Available online at www.sciencedirect.com
ScienceDirect
Information Sciences 177 (2007) 3383–3396
INFORMATION SCIENCES
AN INTERNATIONAL JOURNAL
www.elsevier.com/locate/ins

Evaluating digital video recorder systems using analytic hierarchy and analytic network processes

Che-Wei Chang [a,*], Cheng-Ru Wu [b], Chin-Tsai Lin [c,1], Hung-Lung Lin [c]

[a] *Department of Information Management, Yuanpei University, 306 Yuanpei St., Hsin Chu 30015, Taiwan, ROC*
[b] *Department of Finance, Yuanpei University, 306 Yuanpei St., Hsin Chu 30015, Taiwan, ROC*
[c] *Graduate Institute of Business and Management, Yuanpei University, 306 Yuanpei St., Hsin Chu 30015, Taiwan, ROC*

Received 8 April 2006; received in revised form 6 February 2007; accepted 11 February 2007

Abstract

Digital video recorder (DVR) systems are novel security products with significant potential for application in the surveillance market, which, like many other areas of security technology, is changing quickly. Consumer demand and procuring budgets of system development firms are increasingly being emphasized, motivating upgrades to system quality. Digital surveillance systems include both hardware and software. Procurers have difficulty complying with these standards due to the wide gap between the descriptions in the standards and interpretations of evaluations of digital video recorder systems such as the functions of channel, recording, playback and display, communication and remote transmission. A case study compares the analytic hierarchy process (AHP) and analytic network process (ANP) decision models, and the comparison results indicate that interdependencies can affect real decisions. For network-like decision models (i.e., decision problems that can be structured in a network model form), ANP represents an effective tool for providing an accurate solution for administrators or managers of this case.

Keywords: Analytic network process (ANP); Analytic hierarchy process (AHP); Multi-attribute decision-making (MADM); Digital video recorder system; Software evaluation; System evaluation

1. Introduction

Digital video recorder (DVR) systems are novel, exciting security products in the surveillance market, and, like many other areas of security technology, are rapidly evolving. Digital surveillance products include PC-based systems, standalone systems and digital set top box (STB) systems. Digital STB systems include digital

* Corresponding author.
E-mail addresses: chewei@mail.yust.edu.tw (C.-W. Chang), alexru00@ms41.hinet.net (C.-R. Wu), ctlin@mail.yust.edu.tw (C.-T. Lin), hsa8936.hsa8936@msa.hinet.net (H.-L. Lin).
[1] Tel./fax: +886 3 530 2588.

0020-0255/$ - see front matter
doi:10.1016/j.ins.2007.02.010

cable STB, digital satellite STB and digital TV [5]. Digital surveillance technology is growing in complexity, complicating efforts to ensure the system stability and quality of individual product types.

Consumer demand and procuring budgets of system development firms are receiving increasing attention, motivating improvements in system quality. Digital surveillance systems include hardware and software. Procurers cannot easily comply with these standards, due to the existence of a large gap between the descriptions given in the standards and interpretations of evaluations of digital video recorder systems such as functions of channel, recording, playback and display, communication and remote transmission.

The government of Hsinchu City, located in northern Taiwan, is interested in improving monitoring of public spaces. Hence, the Hsinchu City Government is applying DVR systems in place of their traditional surveillance camera systems. The DVR system circumvents restrictions of traditional surveillance camera systems, which include: (a) lapses in recording due to operator neglect or machine error; (b) difficulty in locating a desired time sequence following completion of a recording; (c) poor video quality, and (d) difficulty in maintaining and preserving tapes due to a lack storage space and natural degradation of film quality.

According to government procurement regulations, regional governments need to select at least five evaluators and review more than three firms before selecting the best DVR system. This study considers four candidate DVR systems that are common in the surveillance market, manufactured by Firms A, B, C and D, respectively. However, selecting a DVR system is a multi-attribute decision-making (MADM) problem. MADM is a methodology that helps decision-makers make preference decisions selection regarding a finite set of available alternatives courses of action characterized by multiple, potentially conflicting attributes [30,19]. MADM provides a formal framework for modeling multi-attribute decision problems, particularly problems demanding a systematic analysis, including analysis of the decision complexity, regularity, significant consequences, and the need for accountability [3]. Among those well-known methods, MADM has only recently been adopted to evaluate DVR systems. MADM applies a set of attributes to solve a decision problem. Existing evaluation problems or studies have applied AHP and ANP to set up a hierarchical or network skeleton, within which multi-attribute decision problems can be structured (e.g. [2,4,6–15,21,22,27–29]).

The applicability of the proposed model is demonstrated in a case study. The propose model as well as the basic concepts of AHP and ANP. The results of the system stability test indicate the advantages of the ANP decision model in determining the value of ANP. However, this case study compares the AHP and ANP decision models, and the results indicate that interdependencies can affect real decisions. Significantly, the proposed method can assist purchasers or users in assessing the DVR systems, making it easily applicable for academic and commercial applications.

2. Methodology

AHP, presented by Saaty in 1970s, is designed to structure a decision process in a scenario affected by multiple independent factors [24,25]. A complex problem can be divided into several sub-problems based on the hierarchical level, where each level denotes a set of criteria or attributes related to each sub-problem. The top level of the hierarchy denotes the goal of the problem, and the intermediate levels denote the factors of the respective upper levels. Meanwhile, the bottom level contains the alternatives or actions considered when achieving the goal. AHP permits factors to be compared, with the importance of individual factors being relative to their effect on the problem solution. AHP has been widely applied in decision-making since its introduction, and has been widely applied in the literature.

Whereas AHP denotes a framework with a unidirectional hierarchical relationship, ANP permits more complex interrelationships among decision levels and attributes. The ANP feedback approach replaces hierarchies with networks, in which the relationships between levels are not easily classified simply as hierarchical versus non-hierarchical, or direct versus indirect [17]. For instance, not only does the importance of the criteria indicate the importance of the alternatives as in a hierarchy, but the importance of the alternatives may affect the importance of the criteria [23]. Hence, a hierarchical framework with a linear top-to-bottom form is not appropriate for complex systems.

A network can represent a system involving feedback, in which nodes correspond to levels or components [24]. Node elements may affect some or all the elements of any other node. Networks can contain source nodes, intermediate nodes and sink nodes. Arcs represent network relationships, and their directions signify