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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 expecting to obtain important benefits such as improved efficiency or greater transparency. However, many e-Government projects fail to deliver their promises in terms of specific outcomes. 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. This paper proposes the use of institutional theory and dynamic simulation, particularly system dynamics, as an integrated and comprehensive approach to understand e-Government phenomena. Combining a sound theory and a sophisticated analytical technique will help to improve our understanding about ICT in government settings. The paper draws on the case of the e-Mexico program, particularly on the strategy to create web-based content portals for citizens 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 and their content. The results provide evidence to demonstrate important bidirectional relationships between formal processes (institutions), agency networks (organizational forms), and the resulting characteristics of the four thematic portals (enacted technology).

1. Introduction

Electronic government (e-Government) has been recognized as a powerful strategy for government transformation. In the last 10 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 in terms of specific outcomes (Heeks, 2003). Some such failures are the result of a lack of understanding about the complex relationships among technologies, information use, organizational factors, institutional arrangements, and socio-economic contexts involved in the selection, design, implementation, and use of information and communication technologies (ICT), producing mismatches and unintended consequences. In order to improve this situation, we need to put together theories and analytical techniques, which allow identifying and capturing the complexity of the relationships between relevant variables.

Therefore, it seems necessary to develop analytical approaches that combine a 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 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 (Luna-Reyes, Black, Cresswell, & Pardo, 2008). 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 (Fountain, 2001). System dynamics has also been an effective research method to understand complexity and time trends in e-Government and other ICT related domains.

This paper applies this integrated research approach to the case of the e-Mexico program, particularly to the strategy that created web-based content portals for citizens 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

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engaged in the creation of internet portals, which included relevant content in these four areas. The case is interesting because it illustrates the ways in which differences in institutional arrangements (formal processes) and organizational factors (agency networks) resulted on different technology enactments (characteristics of the technological artifacts and how they are perceived by social actors). Therefore, the purpose of this paper is twofold. First, it shows the importance of specific institutional arrangements and organizational forms on the characteristics of the resulting technology (enacted technology). It also demonstrates the recursive and complex nature of the relationships between these three variables: enacted technology, organizational forms, and institutions. Second, the paper shows the advantages of combining a sound theory and a sophisticated analytical technique in order to explain complex e-Government phenomena. Institutional theory is accepted as a powerful lens, but has been used at a very abstract level. System dynamics requires the specification of the variables and their relationships and, therefore, provides institutional theory with a systematic way to operationalize abstract theoretical concepts in specific and practically relevant variables. Together, they demonstrate the great explanatory power of sound theories and computer simulation as an integrated research approach.

The paper is organized in five additional sections after this introduction. The next section includes a brief review of institutional theory and the ways in which it is connected to 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.

2. Literature review

We propose that institutional theory in general and the technology enactment framework in particular represent a powerful theoretical lens to explain specific information technology impacts (productivity, life style, etc.) for specific organizations or individuals and allow to understand the recursive and complex 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 & Pugh, 1981; Sterman, 2000). In the next sections, we briefly describe institutional theory, showing the technology enactment framework as a highly integrated and refined representation of institutional theory applied to ICT initiatives. Then, we briefly describe system dynamics as our preferred simulation approach.

2.1. 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 (Fountain, 2001; Kling, 2000; Orlikowski, 2000; Orlikowski & 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 & 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 (Fountain & Gil-Garcia, 2006; Gil-Garcia, 2005).

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 & Olsen, 1989). These guidelines are historically produced and reproduced and, therefore, are taken for granted and not questioned (Zucker, 1977). Institutions have been defined as mechanisms that are perceived as objective and constrain the behavior of individuals (Berger & Luckmann, 1966). 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. These different conceptualizations and foundations have been summarized in three pillars that represent or support institutions: cultural-cognitive, normative, and regulative (Scott, 2001).

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 (Hassan & Gil-Garcia, 2008). We describe a recent institutional framework that integrates technology as a critical component of the analysis: the technology enactment framework. The technology enactment framework (Fountain, 1995, 2001) could be considered one of the most refined and integrated institutional approaches to the study of technology in organizations, particularly government agencies (see Fig. 1). Technology enactment focuses on the intersections between institutions, bureaucratic structures, and information technologies. The basic logic of this framework is that "objective technologies" (hardware, software, networks, etc.) are shaped by organizational forms and institutional arrangements to become "enacted technologies." Similarly, organizational forms and institutional arrangements are affected by the selection, design, and use of ICT, acknowledging the bidirectional relationships between ICT and social structures (Orlikowski, 1992, 2000).

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 (Fountain, 2001). 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 (Puron Cid & Gil-Garcia, 2004). The enacted technology produces certain organizational results or outcomes in terms of efficiency, effectiveness, and transparency, among others. These outcomes also affect the enacted technology, the organizational forms, and the institutional arrangements.

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,

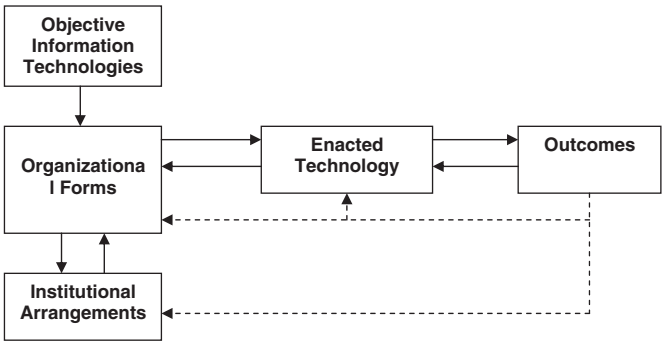

Fig. 1. Technology enactment framework (Fountain, 2001).

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, 2001). Therefore, the technology enactment framework acknowledges the recursive nature of the relationships between organizations, institutions, and information technologies.

2.2. Dynamic simulation

System dynamics is a method for studying and managing complex feedback systems (Forrester, 1961; Richardson & Pugh, 1981; Roberts, Andersen, Deal, Grant, & Shaffer, 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 hypotheses about the impact of feedback processes on specific problematic behaviors in a system. 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, Andersen, & Luna-Reyes, 2004). System dynamics has been also successfully used to better understand information technology problems in organizations (Abdel-Hamid & Madnick, 1991; Georgantzas & Katsamakas, 2008; Luna-Reyes, Andersen, Richardson, Pardo, & Cresswell, 2007; Luna-Reyes et al., 2008; Madachy & Tarbet, 2000).

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 & 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 feedback loop is a closed path of causal links. “A feedback loop exists when decisions change the state of the system, changing the conditions and information that influence future decisions” (Richardson, 2000, p. 9). 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 Fig. 2). Stocks (or state variables) represent accumulations in the system (rectangles in the figure), 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 graphical representation is consistent with the basic assumptions of institutional theory and the technology enactment framework. As shown in Fig. 2, the Organizational and Institutional Framework either constrains or enables organizational activity oriented to the development of a particular Technology Enactment. It is also demonstrated that 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 organizational activity by constraining or promoting either effort or effectiveness. Technological artifacts accumulated in the stock of Technology Enactment are just software components, processes, or documentation with no particular characteristics at all. However, technological characteristics are co-created along with these artifacts as shown in Fig. 2. 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 (marked with thick arrows) represents the recursive interactions among variables or the process of enacting technology.

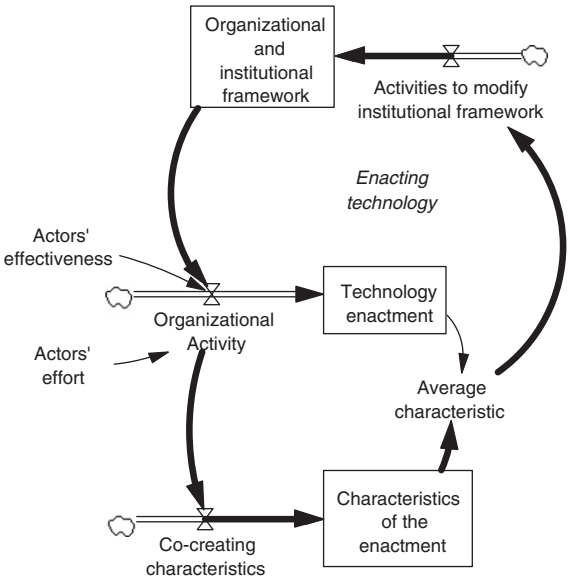

Fig. 2. A system dynamics stock-and-flow diagram.

3. Research design and 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 was to understand the mechanisms and results of collaborative digital government in Latin American contexts. It has also provided 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 portals in the areas of government (e-Government), health (e-Health), education (e-Learning), and economy (e-Economy), all of which are part of the e-Mexico initiative. Specifically, the results reported here are based on analysis of documentation and 26 semi-structured interviews with public managers involved in the implementation of these programs at the ministry of Communications and Transportation, 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 shared a leadership role with leaders presiding over each of the four areas. Other participant organizations also interviewed were the ministry of Labor, the ministry of Social Development, the National Commission for the Defense of Users of Financial Services (CONDUSEF), The

National Council for Education Promotion (CONAFE), the Directorate of Public Libraries, the Mexican Institute for Social Security (IMSS), the Institute for Social Security of State Employees (ISSSTE), and a private university.

The 26 interviews took place from November 2006 to March 2007. Each individual interview had an average duration of 1 h. 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 technology characteristics (enactments) and results of the four portals created in collaboration with different agency partners. For example, the e-Government portal, coordinated by the ministry of Public Administration is significantly different from 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 the different 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 were outlined as a preliminary conceptual map of a simulation model.

System dynamics relies on a variety of qualitative and quantitative data sources in the construction and formulation of dynamic models. As mentioned above, the premise is that dynamic behaviors (performance over time) are closely linked to an underlying structure of feedback loops. Dynamic simulation helps us obtain a better understanding of verbal theories and any unexpected outcome obtained from them, with the potential to inform or improve the activities of both theorists and empirical analysts (Patrick, 1995). In some ways, using system dynamics models to build and test the consistency of theory internally and with the data is comparable to other qualitative theory-building approaches (Kopainsky & Luna-Reyes, 2008). When generating theory from a case study using system dynamics,

> A formal model is constructed by inferring from data and theoretical statements some hypotheses about causal relationships that generate a particular pattern of behavior over time observed in the case. Model-building proceeds iteratively by representing the hypotheses in a mathematical form, simulating, comparing the model output with observed behaviors, and returning to the observations and theories to refine the hypotheses represented in the model by changing its structure. In this sense, a formal model is a non-textual, mathematical expression of a theory of the cause-and-effect relationships that systematically produces the patterns of behavior observed in the field (Black, 2002, p. 120)

The model-building process includes many iterative assessment and validation elements (a good compilation of these kinds of tests can be found in Chapter 21 of Sterman's (2000) book), seeking face validity, verifying model parameters, checking for dimensional consistency, running sensitivity tests, and qualitatively assessing the model behaviors. For this particular modeling effort, the validity of the model structure comes from two main sources. First, the main variables included in the model are grounded on the descriptions of each network and content portal found during the interviewing process. On the other hand, these variables and processes are consistent with the main constructs in the technology enactment framework. Moreover, the model was built in several iterations. After each iteration, we conducted extensive sensitivity tests to verify model behavior under several parameter conditions. Finally, and although we did not have actual time series for each content portal, the model has the capability to reproduce qualitative behaviors that are consistent with the stories told by interviewees and the final state of each content portal.

4. The e-Mexico program: a case of differentiated technology enactments

President Fox started a very ambitious program in 2000 to promote the Mexican Digital Society and the use of ICT to improve government services. One important component of the program was called the e-Mexico system, and it 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 the whole 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, 2003a)

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, 2003a).

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 consisted on a series of face-to-face meetings that included plenary presentations and working groups on specific themes. 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 also 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 establishment 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, 2003b).

The e-Mexico strategy was organized around three main "axes", or lines, of action, and with a value-oriented, collaborative focus. The three main axes were: (1) to create infrastructure that allows citizens to connect 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 paragraphs include a brief description of each of the three action streams.

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 7200 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 content 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 call 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 consists of an architecture to facilitate government interoperability and services development.

In 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 seeks to offer new options to access education and training, promoting education for everyone as a way to personal development. The e-Health portal intends to increase public health by eliminating barriers to access well-being information and services such as social security. The e-Economy portal seeks 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, the e-Government portal is a medium to offer government information and services (e-México, 2003a).

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 the actual 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 show in the following paragraphs how important differences were clearly associated with institutional and organizational factors.

4.1. 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 Social Security of 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 the health field, such as telemedicine, electronic health records, and publishing preventive health information. In this way, the e-Health portal initiative was in concordance to the goals of this network, and provided them with the technical infrastructure to make it possible.

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 led to the first version of a nicely integrated portal offering health information from all organizations involved. The current version of the portal is shown in Fig. 3.

4.2. The e-Learning portal

A second important network of organizations was lead by the Ministry of Education and the e-Mexico coordination to create the e-Learning portal (see Fig. 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 related to the development of Digital Community Centers (DCC) across the country.

The public education system in Mexico is a huge decentralized system (education falls under the responsibility of state governments) that responds very slowly to any request. Although organizations in this sector are used to work together, they usually move at their own pace. As one of the interviewees described,

> *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, step-by-step, to the Federal level.*

Moreover, the elementary 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 aspects of 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 centralized culture of the Ministry of Transportation (where the e-Mexico coordination was hosted) created some initial disagreements. However, given the importance of the size of the education system, it had 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 actually a collection of links to learning and training materials. Almost 3 years later, ILCE finished the education portal which is currently linked to the original e-Learning portal as shown in Fig. 4.

4.3. The e-Economy portal

The e-Economy portal effort was led by the Ministry of Economy and the e-Mexico Coordination. Up until 2000, the Ministry of Economy

Fig. 3. The e-Health portal.

was called 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 up until 2000, the Ministry of Economy was very interested in promoting a particular strategy to develop the IT industry in Mexico, as well as promoting IT use by SMEs. This effort was coordinated with the main IT industry associations in Mexico through the PROSOFT program. According to some participants in the process

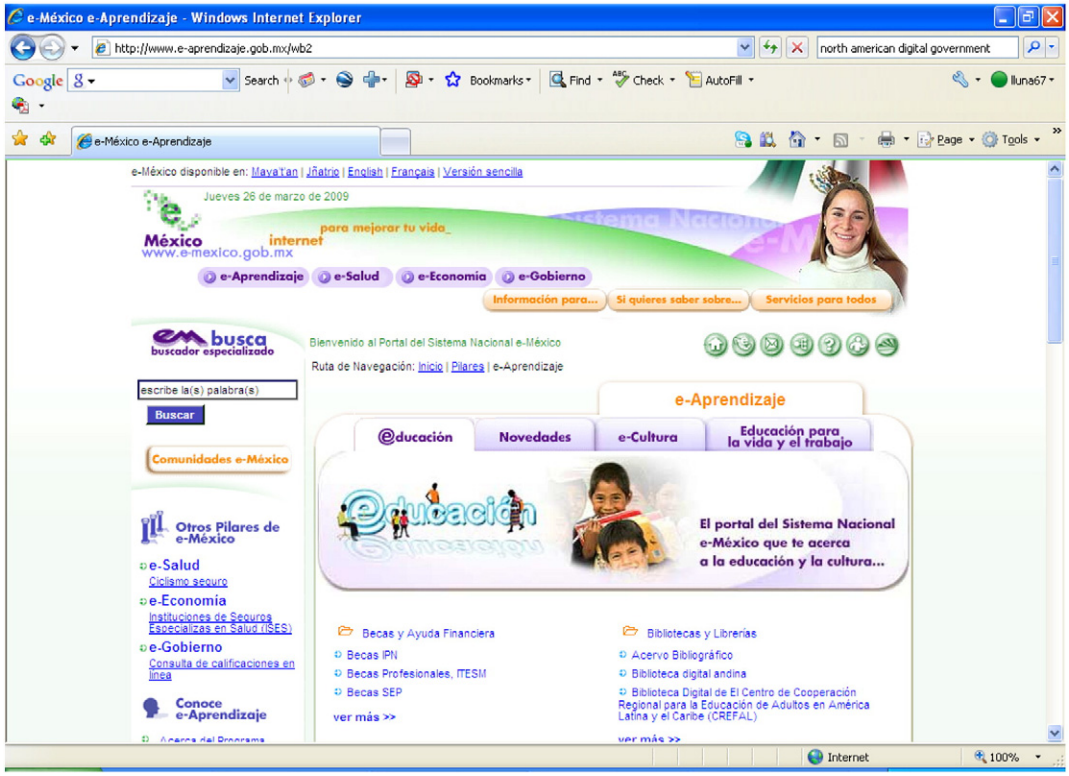

Fig. 4. The e-Learning portal.

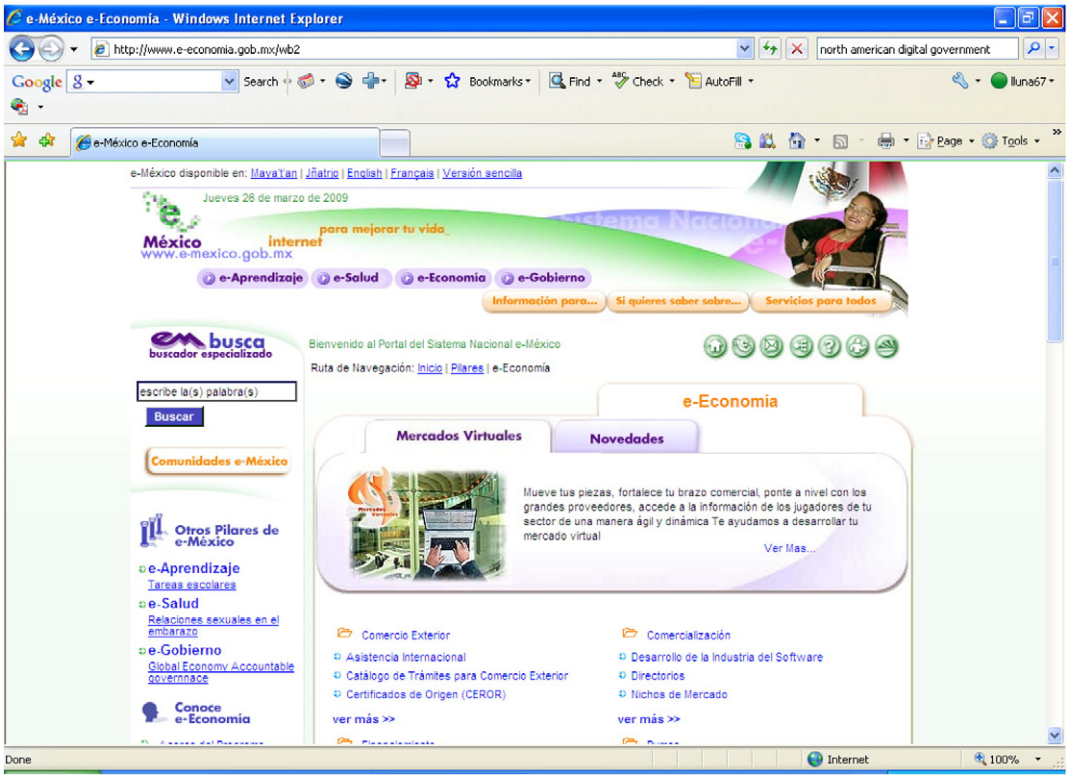

Fig. 5. The e-Economy portal.

from the e-Mexico coordination, this perspective was quite limited because e-Economy should include many other organizations. In this way, the e-Mexico coordination pushed for a wider 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.

As a result of this lack of alignment in goals, two different portals emerged from the process. The e-Economy portal (see Fig. 5), was

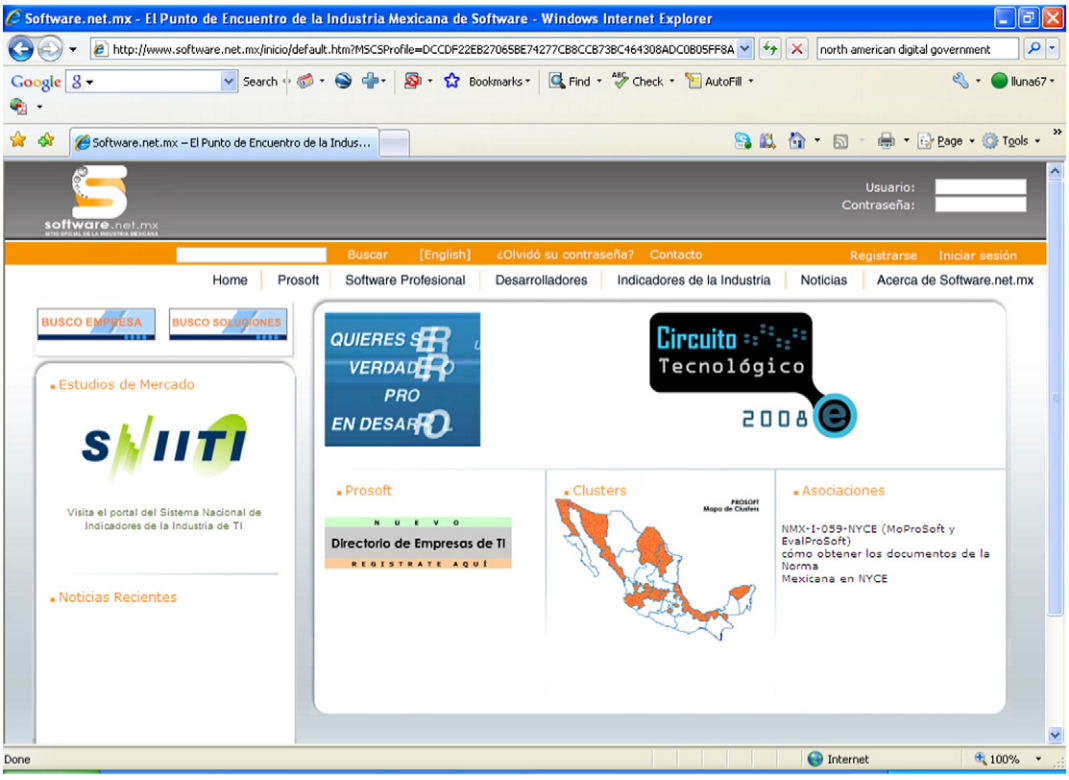

Fig. 6. The PROSOFT portal.

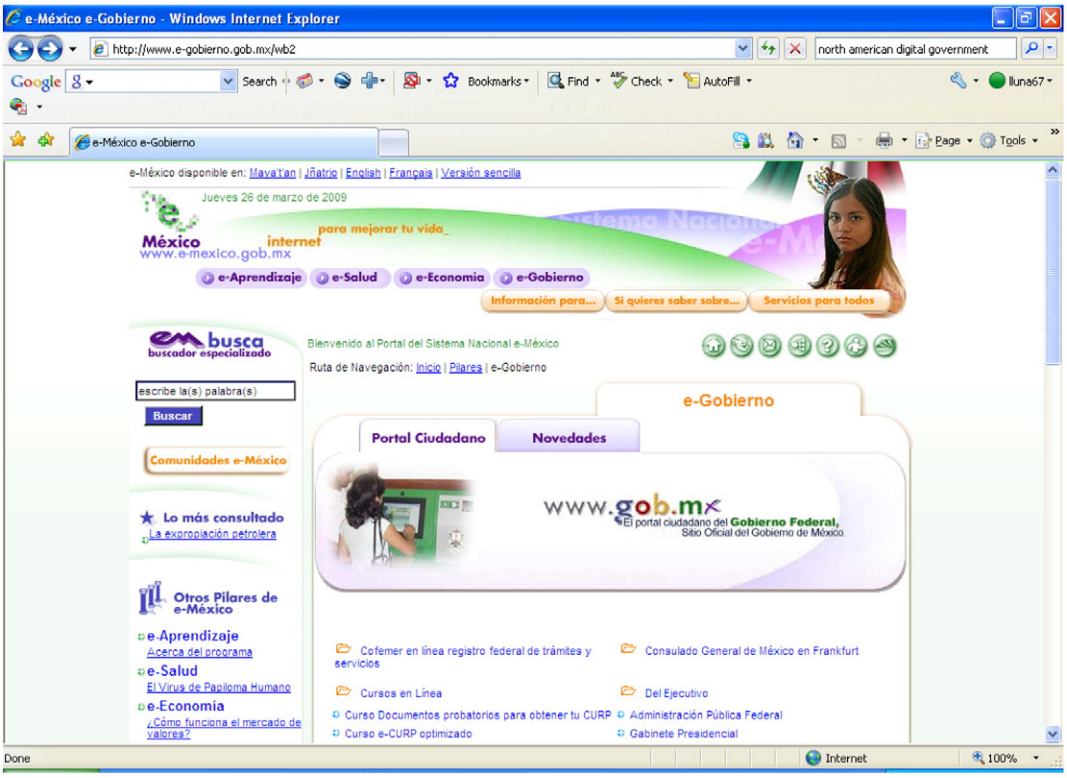

Fig. 7. The e-Government portal.

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 Defense 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

Fig. 8. The citizen portal gob.mx.

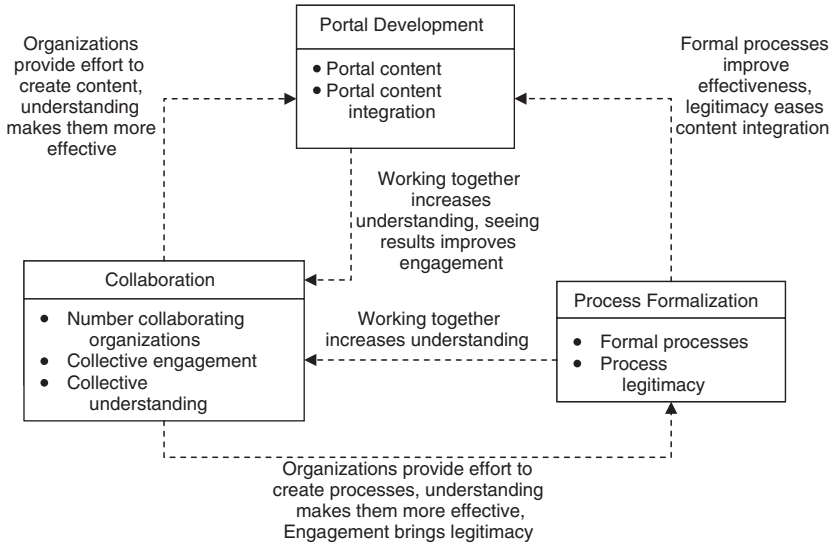

Fig. 9. Overview of model sectors and structure.

Fig. 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 direct influence on the development of the PROSOFT portal, which was developed following the processes chosen by the actors involved in such development, mainly the Ministry of Economy and its industry partners.

4.4. 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 many intersections with the Presidential Mandate to create the e-Mexico system, which caused 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 Fig. 7), and the citizen portal created by the Ministry of Public Administration (see Fig. 8).

Similar 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 developed its own processes and standards for the citizen portal. The relationship between the two Ministries has been mainly devoted to the clarification of roles and 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 broad 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.

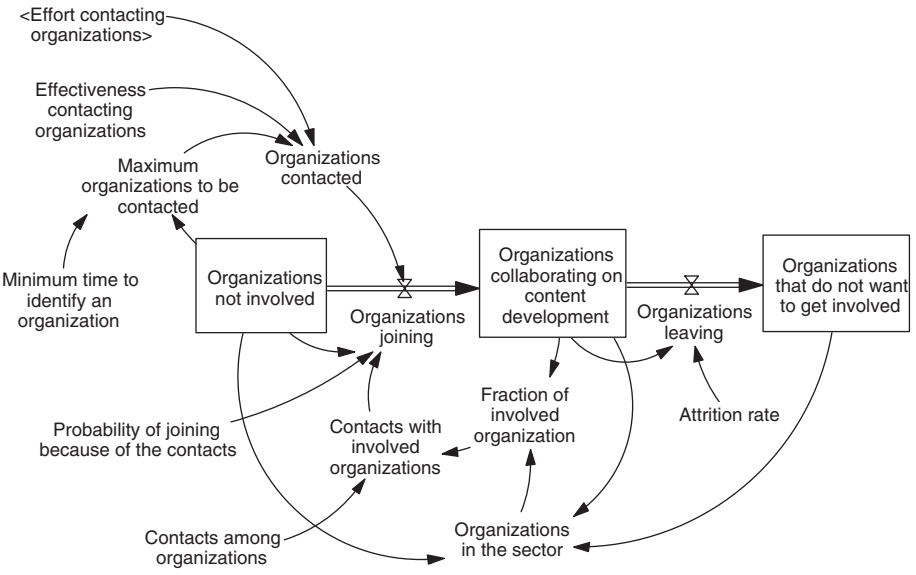

Fig. 10. Contacting organizations for the project.

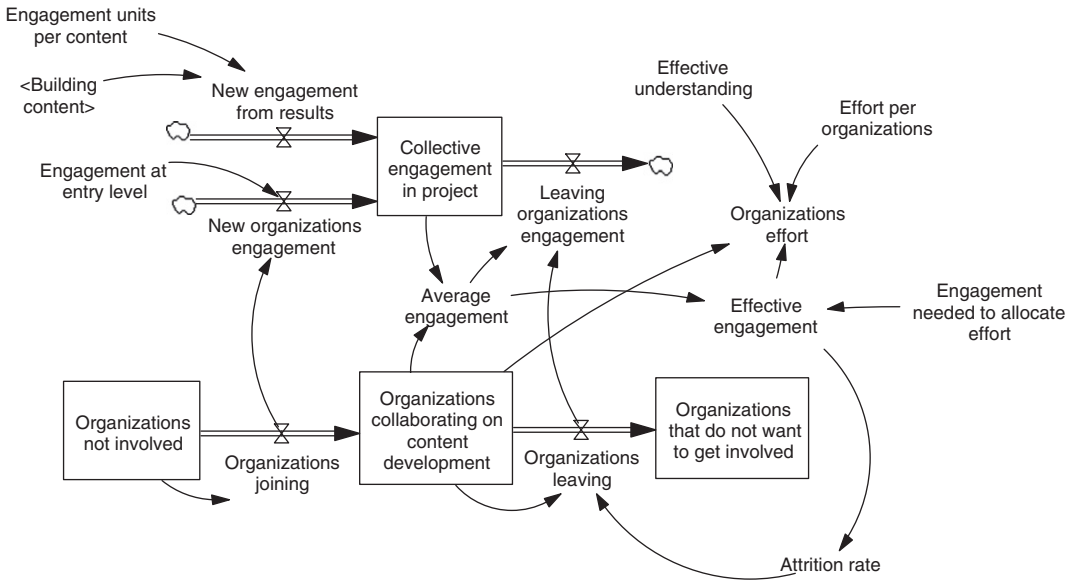

Fig. 11. Engaging in the project.

5. System dynamics model

We have developed a preliminary system dynamics model that represents a theory of how institutional, organizational, and technological elements interact 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 behavior).

5.1. Model structure

Fig. 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 produce portal content, and this content is enacted with different levels of integration (technology enactment). As we mentioned 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* (institutional arrangements). Effort to develop content and to develop formal processes is provided by organizations joining the project in the *collaboration sector* (organizational forms). 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 content 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 increases the effectiveness of the efforts in developing content, and its legitimacy contributes to the integration of this content.

As shown in Fig. 10, organizations joining the project of content creation are modeled according to innovation diffusion theory. The process has two components, an exogenous component related to efforts convincing organizations 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 co-created while organizations work together (see Fig. 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. Fig. 11 shows the co-creation structure for engagement, and demonstrates how organizations build engagement while seeing results in the creation of content. There is a very similar structure to represent organizations' understanding of the project. In this way, organizational characteristics are intertwined in a recursive interaction with the creation of content in the enacting process.

Fig. 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

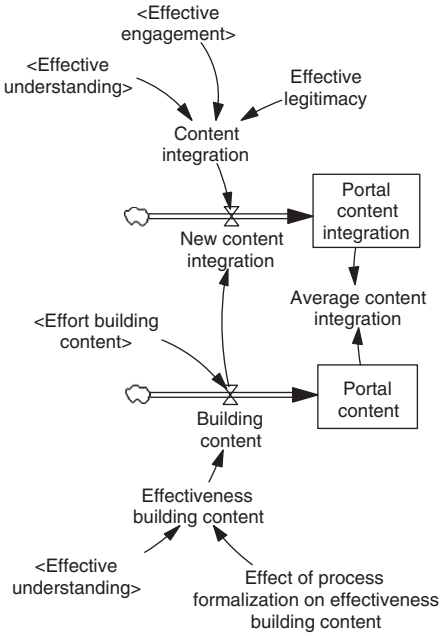

Fig. 12. Building portal content.

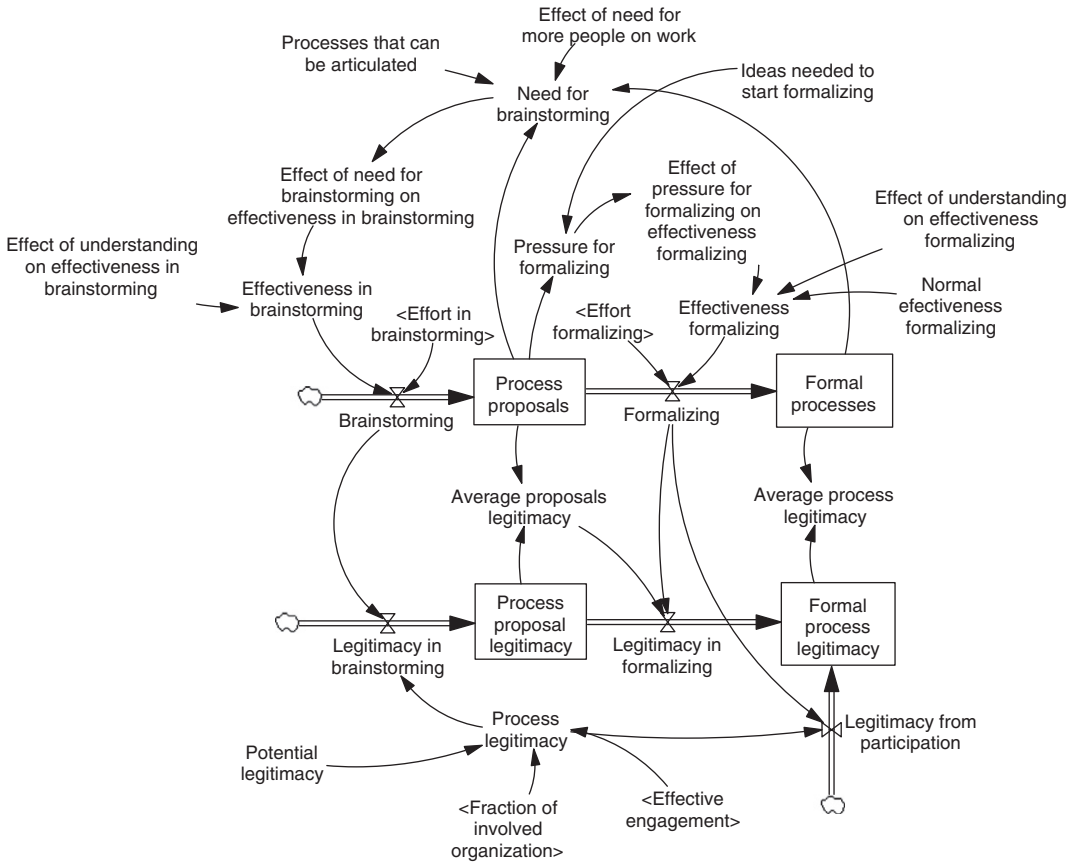

Fig. 13. Developing formal processes.

level of understanding. As it is shown in the figure, content integration is modeled as another co-creation structure. Integration is again a variable that can take any value between 0 and 1, and is a function of engagement, understanding and the perceived legitimacy of the formal processes in place. That is to say, content integration is a content characteristic that can be enacted in many different ways. A particular enactment depends on organizational and institutional factors such as the engagement or project understanding of network members, or the existence of formal legitimate processes to create content.

Fig. 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 content. 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. That is to say, the existence of institutional arrangements such as

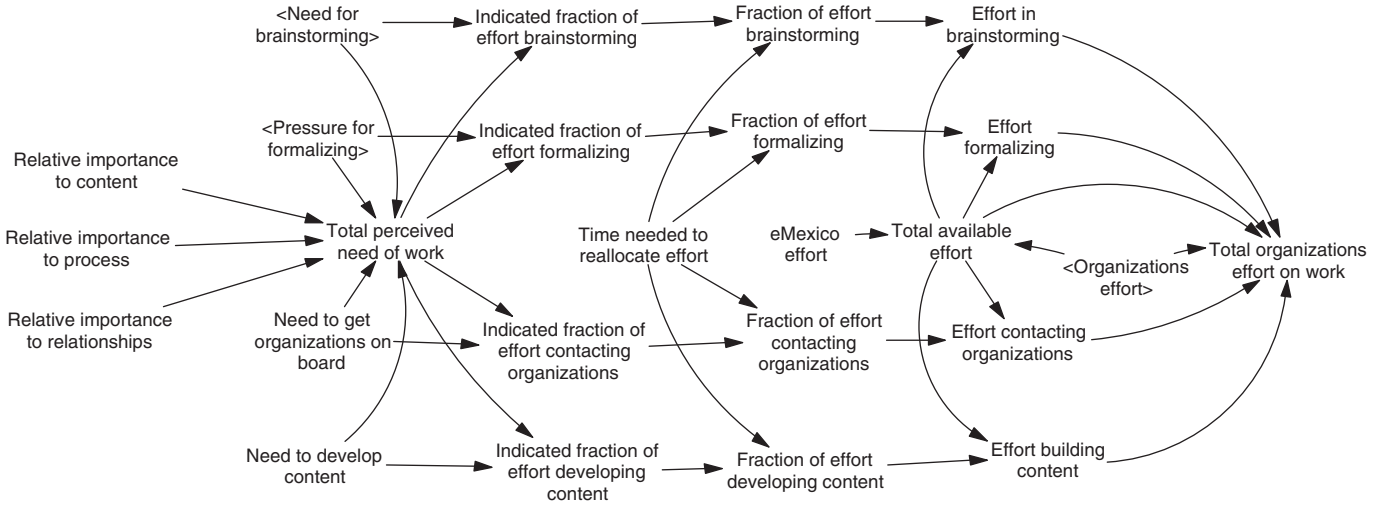

Fig. 14. Allocating effort.

legitimate formal processes constrains or enables a particular enactment, but it is at the same time modified by organizational factors and project progress in the enactment process through a series of recursive processes or feedback loops.

Finally, there is a structure in the model to allocate effort endogenously in the four main activities represented in the model structure: contacting organizations, creating content, brainstorming, or formalizing processes (Fig. 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, process activities or building relationships activities, which map to portal development, formalizing processes and building the network respectively. The next section presents a series of model experiments and scenarios related to the four content development projects of the e-Mexico program.

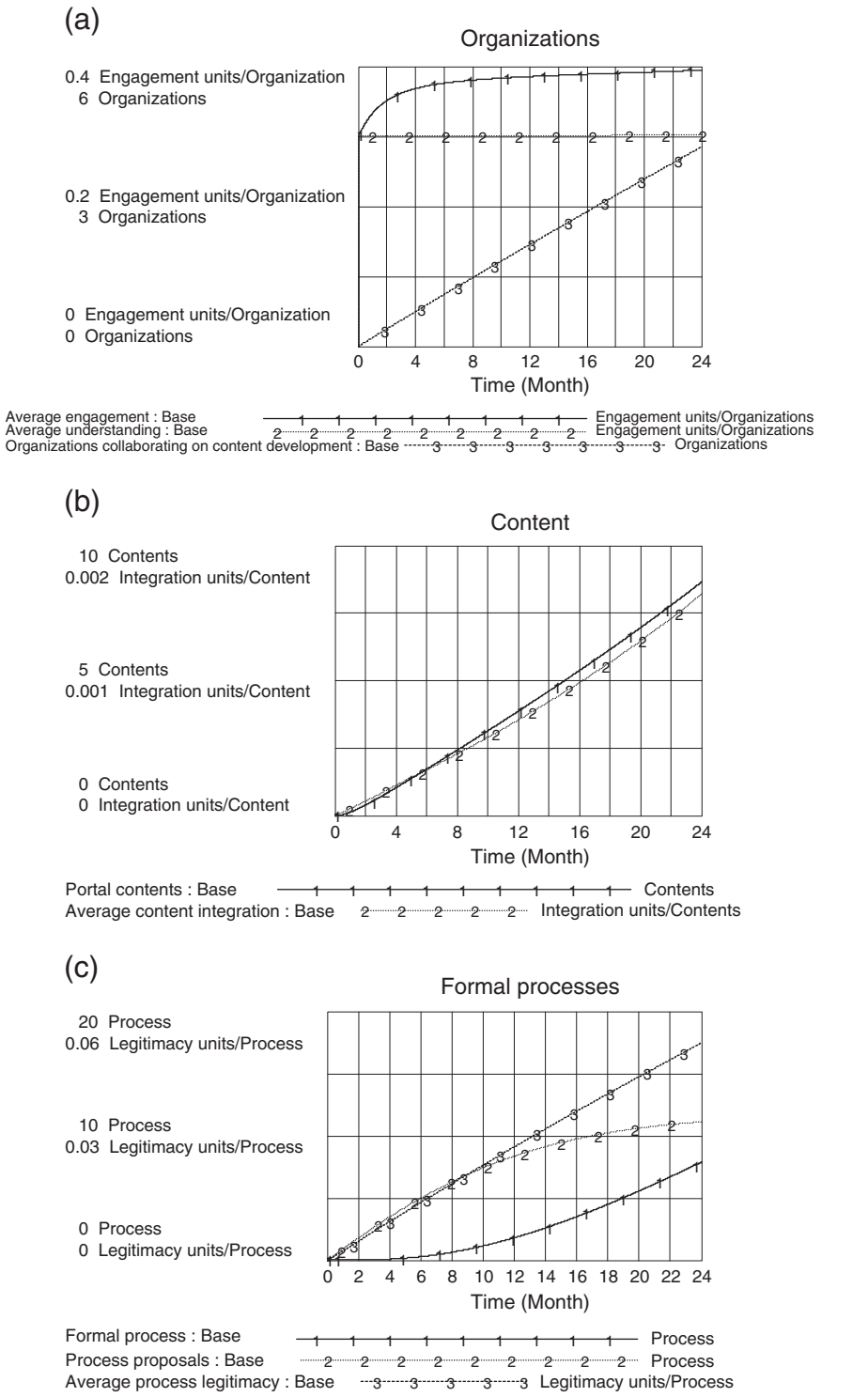

Fig. 15. Model base behavior.

Table 1
Parameter changes to produce the 4 scenarios.

Parameter	Base run	e-Health	e-Government	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

5.2. Model behavior

In this section of the paper we show some basic model behavior, and then we suggest 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.

Figs. 15a–c show some of the basic model behaviors. The base behavior of the model shows a rather bad project of content creation. As shown in Fig. 15a, only a 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 Fig. 15b). The network of organizations on this base scenario only develops about 10 units of content with a very low level of integration (almost zero). Organizations in this project develop some formal processes and several process proposals, but again, as shown in Fig. 15c, proposals have a low level of legitimacy given the small participation of organizations in this project.

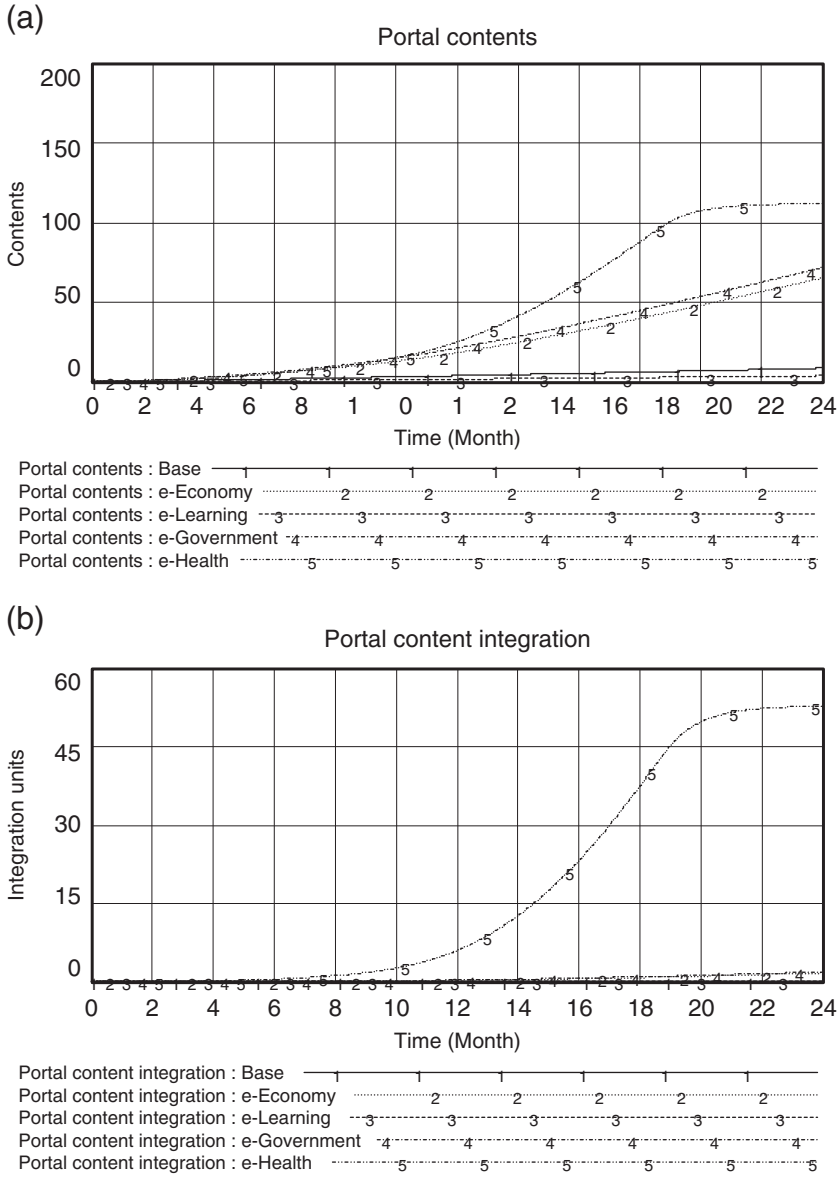

Fig. 16. Portal content in the four scenarios.

To reproduce the scenarios in each of the four projects, we built four scenarios varying the parameters presented in 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 development, process formalization, and relationship building activities. The parameters defining the four basic scenarios as well as the main characteristics of each network emerged from qualitative interpretations from the interviews to project participants.

The e-Health network came into the project with higher levels of engagement and a denser 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 are reflected in a higher understanding of the projects. Moreover, they have very specific goals to their respective portals. Finally, the e-Learning network is the less effective contacting 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 ministries as the sector heads.

Figs. 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 content, but 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 content, but with low levels of integration, reflected in the existence of two different portals on each of these networks. This low level of integration is also reflected in the fact that the "portals" are actually collections of links. The less successful network was the e-Learning one, which not only was able to create modest content, but also with low levels of integration. In the model, the lack of progress in terms of content developed by the e-Learning network is mainly explained by the small number of organizations truly engaged in the project (Fig. 17a). Moreover, their efforts are not very effective because of the

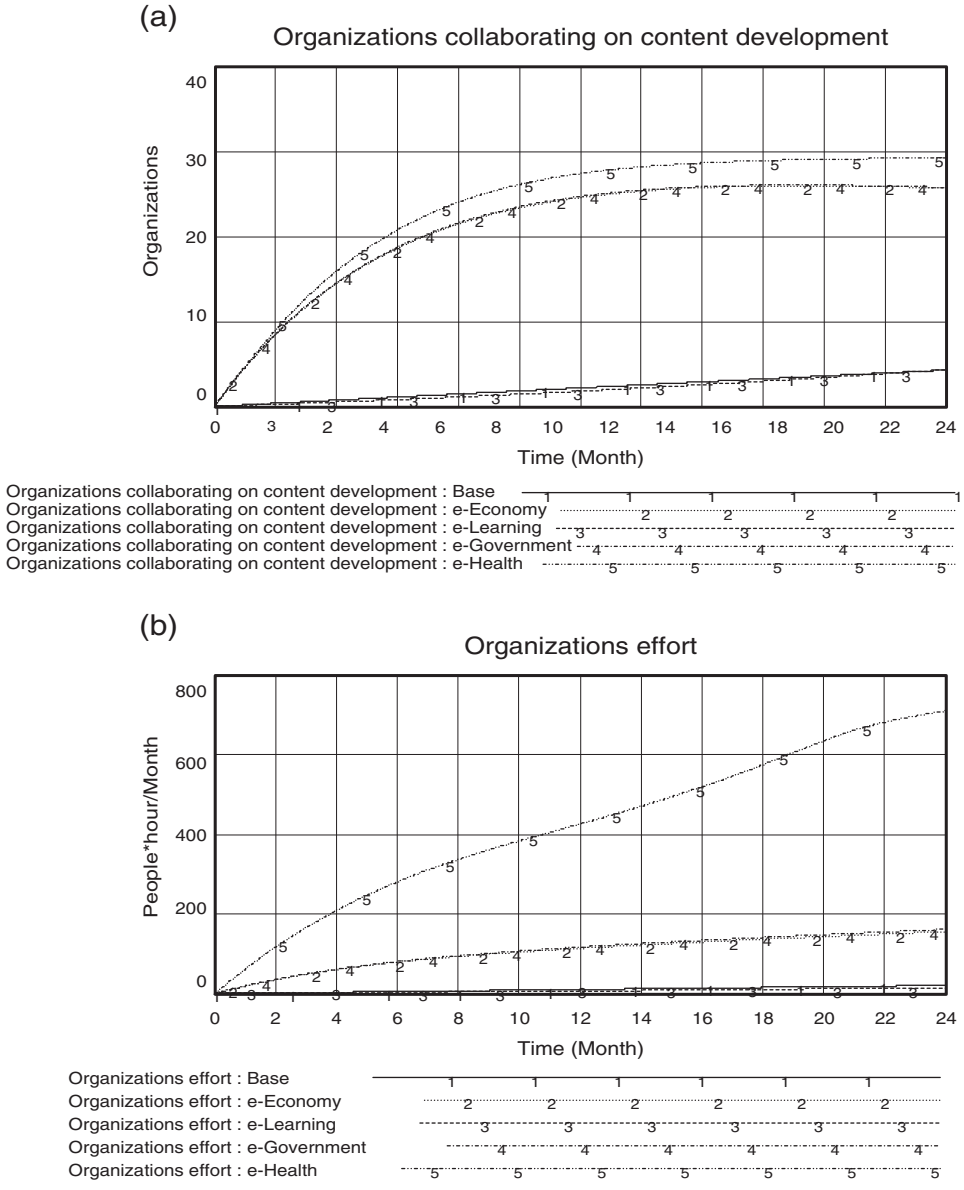

Fig. 17. Organizations and effort in the four scenarios.

limited understanding related to the project as a whole (Fig. 18b). The e-Government and e-Economy networks, on the other hand, have similar effectiveness in involving organizations in the project, and both networks are also in a similar position when compared to the e-Health network (Fig. 17a). However, total effort is smaller because organizations are much less engaged in these processes.

When considering content integration, the e-Health network is the only one achieving high integration levels because this is the only network that finishes also with high levels of understanding, engagement and legitimacy of the processes (see Figs. 18a and b and 19b). The e-Government and e-Economy networks, although having good levels of understanding of the project because of their experience and knowledge in portal creation, do not reach a good level of integration because of the small engagement and participation in the process from other agencies. Figs. 18a and b 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 of the other networks finished with very similar levels of understanding and engagement compared to the initial levels. In the e-Learning network, as mentioned above, there is not enough participation to increase levels of understanding and engagement. The e-Economy and e-Government networks, on the other hand, present similar patterns of behavior in these two variables. Engagement levels show some increase because of the results in content development; however, understanding does not grow because it grows only when organizations work together, and in these two networks there are lower levels of collective effort (Fig. 17b).

Finally, Figs. 19a and b 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 a 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. Again, main differences on legitimacy levels are explained by the collective effort.

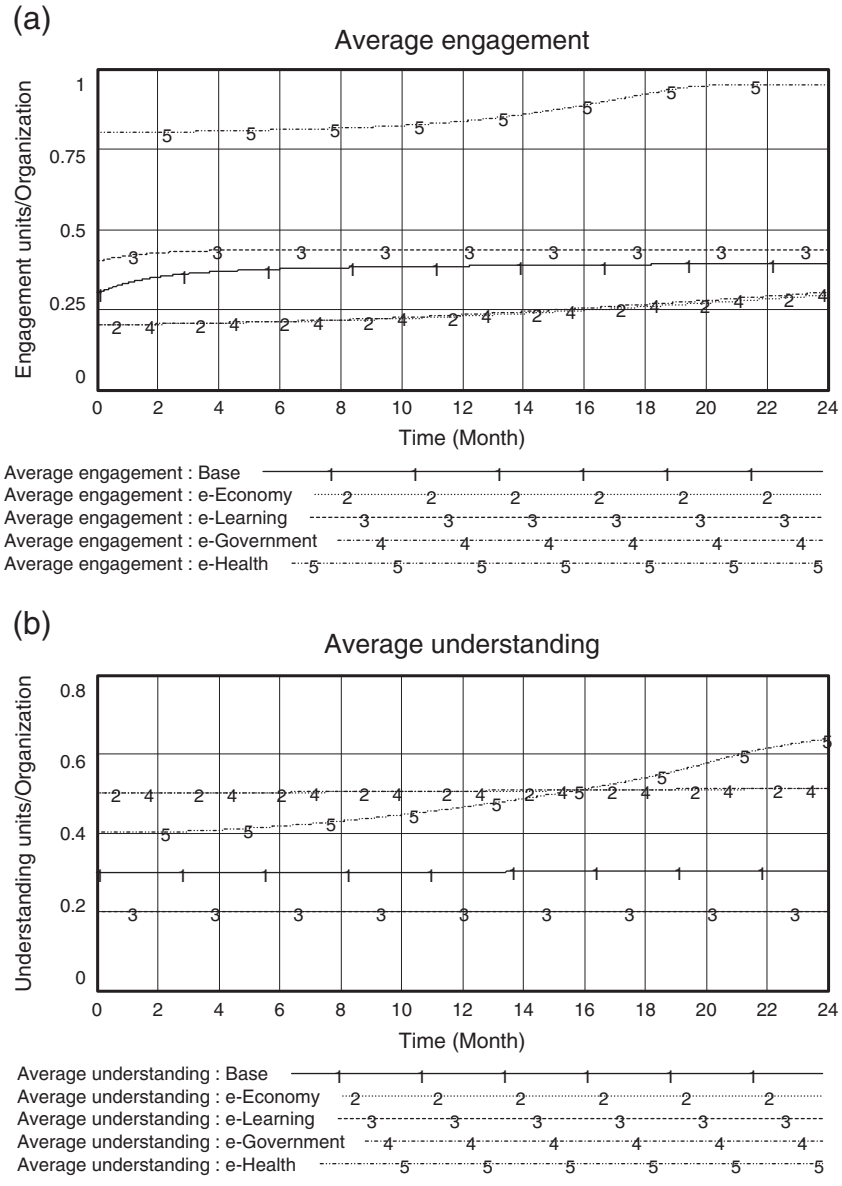

Fig. 18. Engagement and understanding in the four scenarios.

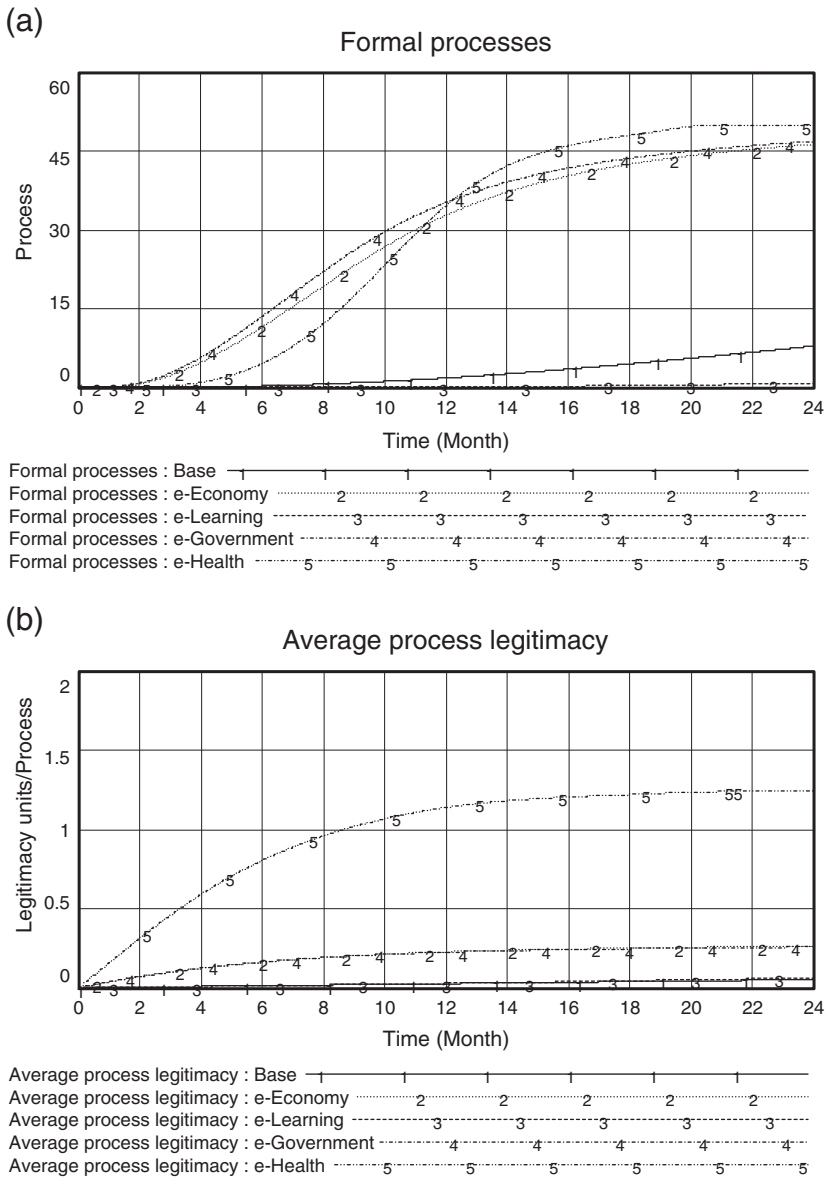

Fig. 19. Formal processes in the four scenarios.

Processes are only legitimate when agencies work together towards the formalization of these processes.

6. Concluding remarks

As mentioned at the beginning, this paper has two main objectives. The first of them is to show the importance of specific institutional arrangements and organizational forms on the characteristics of the resulting technology (enacted technology). The second one is to show the advantages of combining institutional theory and system dynamics in order to explain complex e-Government phenomena. Regarding the first one, the paper provides evidence of the dynamic and recursive relationships between the enacted technology (characteristics of the portals), the organizational forms (agency networks), and the institutional arrangements (formalized processes). In this current model (theory), technology enactments (such as content integration in a portal) is co-created in a recursive process in which organizational characteristics (such as network engagement and understanding) or the existence of legitimate formal processes (institutional arrangements) enable or constrain a particular enactment (characteristics of the technology). At the same time, however, organizational characteristics have an impact on the institutionalization process, and existing institutions also affect organizational characteristics such as effort or effectiveness.

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 with observations of the content development networks present in the e-Mexico program. Experiments with the model suggest that strong leadership or the existence of a previous network are key components in the creation of a project team, however, a good balance of relationships, results- and process-orientation are also important in the capitalization of the efforts of the team. For example, the strong leadership observed in the e-Health, e-Economy, and e-Government networks was successful in bringing into the project an important number of organizations. However, only in the e-Health project were organizations willing to provide with the necessary effort to build an integrated Web portal, which we believe was the result of the existing relationships among network members, and their high levels of engagement in the project.

Regarding the second objective, the paper has shown that combining institutional theory, particularly the technology enactment framework and computer simulation, specifically system dynamics can help to obtain a better understanding of e-Government phenomena. Institutional theory is widely recognized as a powerful theoretical lens, but it has been used at a very abstract level and, therefore, its utility has been questioned. System dynamics allow the researcher to specify the variables and relationships hypothesized using institutional theory in a very systematic way. In fact, given the mathematical nature of computer simulation, the variables have to be operationalized not only conceptually, but also mathematically, when developing the system dynamics model. Thus, this integrated and comprehensive approach takes advantage of the complexity of institutional theory and its main concepts, but it is able to operationalize them and explain them in very specific terms. Moreover, the simulation model can be considered as a theory that can be tested for internal consistency as we have done in the previous section.

The e-Mexico program does not have a very common design, considering supply (content and services) and demand (internet access through digital community centers) components. The analysis presented in this paper clearly shows the relationships between technology, organizational forms, and institutions. However, more research is needed to know if these relationships are equally clear in more traditional (supply-only) e-Government initiatives. Similarly, 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 an improved formal theory of technology enactment in future research efforts. However, the results of this study clearly demonstrate the complementarities between sound theories and sophisticated analytical techniques such as system dynamics. More research is needed to explore this powerful combination in other e-Government contexts.

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