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Appropriate way of accessing the Internet among villages of Khuzestan Province using analytical hierarchy process (AHP) model

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In order to achieve the rural development destination, human development is necessary. Information and communication technology (ICT) as a knowledge extension innovation can help to improve the human development level of rural stakeholders. This paper explores the use of the analytical hierarchy process (AHP) for selecting an appropriate way of Internet access in Khuzestan villages. A panel of 24 experts of rural ICT center in Khuzestan utilized AHP to determine the priority of three methods of Internet access. The findings indicated that DSL according to cost criteria and wireless, regarding both quality and speed criteria were the most important. Furthermore, wireless was recognized as the best way of accessing the Internet in Khuzestan villages.

Key words: Analytical hierarchy process (AHP), Internet access, experts’ decision, village, Khuzestan Province.

INTRODUCTION

Approximately half of the world's population live in the rural areas of developing countries, and most of these people are peasants who depend on farming for their livelihood. Development of these areas seem to be imperative (Abdolrahman and Smith, 1996). One of the most important approaches to rural development emphasizes the role of ICT. Information community is the basis for rural development at the beginning of the third millennium. In this approach, information and communication technology (ICT) is recognized as the focal point of sustainable development in general and rural development in particular (Harris, 2004). Since the last few decades, international organizations for development have turned their attention to rural Internet centers and Internet literacy of villagers, so that now developing such centers is considered one of their main activities. In their development plan recommended to various countries, they have given priority to Internet access as much as life's basic necessities such as drinking water and electricity. United Nations and the World Bank put information technology high on the agenda, when it comes to programs of development and alleviation of poverty (UN, 1999; World Bank, 1999).

ICT is a system used to produce, store, send and restore information. The information consists of texts, sounds, images, photos, etc (Rama, 2004). ICT exclusively covers a set of related technologies including telephone. Internet as the top technology provides the possibility to transfer information e.g. text, sound, image, video, etc (Accascina and Victor, 2003). Failure to exploit high technology in rural areas is one of the problems in...
Level 1:
Overall Goal
Selection of access the internet

Level 2: Criteria
(Objectives)

Level 3: Alternative
Actions

- DSL
- Cable
- Wireless

Figure 1. Hierarchical model for access the Internet in Khuzestan villages.

developing countries (Abdolrahman and Smith, 1996; Lahsaeizadeh, 1990). Khuzestan Province, located in the southwest of Iran, is the geographical area studied in this research. The rural population of this province is 1,383,946, which is 32% of the whole (2006). The purpose of this study was to find out the best ways of supplying Internet in the villages of Khuzestan Province to facilitate rural development. Different ways of supplying Internet were prioritized to introduce the best way, and to help the authorities to make an informed choice considering the budget and the facilities they have.

Various studies have been done on rural ICT in different countries of the world. A comprehensive service which has received increasing attention is the relatively recently developed ICT that has been widely documented in a variety of problem areas (Alphonce, 1997). Fast and reliable access technology is necessary for effective and efficient e-governments services. For instance, if broadband (high speed) Internet is available, services such as audio and video presentations can be provided quickly and reliably. A critical question with long-term consequences is how best to determine the Internet access infrastructure. To address this question, we formulate the decision making process as an analytic hierarchy process (AHP) model, which can incorporate hard to quantify criteria, as well as easy-to quantify criteria simultaneously. Specifically, following the approaches of Douligeris and Pereira (1994), we have cost, quality, and speed as the criteria (Douligeris and Pereira, 1994).

RESEARCH METHOD

The area studied was Khuzestan Province, as big as 67,282 km², which is located in the southwest of Iran (2006). This study was a field study of survey type. The framework and the purpose of the research were decided based on library and Internet research. Using a questionnaire which compared pairs of variables, data was collected. All twenty four experts working in rural ICT departments of Khuzestan Province were interviewed to fill in the questionnaire. Using AHP and Choice Expert software the data collected was analyzed to prioritize different ways of supplying Internet in villages of Khuzestan Province. The Analytical Hierarchy Process (AHP) is an intuitively easy method for formulating and analyzing decisions. The process was developed to solve a specific class of problem that involves the prioritization of potential solutions (Byun, 2001). Analytic hierarchy process is a tool utilized to support decision making. In order to determine the number of paired comparisons, Teknomo formula (Teknomo, 2006) is used as follows;

\[ C(n, n) = n(n-1) / 2 \]

C: Comparison; N: number.

The approach is based on three major components:

(1) AHP starts by separating a complex problem into a hierarchy; each level consisting of a few manageable elements and each element is, in turn, divided into another set of elements. The process continues down to the most basic elements of the problem. Typically, the specific course of action (e.g., alternative access Internet, Figure 1), is represented at the lowest level of hierarchy. There is no single general hierarchical structure and one of the major attributes of the AHP is the flexibility it allows decision-makers.

(2) A measurement methodology is used to establish priorities among the elements within each stratum of the hierarchy. This is accomplished by asking the decision-makers (experts) to evaluate each set of elements, in a pairwise fashion, with respect to each of the elements in a higher stratum. This measurement methodology provides the framework for data collection and analysis of the AHP. Structurally, the hierarchy is broken into a series of paired comparison matrices, and the participants are asked to evaluate the off-diagonal relationship in one half of each matrix. The pairwise comparison is based on a 9-point scale, which is typically used in AHP analysis (Table 1).

(3) A measurement theory establishes the priorities of the hierarchy and the consistency of the judgmental data provided by the participants (Wind and Saaty, 1980). This stage includes calculating
Table 1. AHP comparison scale.

<table>
<thead>
<tr>
<th>Intensity of importance</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance of one over another</td>
</tr>
<tr>
<td>5</td>
<td>Strong or essential importance of one over another</td>
</tr>
<tr>
<td>7</td>
<td>Very strong importance</td>
</tr>
<tr>
<td>9</td>
<td>Absolute importance</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate values between to adjacent judgments</td>
</tr>
</tbody>
</table>

Reciprocals of above: If factor \( i \) has one of the above numbers assigned to it when compared to factor \( j \), then \( j \) has the reciprocal value when compared with \( i \).

the priorities and consistency (Wind and Saaty, 1980; Quaddus and Siddique, 2001).

Prioritization involves pairwise comparison of various elements residing at the same level with respect to an element from the upper level of the hierarchy. A consistency ratio is calculated to check the consistency of judgments. Inconsistency is likely to occur when decision-makers make careless errors or exaggerated judgments during the process of pairwise comparison. A consistency ratio of 0.1 is considered the acceptable upper limit (Hafeez et al., 2002). The final outcome of the AHP is an optimum choice among alternative decisions. The model utilizes quantitative, as well as qualitative factors in its analysis (Tavana, 2004).

The analytical model of the study

The basis for AHP is to establish a hierarchy of decision making. Any decision making can be designed as a hierarchy, so that the first level shows the purpose of the decision maker, and prioritization of paired options is usually carried out to achieve this purpose. The middle level(s) show criteria used by planners to reach the purpose. And the last level shows the options available to achieve the purpose (Badri, 1999). Using this model, which was first designed by Thomas L. Saaty, comparison of the criteria and options of the decision makers is made in a pair-wise fashion. This results in prioritization and choosing the best option among the competing options (Badri, 2001). The following figure shows the structure of the hierarchy in this study. Interviews with professors, experts of rural ICT, and villagers made it possible to find out the variables of this research. Different levels of the hierarchy in this study is shown in Figure 1 which includes the following. The best way of accessing the Internet in rural areas, the purpose, is at the first level. The second level includes three basic criteria which influence the choice of ways of Internet access in Khuzestan Province. They are the cost, the quality, and the speed of the Internet. The operational definitions of these criteria are:

**The quality of information:** The security and reliability of the information.

**Cost:** All fixed costs (often to establish the facility, purchase and install the equipment at the beginning of the project) and varying costs (to solve Internet problems, repair equipment, pay the personnel, etc).

**Speed:** By speed, we mean how broad the band is (how broad the Internet is to the user, and how broad the user is to the Internet), and delay time (lack of connection to the network).

The third or last level includes different ways of providing the Internet or the alternatives that is Cable, DSL, or Wireless. In DSL (digital subscriber line), telephone service (fixed) is used to send and receive data on the Internet and make calls simultaneously. The medium used in DSL is twisted pair. In Cable service, Cable TV is used. A part of Cable TV band is allocated to send and receive data. The medium used in this service is called coax cable. In Wireless service, setting two antennas exactly opposite each other (point to point), one of which is connected to a computer and the other to an ISP (Internet service provider), we send and receive data (Andrew, 2000).

**RESULTS AND DISCUSSION**

At the first stage, to analyze the data from the field study, the criteria in question were compared in a pairwise fashion, and according to the research framework. Then, the alternatives were compared according to the criteria. Finally, the results of the comparisons according to each criterion were considered. In another word, the alternatives were compared with the purpose of the study. Figure 2 demonstrates the comparisons of this stage. As can be observed in Figure 2, the most important criterion according to the purpose, which is quality, has a value of 0.413. The other criteria, namely cost and speed have values as 0.327 and 0.260 respectively. When comparing the alternatives in a pair-wise manner according to the cost by the experts, we got a value of 0.481 for DSL which is the most preferred. That is due to the fact that providing DSL is the least expensive.

Cable and Wireless, with values of 0.405 and 0.114 respectively, came second and third. Comparisons according to the quality revealed that Wireless with a value of 0.500 is the most preferred. Cable and DSL with an equal value of 0.250 came next. Comparisons according
to the speed demonstrated that Wireless with a value of 0.659 is the most preferred. Cable and DSL with values of 0.185 and 0.156 respectively came second and third. Considering the results of all comparisons according to the criteria, or in another word, comparisons of the alternatives according to the objective of the study demonstrated that DSL, with a value of 0.395, is the most preferred alternative. Wireless and Cable with values of 0.313 and 0.292 respectively turned out to be the less preferred ones.

CONCLUSION AND RECOMMENDATIONS

Selection of appropriate Internet access ways is a very complex task. There is no general agreement on how to go about selecting an Internet access way. Experts of rural ICT center in Khuzestan Province are constantly confronted with the problem of choosing a particular Internet access way among possible alternatives. There is an increasing awareness that choosing Internet access ways, solely on the basis of economic viability, may not result in the selection of the best alternative. A selection process that considers as many of the relevant criteria as possible is better than reliance on a single criterion. A few experts of rural ICT center, had made inappropriate decisions regarding the choice of Internet access ways. They considered only the cost, and for this reason their opinions were not adopted in this research.

It is recommended that in the future, the criteria for inclusion in the AHP model should be selected through consultation with villagers. Although villagers do not have the expertise and resources to use decision software independently, extension agents should be trained to use the decision tools, for two reasons. First, to select the appropriate Internet access way for promotion (among villagers of a particular recommendation domain) in extension programs. Second, to help individual villagers make decisions that are more appropriate with respect to selection of Internet access ways and lead to an understanding of the reasons behind their decisions. As the experts of the rural ICT department of Khuzestan Telecommunication Office favor Wireless service over the other two services, providing the Internet by Wireless is recommended.

However, considering the fixed and varying costs of this service which are higher than DSL, and Cable, we recommend that parts of the province that have more populated villages and villages that lie next to each other enjoy this service, so that a larger number of people will have access to the Internet and ICT in a shorter time. Wireless service might not be possible due to a limited
budget or technical problems. If so, the other options, DSL, and Cable, should be considered respectively.

REFERENCES


Harris RW (2004). Information and Communication Technology for Poverty Alleviation, Malaysia: ANDP-APDIP.


