



Revista Facultad de Ingeniería Universidad de Antioquia

ISSN: 0120-6230

[revista.ingenieria@udea.edu.co](mailto:revista.ingenieria@udea.edu.co)

Universidad de Antioquia  
Colombia

López, Sandra María; Cárdenas Soto, Ana María; Pérez, Héctor Alonso  
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Revista Facultad de Ingeniería Universidad de Antioquia, núm. 55, septiembre, 2010, pp. 203-209  
Universidad de Antioquia  
Medellín, Colombia

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## **Variables that dynamize access to information and communication technologies in middle income families from Aburrá Valley**

## **Variables que dinamizan el acceso a las tecnologías de información y comunicación en familias de ingreso medio del Valle de Aburrá**

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(Recibido el 26 de Octubre de 2009. Aceptado el 6 de abril de 2010)

### **Abstract**

This paper presents the methodology for the selection of the most important or essential variables to access information and communication technologies (ICT) in middle-income families from a developing country. The variables are chosen through a combination of three different methods for the interpretation of the results based on structural analysis using MICMAC (Impact Matrix Cross-reference Multiplication) software.

----- **Keywords:** information and communication technologies (ICT), structural analysis, ICT access

### **Resumen**

El presente artículo muestra una metodología para seleccionar las variables que tengan una influencia significativa en la dinamización del acceso a las tecnologías de información y comunicación (TIC) en las familias de ingreso medio en el Valle de Aburrá, así como las interrelaciones principales entre esas variables. Las variables se escogen a partir de la combinación de tres métodos de interpretación de resultados, basados en Análisis Estructural con el software MICMAC (Impact Matrix Cross-reference Multiplication).

----- **Palabras clave:** tecnologías de información y comunicación (TIC), análisis estructural, acceso a TIC

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## Introduction

The Information and Communication Technologies (ICT) are powerful tools to achieve people's goals, since they aim to facilitate information exchange and interactions between them, with fewer restrictions over time and space than other communication media. Therefore, the presence of ICT, especially of Internet, in society is a determining factor for development [1-3] given opportunities in education, work, entertainment, transactions, and health, as the millennium development goals suggests [4]. The economic and social impact of ICT led governments to recognize the importance of these technologies, and have been incorporated in government plans and by all citizens [5-7]. It is therefore an important issue to understand and identify the main factors that can change the process in order to dinamize the incorporation of ICT in a particular context. This paper analyzes ICT access for the middle income families in an urban region of Colombia, focusing mainly on finding the variables that are essential to the specific context, that have strong influence in the dynamics of family's access to ICT and the relationship between these variables.

The factors affecting access to ICT have focused primarily on demographics such as age, type of members in the family, etc., in some cases combined with pricing policies and capacities. However, in this research the focus is on variables that may be affected, not only observed to streamline the process of access to ICT in a particular context.

### **General concepts of structural analysis**

The goal is to identify in the most objective way the variables that have strong influence on the dynamic of ICT access. The methodology takes as a base the Structural Analysis with MICMAC methodology that aims to show the influential and dependent variables and therefore the key to the evolution of the system. The software MICMAC -Impact Matrix Cross-reference Multiplication Applied to a Classification of Laboratory for

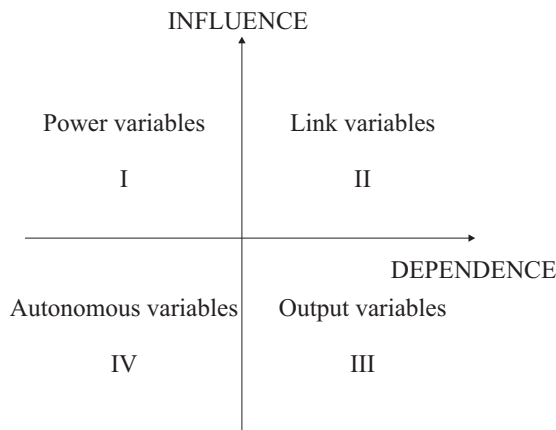
Prospective Studies LIPSOR of France- [8], is a computational tool that helps to analyze the relationship between variables.

### **Variable selection**

*The structural analysis consists of three phases* [9]: The first phase is the identification, definition and homologation of factors involved in the problem. To carry out this phase, there must be done an exhaustive inventory of factors. The reduction of the factors through the contextualization of the definition of each variable minimizes the number of variables in cases where different names are given to variables with the same meaning or variables do not apply for the particular problem. The second phase is based on the description of the relationship between variables. This relationship is discussed in meetings with experts using a matrix of double input, grading the direct influence of a variable over other variables as strong, average, weak, non-existent or potential. The numerical value assigned to the relation is from 3 to 0, with 3 representing a strong relation and 0 for a lack of relation, the letter P has been assigned for a potential relation. This matrix is entered in the software MICMAC when the information from the matrix is processed to obtain the interrelationships that may not be evident through the direct analysis made by the experts. That leads us to the third phase: the identification of essential variables of the system, the software MICMAC delivers the factors introduced in the matrix, organized in an influence-dependence Cartesian graph, which should be interpreted as follows: a variable has more influence on other variables if the variable is at the top of the y-axis, and with regard to their dependence, if it is right on the X axis, this means it is more dependent than those on its left, as shown in figure 1.

The main methods for the selection of the key variables of the system, using the interpretation of the influence of the variables, according to their location in Cartesian graph are: Analysis of the four quadrants, which is designed to find the most relevant variables for the formulation of strategies [9]; The strategic axis, that is the projection

of variables on the diagonal to the Cartesian graph, ordering the variables according to their importance for the system [10]; the method of the nine quadrants, which focuses on analysis of the variables with greater power and dependence on the change of the system [11]. This paper proposes the combination of the three previous described methods to select variables that are the most relevant to the dynamics of the system.



**Figure 1** Variables relationship-influence-dependence

### **Methodology for selection of variables**

To be consistent in the application of structural analysis methodology, in Phase I of the methodology there was reviewed an exhaustive list of aspects that are involved in the process of Internet access from primary and secondary sources.

Secondary information is obtained from studies and literature of research [12-16], global organizations and telecommunications operators [17-21], and policies of different countries [5-7] as well as international indicators that compare the progress of ICT in different countries [22-24].

Another information was obtained from primary sources from working sessions and interviews with experts and research groups that have experience on the topic, in the areas of psychology, anthropology, engineering, social communication, philosophy and economics. A special consideration for the selection of these

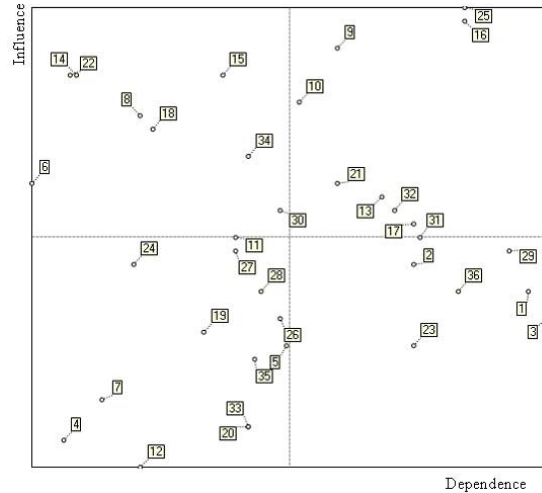
experts is that they are directly involved in the process of ICT from different knowledge areas in representative applications such as e-medicine, e-education, e-health, administrative, technical or philosophical ICT process. Part of this work was done with international experts; their analysis was focused on a global vision of access to ICT and with regional experts from the specific region in a developing country, with emphasis on the special conditions in the context for the processes.

The result of this work is a list of over 150 factors which were defined and reviewed in order to find those that had a different name but its meaning was similar, allowing a reduction to a common factor or eliminating those that were not relevant for the context. Using this process the list of the variables was obtained for a total of 82 variables selected in this stage for the context discussed in the sessions, 50 of which can affect the decision on access to ICT.

*In phase 2* according to the Structural Analysis, the variables are placed in a matrix of double-input with the collaboration of the expert group based on the grading of the direct relationship between variables (item 2). The analysis was focused specifically on the particular context of study. The location in the plane of each variable according to the relation of dependence/influence with other variables is shown in figure 2.

The third phase uses the results delivered by the software MICMAC of the matrix built in the second phase, this phase was used to identify the variables that have some influential and/or dependence between variables for the process to ICT access. Analyzing the results obtained in the Cartesian plane can be seen that there are two important implications for case study:

Figure 2 shows that there is a large concentration of Autonomous Variables. A representative number of variables are located in the power and output quadrants, and only 2 variables in the link quadrant, making an L-shaped figure, this demonstrates that the combination of factors analyzed, at the present tends to remain very stable [9].

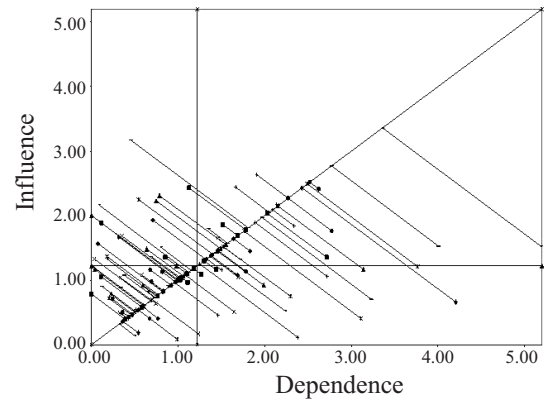


**Figure 2** Influence / dependence of access to ICT variables Use software MICMAC of LIPSOR LABORATORY

On the other hand, the number of essential variables obtained is high, a maximum of 20 [9].

Therefore, the system has yet to seek higher goals of access, use and adoption to Internet for the population under study, but in this situation it is difficult to identify which variables could be affected by policies or strategies to achieve dynamism in the process of access to ICT. Given these assumptions, it was decided to place more emphasis on the most important variables of the process, so that decision makers can act on the variables that allow the system to move towards more households with ICT access

The first filter is to take the variables located in the quadrants of power, link and output (figure 2), based on the initial set of 82 variables, thereby selecting the most strategic variables according to the method proposed by Godet [9]. The second filter is to apply the method of strategic axis, in which variables are projected on the diagonal through the center of influence and dependence on the Cartesian graph (see figure 3). The variables that have values beyond the arithmetic media (eq. 1) are considered to be more relevant for the system than the others [10]. It shows the order of importance of the variables.



**Figure 3** Strategic Axis

$$E = \frac{100}{n} \quad (1)$$

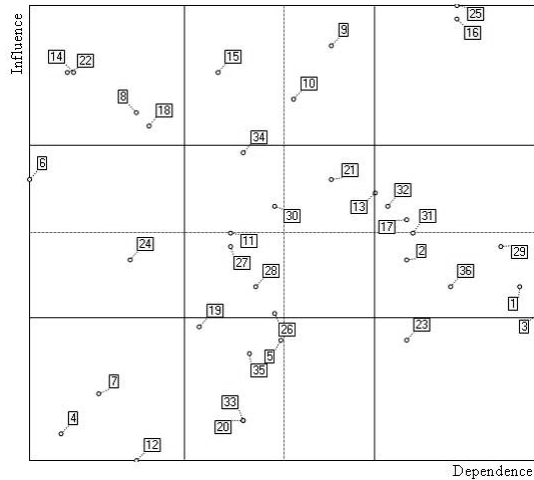
Where,

E: expected value

N: number of variables

When combining the results of analysis of the four quadrants and the analysis of strategic axis, 36 variables were selected. This selection represents a large number of variables that requires a new analysis by the experts. On the results of the method of the four quadrants and the strategic axis is necessary to apply a third and final filter that selects the variables with strong power applying the method proposed by Popper [11], the analysis of the nine quadrants, that considers the most important variables those with a strong power to change the process for its relationship between influence and dependence of the system.

This research combines three different methods of variable analysis: the analysis of four quadrants (strategic variables), the analysis of strategic axis (the most important variables) and a third analysis of dependence and variables that have strong power to change the system; in this case there are 16 variables that can be selected as the most important variables in the sense of ensuring that the system could be modified and that the variables have a strong influence over the process of incorporate ICT in people's lives. (See figure 4)



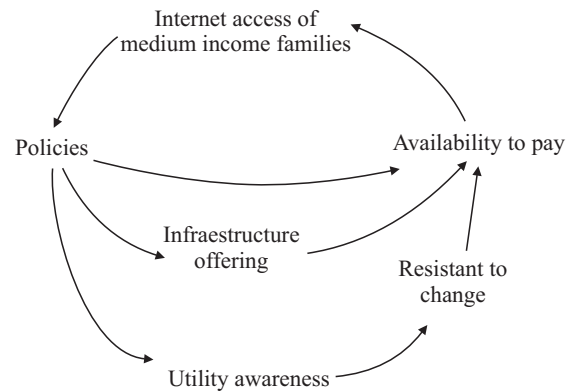
**Figure 4** Analysis of nine quadrants

## Results and discussion

In the previous methodology the most important variables on which the decision makers must act to achieve the dynamism on Internet access in the system are: Infrastructure offering, utility awareness, willingness to pay, and resistance to change. Other variables related to ICT access are common to find in singular analysis and also appear in the strong variables for the present research, but they disappear when the tree methods of variable selection are combined, like education level or age. These variables are important for the system, but they can't be changed with endogenous policies. The relationship between variables is relevant to achieve the proper effect on the context, especially considering that this process is not linear and that the implementation of policies should be done holistically. Initially, the MICMAC gave us a diagram with main relationships, which is shown in figure 5.

The initial goal of the system is that families which do not have ICT access can connect and use them to achieve benefits of ICT [6, 25]. As shown in figure 5, access to infrastructure (the net) is a prerequisite for the connection, so a service provider is necessary with enough coverage to reach the house. However there are variables associated with access that show that this is not the

first step. It is also necessary that families should be available to pay the monthly value for the service, which depends on the desire of families to have the service and also depends of their utility awareness overcoming resistance to change.



**Figure 5** Relationship between Variables to ICT. Access of medium income families in a developing country

## Conclusions

The combination of three methods of analysis has managed the focus on the variables that most changed the process of ICT access. It should be noted that the variables that are not included in this selection are variables that are part of the system; but the result indicates that the approach towards the formulation of strategies should focus on key variables.

The used methodology reduces the subjectivity in the selection of essential variables for analysis of a given system, because it considers different views of the problem and from different disciplines.

It is increasingly important to understand the structure of the relationships that exist in the processes of access to information and communication technologies for a particular community and in a specific segment, because this allows better directional strategies for ICT and determining factors in the development and competitiveness.



For this reason it is necessary to take into account the particularities to determine what factors are most relevant depending on the context in which they are analyzed. The indicators that measure progress in the adoption of information and communication technologies are focused mainly on the progress of infrastructure and some of its uses, yet we must emphasize the need to adapt this analysis to the particular context in order to see the real effects of the use of ICT in each case.

The relationship between variables is determining to find the way of a better access process.

### Acknowledgements

The authors thank UNE and the University Pontificia Bolivariana for their support and sponsoring of this research. The participants in the panels of experts, Joven TIC Group of Universidad Autónoma de Barcelona, Artur Serrá of I2CAT, Lucio Mauricio Henao, Jackson Reina, Adriana Vega, Eduardo Domínguez, Erika Jailler, Diego Cuartas, Jairo Martínez, Nathalie Ortiz and Diego Palacio.

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