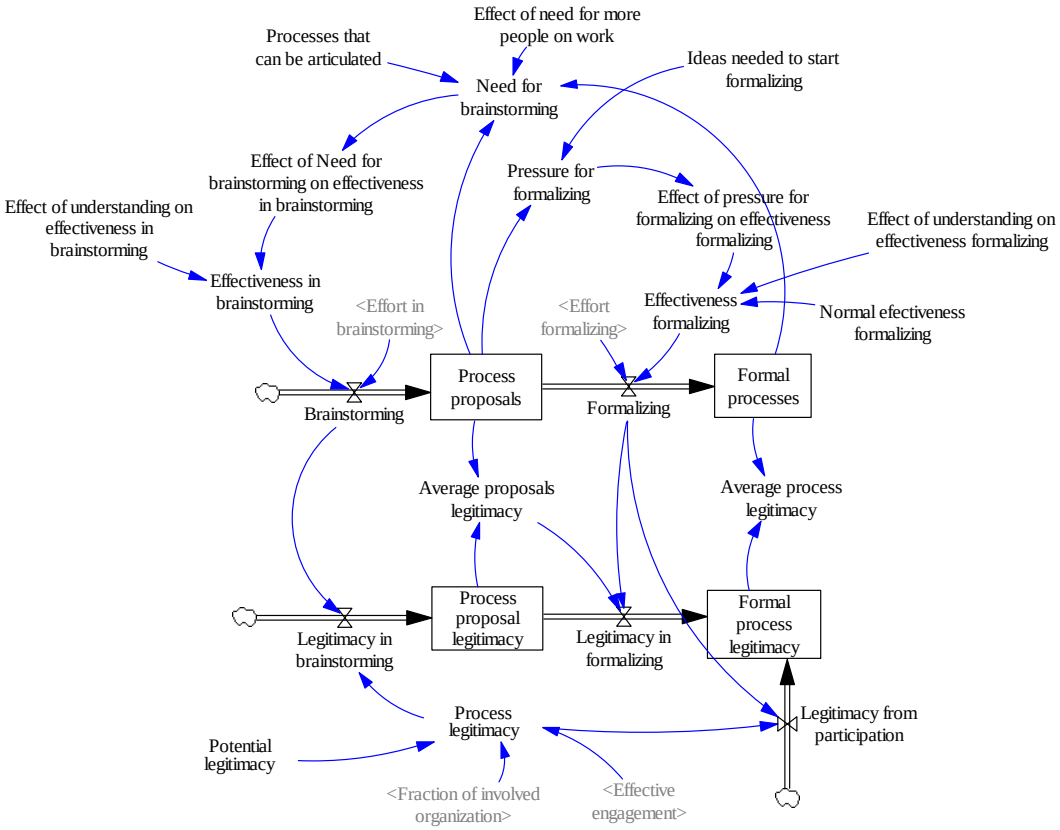


Figure 13. Developing Formal Processes.

Figure 13 shows the basic structure in the process formalization sector. The structure is similar in nature to the structure of content development, but processes are created in two stages. On the first stage, organizations develop process proposals that can be formalized in a second stage. The ratio between Formal processes and the total processes in these two stages has a positive impact on the effectiveness of the network on building contents. Process legitimacy is built by the collective participation in the development of these processes, and in turn, it affects the level of integration also in a positive way.

Finally, there is a structure in the model to decide endogenously on effort allocation in the four main activities represented in the model structure contacting organizations, creating content, and brainstorming or formalizing processes (Figure 14). It is also important to note that the e-Mexico coordination is considered in the current model as an additional source of effort given its role as project leader. Organizations in the network have the capability of emphasizing or give different relative importance to content creation activities or process activities or building relationships activities, which map to portal development, formalizing processes and building the network respectively.

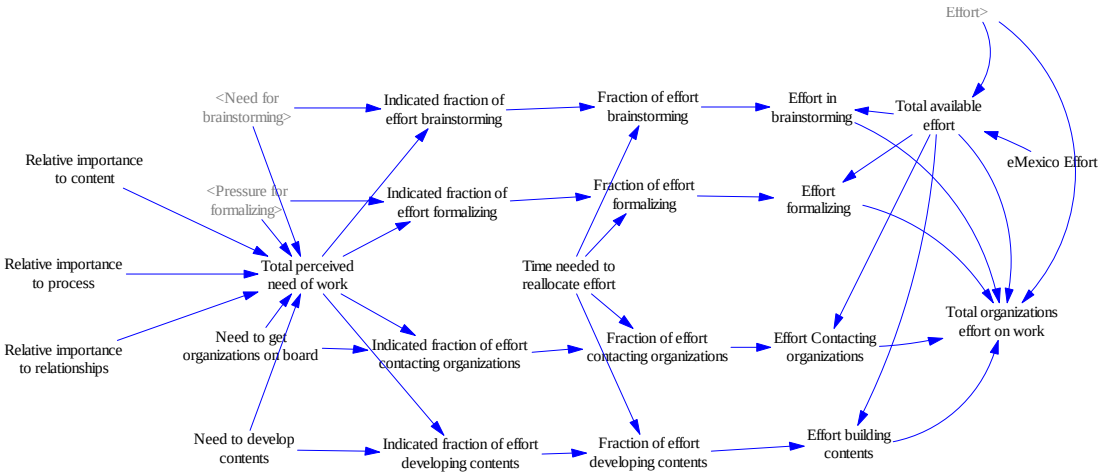
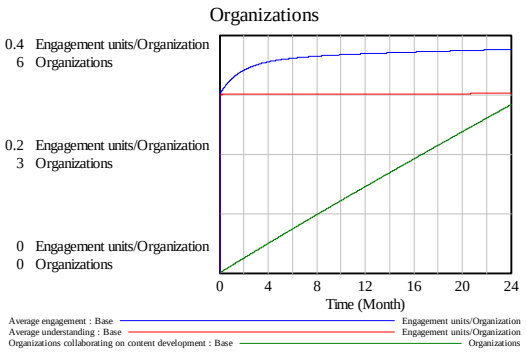


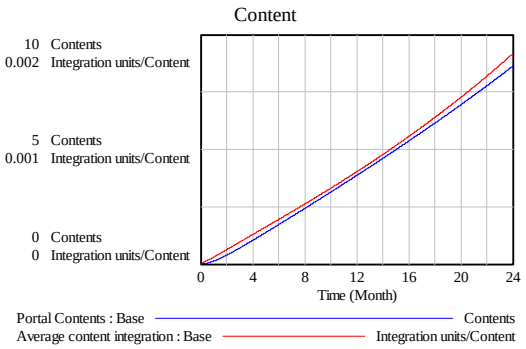
Figure 14. Allocating Effort.

The following section presents a series of model experiments and scenarios related to the four content development projects of the e-Mexico program.

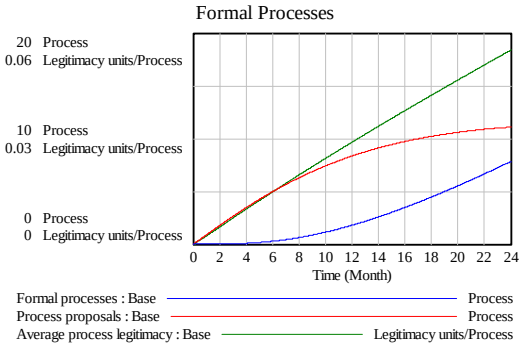
Model Beahvior



(a)



(b)



(c)

Figure 15. Model Base Behavior.

In this section of the paper we start showing some base model behavior, and then we continue suggesting four possible scenarios that correspond to each of the four projects in the e-Mexico content development strategy: e-Health, e-Learning, e-Economy, and e-Government.

Figures 15a, 15b and 15c show some of the basic model behaviors. The base behavior of the model shows a rather bad project of content creation. As shown in Figure 15a, only few organizations join the project and each of them participate in the project with low levels of engagement and understanding. Engagement grows a little as a result of some participation on collaborative content development (see Figure 15b). The network of organizations on this base scenario only develops about 10 contents with a very low level of integration (almost zero).

Organizations in this project develops some formal processes and several process proposals, but again, as shown in Figure 15c, proposals have a low level of legitimacy given the small participation of organizations in this project.

To reproduce the scenarios in each of the four projects, we built four scenarios varying the parameters on Table 1. The main parameters modified were the initial levels of understanding and engagement, the effectiveness contacting organizations, the density of the organizations in the network (reflected by contacts among organizations), and the relative importance given by each network to content, process and relationship building activities.

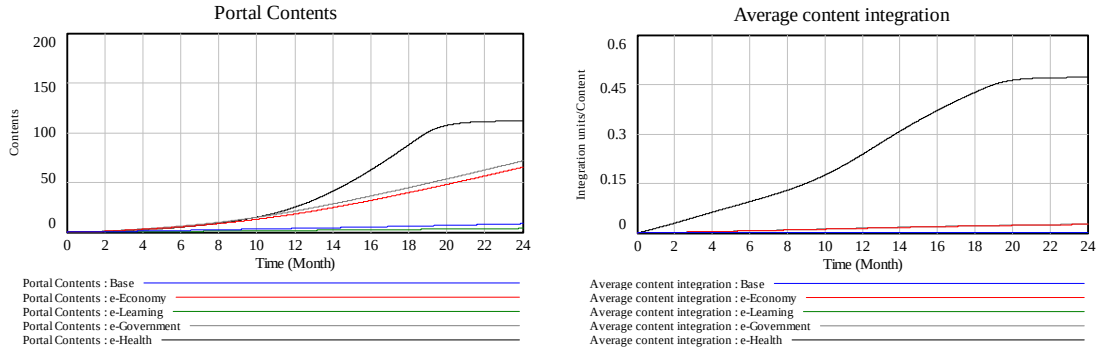
The e-Health network, came into the project with higher levels of engagment and a more dense network given their previous relationships. The e-Government network came with a lower level of engagement because of the conflicts between the goals of the two leading organizations. This same value is also representative of the e-Economy network. However, the internal capabilities to build portals in the Ministry of Economy and the Ministry of

Public Administration is reflected in a higher understanding of project. Moreover, they have very specific goals to their respective portals. Finally, the e-Learning network is the less effective contactying organizations because of the decentralized nature of the education system. All other networks have high effectiveness because of the interest of the President's office in the creation of these content portals and the strong leadership of each of the heads of the sector.

Table 1. Parameter Changes to produce the 4 scenarios.

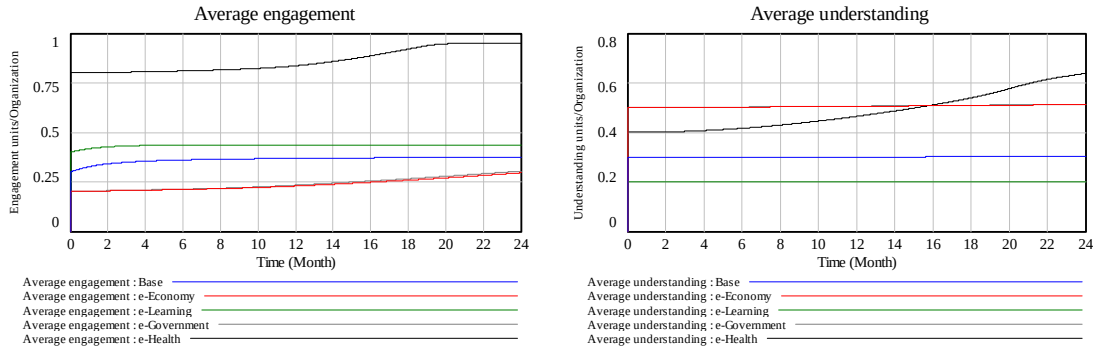
Parameter	Base Run	e-Health	e-Govmnt	e-Learning	e-Economy
Engagement at Entry level	0.3	0.8	0.2	0.4	0.2
Understanding at entry level	0.3	0.4	0.5	0.2	0.5
Effectiveness contacting organizations	0.00625	0.2	0.2	0.00625	0.3
Contacts among organizations	3	10	5	10	3
Relative importance to content	15	10	20	5	20
Relative importance to relationships	10	15	5	20	5
Relative importance to process	10	15	5	20	10

Figures 16a and b show a comparison of content creation in each of the four projects. The most successful network in content creation is the e-Health network, which was able not only to produce an important amount of contents, but it also developed a very well integrated first version of an Internet portal. The e-Government and e-Economy networks were successful in the creation of contents, but with low levels of integration, reflected in the existence of two different portals on each of these networks. The less successful network was the e-Learning one, which not only was able to create few contents, but also with low levels of integration.



(a) *(b)*

Figure 16. Portal Contents in the Four Scenarios.

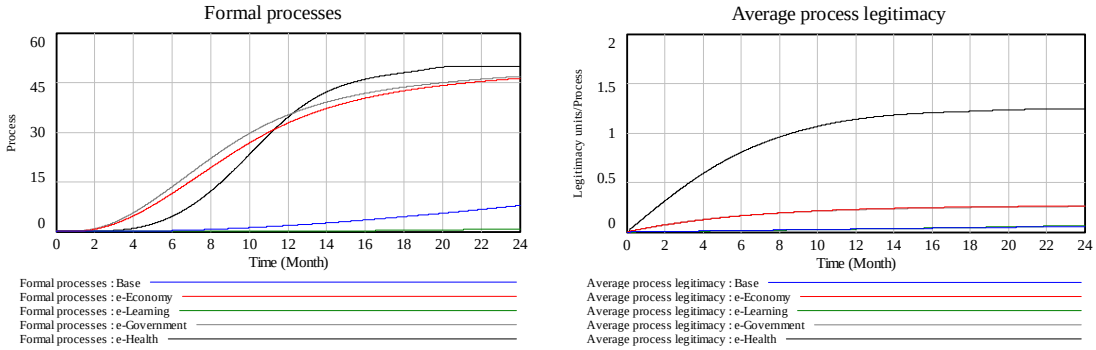


(a) *(b)*

Figure 17. Engagement and Understanding in the Four Scenarios.

Figures 17a and 17b present a comparison of engagement and understanding among the different projects. As shown in the figures, the only network where the endogenous processes increased the levels of understanding and engagement was the e-Health network. All the other networks finished with very similar levels of understanding and engagement compared to the initial levels.

Finally, figures 18a and 18b show the comparison of formal processes on each network and their respective levels of legitimacy. The e-Health, e-Government and e-Economy networks finished with an important number of formal processes. Given their initial lower level of understanding, the e-Health network takes longer to develop formal processes at the beginning, but they are more effective at the end in this process. The e-Learning network has just few processes at the end of the simulation. Considering the levels of legitimacy, the only successful network, with legitimate processes recognized as such for all members of the network is the e-Health network.



(a) *(b)*

Figure 18. Formal Processes in the Four Scenarios.

Final Remarks

In this paper, we presented a model which draws on Institutional Theory and the e-Mexico case to produce a formal Theory of the process of enacting technology. The model reproduces different technology enactments consistent to observations of the content development networks present in the e-Mexico program.

Model results need to be further discussed to assess their value to research and practice, but the initial results are promising. We will continue with further experimentation and model refinements to present a more valid theory of technology enactment.

Acknowledgments

This study was supported by the National Council of Science and Technology (CONACYT-Mexico) under grant SEP-2004-C01-46507 and by the National Science Foundation under grant No. 0131923. The views and conclusions expressed in this paper are those of the authors alone and do not necessarily reflect the views of CONACYT or NSF.

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