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# A cognitive map simulation approach to adjusting the design factors of the electronic commerce web sites

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## Abstract

The electronic commerce (EC) has been widely studied in the academic as well as practical fields. Especially, a lot of special topics regarding the EC such as B2C and B2B have been investigated in literature. However, there are much less studies about the EC sites themselves. Besides, only a few studies exist about the issues regarding how to adjust the design factors of the EC sites. The main objective of this study is to fill this research void by employing two techniques: (1) cognitive map and (2) linear structural relationship (LISREL). The cognitive map was used to operationalize the causal relationships among design factors of the EC sites, and investigate the simulation to find the optimal strategy of adjusting the design factors. The LISREL was performed to prove the proposed research model, where original Technology Acceptance Model (TAM) [Davis MIS Q. 13 (1989) 319] is adopted as a basic framework for providing causal relationships. Usable questionnaires were collected from 114 respondents who are proved to be qualified for this study. They were educated to surf two typical EC sites appropriately and tested before answering the questionnaires. Those respondents who completed questionnaires successfully were given a book coupon of 5\$ equivalent. After LISREL experiments, the proposed research model was tested, and an adjacency matrix was induced which is to be used for the cognitive map simulation. With the adjacency matrix and 15 hypothetical market situations, the cognitive map simulations were successfully performed yielding that the proposed two techniques could be used for successfully adjusting the design factors of the EC sites under consideration in line with the changes in customers' tastes and market situations. One of the noticeable practical advantages of this study is that decision makers can identify the most relevant design factors and thereby allocate limited resources to them reasonably by performing the cognitive map simulation in advance before doing design adjustment to the EC sites in actuality. © 2002 Elsevier Science Ltd. All rights reserved.

*Keywords:* Cognitive map; Electronic commerce sites; Design adjustment; Technology Acceptance Model; Linear structural relationship; Design factors; Outcome variables; Causality coefficients; Adjacency matrix

## 1. Introduction

The recent dramatic advent of the web sites presents new opportunities and challenges to establish, build, and manage customer relationships. Many marketing experts believe that the web sites are more conducive to relationship marketing than other targeted media, such as direct mail. The necessity of strengthening relationship marketing on the web sites makes it imperative for most of firms to understand the user's perceived ease of use, perceived usefulness, behavioral intention to use the sites, and other cognition-related variables (Davis, 1989). Although books and articles abound concerning how to build the web sites, most published works are based on unsystematic opinions or personal experience, not on research.

The web sites are offering a great potential to change the

ground rules by which firms interact with their customers. Electronic commerce (EC) on the Internet is fueling the commercial use of the web sites much more. The web sites used for EC on the Internet are named herein the *EC sites* in the sequel. Through using the EC sites, customers can virtually traverse geographically dispersed sites using browser software, and make rational decisions on specific products and services. Perceived advantages of the EC sites are as follows:

1. They can allow extended market reach crossing geographic borders.
2. Client/server systems, software for cross-platform information processing, multimedia databases, and high resolution color displays, all of which are what the EC sites are equipped, enable even small firms to make their products and services appealing to potential customers worldwide.
3. Customers have a wider selection of brands.

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Meanwhile, customer's behavioral intention to purchase on the EC sites are influenced by atmosphere, functional service, information service, visual representation, service quality, and other factors that the design components (or user interface) of the EC sites are showing. Besides, customer's tastes are changing rapidly as well as market situations, which makes it imperative to maintain the EC sites timely. In other words, it is necessary to adjust the user interface or design components of the EC sites from time to time.

Maintaining the EC sites properly according to the changes in users' tastes and market situations should be strictly based on rigorous research frameworks. Our research problem here is therefore to provide a research-based support in adjusting the design components of the EC sites in line with changes in market situations and user's tastes. To resolve this problem, this study addresses the need for a rigorous research model linear structural relationship (LISREL) to link the cognitive map simulation to adjusting the design components of the EC sites.

The EC sites are now regarded as official cyber place for linking firms to on-line customers. They are being extensively used for creating and maintaining customer relationships on-line. Therefore, it is imperative for firms to adjust the design components of the EC sites, on a regular basis, according to the identified or anticipated changes in customer tastes and market situations. The problem to be solved here is that a number of design factors of the EC sites are interlinked with each other complicatedly via direct and indirect causal relationships. Without systematically investigating and analyzing that causality existent among those design factors, decision makers are not able to perform appropriate steps of simulation to adjust the EC sites. In this sense, we introduce a technique of cognitive map (Lee & Kim, 1997; Zhang, Wang, & King, 1994) to incorporate causality into adjusting the EC sites more satisfactorily. Therefore, we propose research objectives as follows:

1. To identify proper design components of the EC sites influencing outcome variables (or customer relationship) such as user satisfaction, and behavioral intention.
2. To propose a research model for designing and maintaining effective EC sites to help establish, build, and maintain outcome variables.
3. To examine causal relationships among design components and customer relationships by employing questionnaires survey and LISREL for statistical analysis.
4. To explore the cognitive map as a simulation vehicle for determining the optimal strategy of adjusting some design components of the EC sites in consideration of outcome variables.

Research background is introduced in Section 2, where design factors and outcome variables are identified, and the need for cognitive map to fulfill our research objectives is

discussed. In Section 3, research model is proposed with some theoretical backgrounds. Then, in Section 4, experiments with questionnaire data are addressed with discussion. This paper ends with concluding remarks in Section 5.

## 2. Research background

### 2.1. Design factors and outcome variables

The EC sites are one of the IS's which customers attempt to get accustomed to using it for their purposes. If the EC sites are belonging to IS, then there exist many success measures as suggested by Delone and McLean (1992)—system quality and information quality. In addition, Delone and McLean (1992) argued that temporal and causal interdependencies exist among the success measures of IS. Such interdependencies represent causal relationships.

Therefore, in line with argument of Delone and McLean (1992), we also assume that there exist causal relationships among the success measures of the EC sites. One of the important success measures of the EC sites is user interface or design factors (Spiller & Lohse, 1998). The success of the user interface of the EC sites depends on how a variety of design factors are causally interrelated with each other to give convenience, comfortableness, and usefulness ensuring user's satisfaction. Without investigating such causality among the design factors more clearly, the user interface of the EC sites cannot be adjusted effectively as situations are changing.

In line with the system quality and information quality suggested by Delone and McLean (1992), we propose the following design factors which are considered as *constructs* in experiments:

1. *Visual representation* represents a variety of visual effects such as color, image, video, texture to improve visual attractiveness.
2. *Customized design* provides differentiated functions and services representing the site's characteristics to satisfy user's specific requirements.
3. *Functional service* indicates the quality of various functions essential to normal operations as the EC sites, such as navigation, payment, and delivery service, etc.
4. *Information service* means the quality of information necessary as the EC sites, such as product information, site information, company information, product delivery information, frequently asked questions, etc.
5. *Ease of use* refers to the degree to which the prospective user expects the use of the EC sites to be free of effort.
6. *Reliability* is defined as the extent to which prospective users can obtain the intended usage purpose and increase his/her job performance in a secure manner.
7. *Information usefulness* represents how the use of information provided by the EC sites would yield positive benefits for task performance.

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