

# MODELING ACCESS TO INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) FOR ASSESSING A PENETRATION POLICY

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## **ABSTRACT**

*This paper develops a model of access to Information and Communication Technologies (ICT) for increasing our understanding the complexity of this process and to assess policy for the penetration of such technologies in Colombia. The model is based on concepts of bounded rationality, i.e. the mental processing capacity and information availability are limited. It shows that some policies may increase the penetration of ICT when based on people's opportunities and desires.*

## **KEY WORDS**

System dynamics, ICT, Bounded rationality, Access to ICT.

## 1. INTRODUCTION

Information and Communication Technologies (ICT) are very powerful tools to facilitate the way to reach individuals' aims, because they do possible information exchanges and interactions among individuals, with fewer restrictions over time and space other than communication media. Thus, the presence of ICT in society is a determining factor for development, as mentioned in numerous reports on the Information Society (ITU, 2006; UNDP, 2001), especially regarding opportunities in education, work, and health, as the millennium development goals suggest (UN, 2005). ICT is changing the dynamic of communication and the form of sharing, acquiring or transmitting information in the society.

ICT access is thus a relevant issue for any country worldwide because is the first step toward process of use and adoption (appropriation) of ICT. However, there has been a relative limited effect in developing countries, since Internet penetration has been low, and developing countries might have missed opportunities for growth. In Latin America, Internet penetration is 22.2%, compared to North America - 71.1% - or Europe - 43.4% - In Latin America some countries have fewer users than others, i.e in Colombia Internet penetration is only 22.4% while in Chile is 43.2% (Internet world stats, 2007).

In particular, this paper analyzes ICT access for the middle income families in an Urban Region of Colombia, mainly focusing on the dynamics of the family's decision-making process for accessing ICTs. This paper specifically makes reference to Internet access and not to Internet use. It is necessary to clarify that access is referred in this research like connections to Internet, in the next stages of this research we will join other effects of use and adoption.

There is abundant literature on the access, commonly called "adoption" of ICT in areas related to enterprises and some particular applications over education, health, work and commerce; also in the service sector such as cellular phone and Internet. There is also significant literature that deals with diffusion issues about innovations and technologies: the extended Bass model (Bass, 1969) and diffusion of innovations (Rogers. 1995), but in the literature that we know, few of these approaches use system dynamics as the method, either consider the properties of context, and the most important difference with our model is that we focus on variables that can be modified to change the system.

In general, models that have been known in this area do not consider bounded rationality, a concept introduced by Simon (Simon, 1959) as this paper does. The combination of bounded rationality and system dynamics has been used in others research in energy studies (Dyner and Franco, 2004).

The decision process for ICT connection is discussed in the next section, it is based on the concept of bounded rationality that considers real limitations on human decision making capabilities as well as asymmetries in information and social conditions in society. This contrast with the classical economic approach in which these limitations are not usually taken into account. In ICT is very important to consider how and why people or in general families make decisions, because normally in this context there are limitations of income and resistance to change and there is also less ICT availability than in the developed countries. For that reason and the nature of human minds, bounded rationality and system dynamics are appropriate to better understand the structure of the families' decisions-making process in this context, and thus turns useful for effective strategies for ICT penetration in society.

This paper is organized as follows. Section 2 presents the methodology undertaken in this research. Section 3 explains the key concepts for model building and the description of the model itself; section 4 shows previous simulation results; and finally section 5 includes some remarks and conclusions.

## **2. METHODOLOGY**

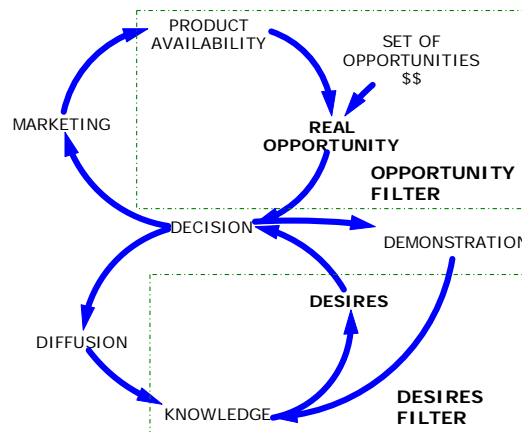
In the variables selection for building the model to simulate the process of ICT access, We used the Structural analysis methodology whit MICMAC (Impact Matrix Coss-reference Multiplication Applied to a Classification) (Lipsor, 2006), doing a complete review of secondary sources, and primary sources (Lopez, Cardenas and Perez, 2008) the latter with the support of expert panels, all people in these panels were related with ICT or it's applications from different knowledge areas as psychology, anthropology, engineering, social communication, philosophy and economy. In this case the most important variables are those that have be able to influence other and some that can be influenced by others to make more efficient the process of ICT access in home, according to the specific context, like ICT Knowledge, Infrastructure and Availability to pay.

Then, we analyze the principal motivations that people have for connecting to ICT and how people in these families make decisions about incorporate the technology in their homes. Here we considered that decisions are undertaken based on needs and desires, not as in the classic economic theory that largely assumes optimality in decision-making processes (Elster. 1989). Using a bounded rationality framework, this research models the behavior of users that are ultimately the ones who decide whether or not introduce the technology in the home.

The referred socio-technological system is dynamic and does not evolve linearly through time (Sterman. 2002). It is not simple to understand the causes of access penetration in communities because of the non linearity's involved, Moreover in this case we are interest in aggregate rather than individual behavior. System dynamics is good for understanding

system structure and should help to assess policies that allow to improve the access to ICT from the way people make the decision to connect.

Within this framework there are two predominant elements for decision-making: real opportunities and people's desires. Figure 1 illustrates the broad conceptual framework proposed in this research. Two constructions are taken from Elster's and Simon approaches regarding opportunities and desires. First, the information asymmetry in decision-making process and, second, the implicit risk assumed to satisfy desires that depends on the opportunities regarding information availability.

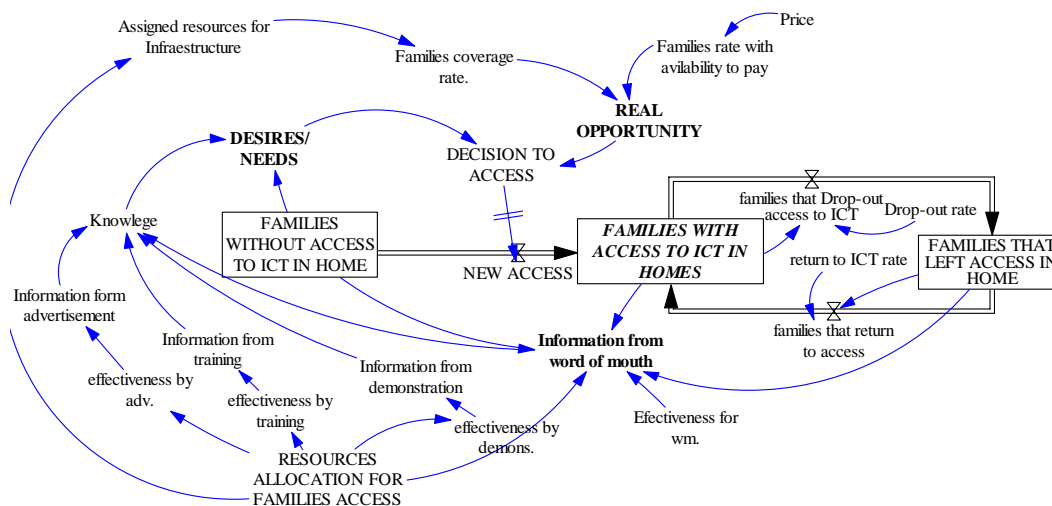


**FIGURE 1 . DESIRES AND OPPORTUNITIES**

Next section presents the bounded rationality concept applied to the problem of access to ICT in families of medium income in Colombia using the variables previously chosen as relevant for understanding the problem.

### **3. ACCESS MODEL TO ICT WITH SYSTEM DYNAMICS BASED ON BOUNDED RATIONALITY**

The general model is shown in figure 2. It was built based on what has been described in above items, it can be appreciated that families' decision-making for connecting to ICTs depends on opportunities and desires, according to Elster's framework previously discussed.



**Figure 2. ACCESS MODEL TO ICT AT HOME FROM FAMILIES WITH MEDIUM INCOME**

In the case of families with medium incomes in the metropolitan area of Colombia, in which this study is focusing, the general opportunities are composed mainly by two factors:

The possibility of connecting to ICT that depends on coverage. This means that the *access-supply availability* that the telecommunication operators have in a particular region, is referred to as the infrastructure that makes it possible to connect to the Internet at home. In some cases the technology can be offered in the region, but do not cover all places, some neighborhoods do not have installed infrastructure for easy connecting. If there is not ICT supply, the possibility of access is null and the families will not be able to connect to these technologies, however, in other cases infrastructure to connect is available and can be carried to the home if the families want, there are different opportunities for families living in the same region.

The second factor that is a determinant in the opportunity to connect homes to ICT, is the *income* and *the families' availability for payment*. In this context availability to pay is referred to the comparison that the people make between the families' income available to spend on ICT and the advantage of access to technology, this factor is especially important, considering that service payment will be monthly.

Some families do not have real opportunities for connection, this may be because the network is not available for them in a particular geographical area, or they do not have the economical means for connection, if suppliers only offer a full flat fee option or they are not aware of the different fee-options for connection. (see figure 2)

Assuming that families have a real opportunity, within their desires, people have limited capacity of information processing and limited available information. Some families, as the ones of interest for this research, have limited technological information; especially they have limited technical understanding and do not know the way of use of ICT and how it

can help them in daily life. Furthermore, these families are not aware of all the alternatives that the market offers regarding ICT.

Thus, in this context, improving the *knowledge* that families have about the usefulness of ICTs may induce them to connect (induce desire for connection). This knowledge might be acquired from different information sources.

One kind of information diffusion is the traditional word of mouth media. It works as follows: People with access to Internet in their homes or in other places, like their job, school, etc., can inform others about what it is and how this technology works. Other information source could be focusing advertisement, . Other source for acquiring knowledge about a technology is the demonstrative effect, facilitating families to experiment and manipulate the technology so they can assess the advantages provided by ICTs; and finally, training, as a way to give knowledge of existence and technology usefulness.

Each one of these sources of information has an effect that may increase the awareness regarding ICT usefulness about technology and their application in daily life.

Thus connection decisions of families without access to ICT depend on both, opportunities and desires. If someone has an opportunity but has not interest in this opportunity, he or she will not take this opportunity.

The system can be affected or changed by *political actions*, acting on both opportunities and desires, and aiming to induce more families with access or connect to ICT (i.e. making them more aware of ICTs).

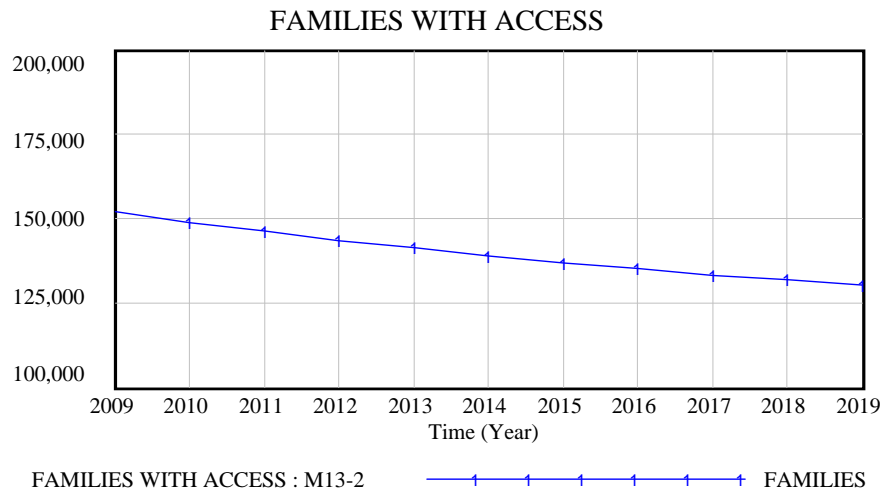
#### **4. SIMULATION RESULTS ABOUT POLICIES PROPOSED FOR INCREASING ACCESS TO ICT AT HOME**

The data for this model mainly come from an experimental design, supported in a longitudinal survey conducted for a sample of the families in the region, and from secondary sources.

Tables 1, 2 and 3 show the main variables that characterized opportunities and desires in this context and the policy applied. Results in terms of increases or reductions in access to ICTs can be seen in the figures 3, 4 and 5 respectively. The initial number of families with Internet access is 152000.

**TABLE 1 . POLICY ONLY OVER COVERAGE.**

<b>OPPORTUNITIES AND DESIRES</b>	<b>POLICY</b>	<b>RESULT</b>
<b>COVERAGE</b>	Invest for increase coverage	95% coverage to families
<b>PRICE</b>	Does not apply	Few willing families
<b>KNOWLEDGE</b>	Does not apply	Low awareness utility

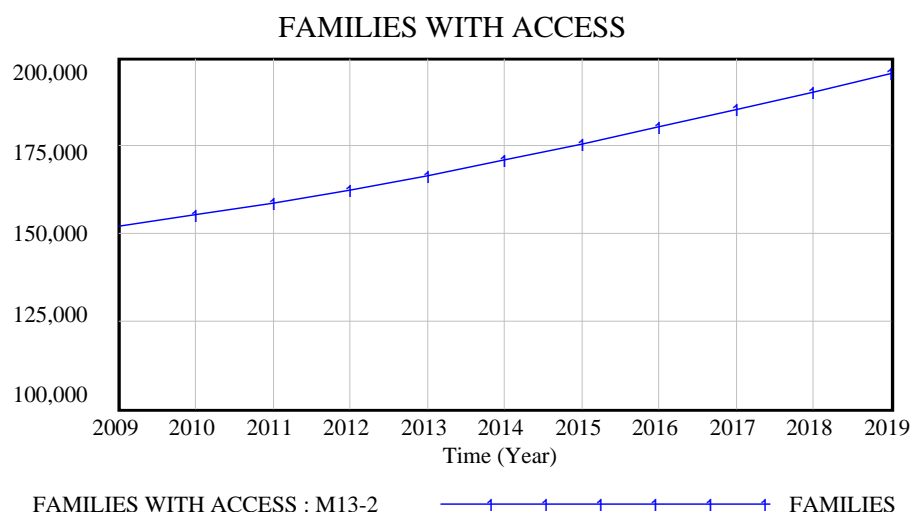


**Figure 3 FAMILIES WITH ACCESS VS. COVERAGE**

When actions aim to increase coverage disregarding price, then access decreases. If there are no activities to increase knowledge and families do not increase awareness of the usefulness of ICT, the final result is fewer families with access.

**TABLE 2 POLICY ONLY OVER PRICE**

<b>OPPORTUNITIES AND DESIRES</b>	<b>POLICY</b>	<b>RESULT</b>
<b>COVERAGE</b>	Does not apply	60% coverage to families without access
<b>PRICE</b>	Lower the cost	A lot of families willing to pay
<b>KNOWLEDGE</b>	Does not apply	Low awareness usefulness



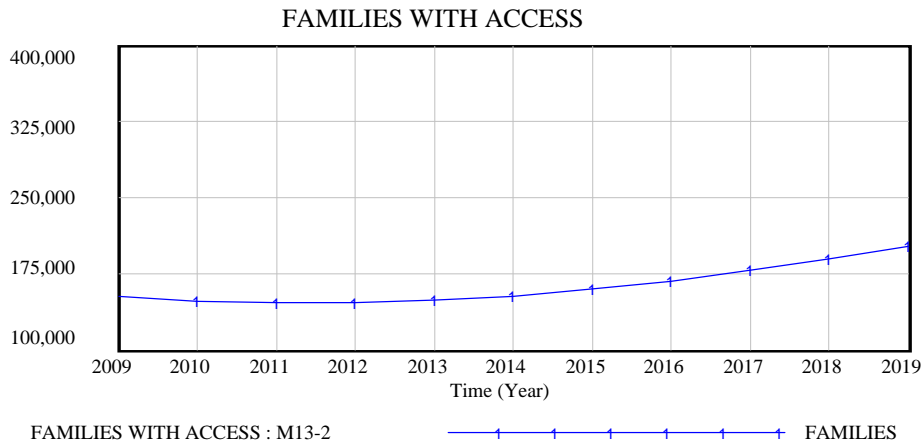
**Figure 4 FAMILIES WITH ACCESS VS. PRICE**

Efforts might be in the direction of lower the monthly access cost to Internet, reducing price significantly, increasing family’s capacity of payment. Although there are limitations in coverage and that the information about ICT utility still low, some increases in access is achieved. However this increase is modest as 60% of households remain with no access to ICT.

**TABLE 3 POLICIES ONLY RELATING TO KNOWLEDGE**

<b>OPPORTUNITIES AND DESIRES</b>	<b>POLICY</b>	<b>RESULT</b>
<b>COVERAGE</b>	Does not apply	60% coverage to families without access
<b>PRICE</b>	Does not apply	Few of families with willingness to pay
<b>KNOWLEDGE</b>	Invest in knowledge	Awareness usefulness high

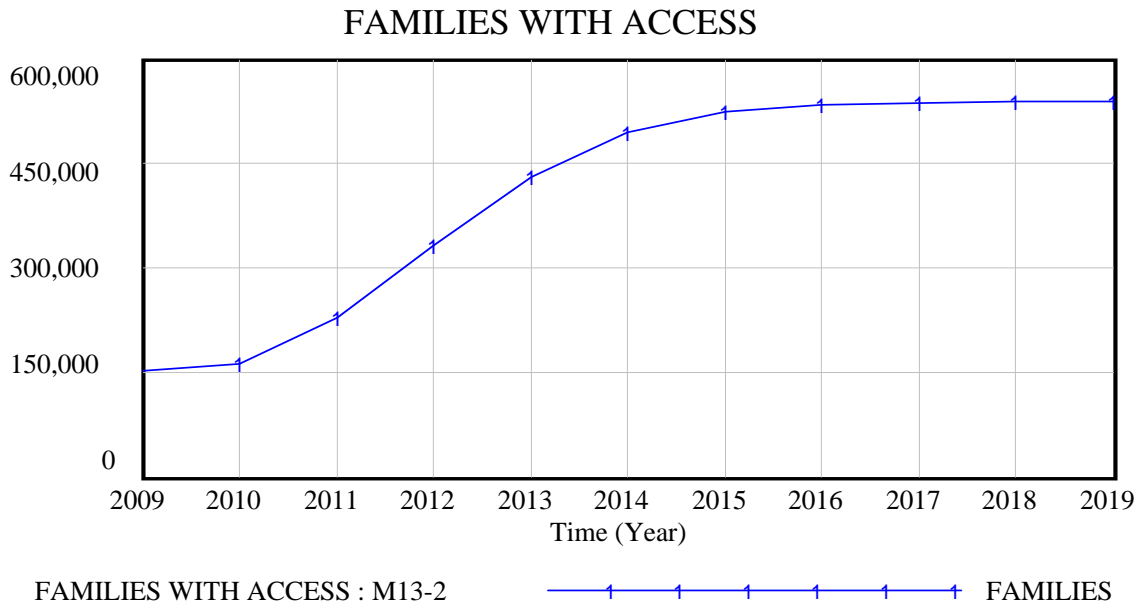




**Figure 5. FAMILIES WITH ACCESS VS. KNOWLEDGE**

Alternatively if policy focuses on increase in peoples’ information about ICT and it’s usefulness, but there are no actions towards coverage and price for private and public users, there will be increases in families access, but total penetration is not achieved.

But if actions are taken considering the three factors previously discussed, results are very encouraging in terms of the higher number of families with access to Internet (see in figure 6), achieving total penetration. This however does not consider external factors and consequently some families may still have no access to ICT in the year 2015; yet very high penetration will be achieved by then.



**Figure 6 POLICY OVER OPPORTUNITIES AND DESIRES OF ACCESS TO ICT.**

## 5. CONCLUSIONS

This paper discusses the diffusion of Internet access in Colombia. Although this ICT technology has been possible since 1994, access is still very limited at home, and that's why it is necessary to examine policies to increase Internet access in the domestic sector.

The preliminary simulation results shown in Figures 3, 4 and 5 indicate that there exist policies that may increase access at home. It strongly depends, as should be expected, on price and coverage. However, this research also indicates that it is important to consider promoting the understanding and awareness of the benefits of the Internet.

Bounded rationality is a useful framework for analyzing the problem of understanding and overcoming limitations imposed by diffusion models that predict penetrations of ICT. Furthermore, given the complexity and the multiple feedbacks present in the problem system dynamics is an appropriate framework for representing the bounded rationality approach.

The model will be further developed and finally tested in an experiment in which families are involved.

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