

A Comparative Cognitive Map Analysis for Buying Processes in Green Marketing

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Abstract-- This study investigates the factors influencing consumer behavior within the context of green marketing. Through a quantitative analysis, it examines how criteria such as social influence, ecoliteracy, environmental consciousness, green product, price, green place and green advertising affect consumers' purchasing decisions. The results provide useful information for companies trying to match their marketing plans to the growing market for eco-friendly goods and eco-friendly activities. In this study, the factors influencing customer behavior in the buying processes of green products are evaluated, and their importance weights are determined. Causal links among the factors and lack of crisp data lead to employ fuzzy cognitive map as an appropriate methodology to assess the factors. The presence of hesitation in data led us to utilize intuitionistic fuzzy cognitive map (IFCM) technique to provide a comparative analysis. The application is illustrated through a case study, which is conducted in a marketing department of a firm located in Turkey.

Keywords-- Fuzzy cognitive map, Intuitionistic fuzzy cognitive map, Green marketing, Customer Behavior, Causal links.

I. INTRODUCTION

Since 1950s, academicians started to focus on the idea of "green marketing." The environmental movement, which increased public awareness of the effects of industrial activity on the environment, was started to rise in 1970s. However academic circles did not start to study and discuss green marketing until the late 1980s and early 1990s [1].

The term "green marketing" was initially introduced during a seminar on "ecological marketing" organized by the American Marketing Association (AMA) in 1975. This event outlined the entry of the related concept into the literature. The proceedings of this seminar led to the publication of one of the earliest books as titled as "Ecological Marketing" [2]. Since then, a number of further publications that provide a thorough analysis of eco-friendly marketing strategies have been published [3, 4, 5]. According to Pride and Ferrell [5], green marketing is also known as sustainable marketing, environmental marketing or ecological marketing. It refers to the organization's effort at designing, promoting, pricing and distributing products that will not harm the environment. As stated by Polonsky [4], green marketing consists of all the activities designed to generate and facilitate any exchanges intended to satisfy human needs, such that the satisfaction of these requirements occurs, with minimal detrimental impact on the natural environment.

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In the past decade, some of the academicians have focused on factors affecting consumers' green product purchase behavior. Alves et al. [6] used a survey technique to evaluate a green behavioral model on a sample of 1175 university students from four different countries. Kumar and Ghodeswar [7] employed a survey-based method to test hypotheses through a 38-item questionnaire, with data collected from 403 working respondents in Mumbai via snowball sampling to investigate factors influencing consumers' green product purchase decisions in India. Kwon et al. [8] proposed an approach to assist decision-making in retail stores for green product advertising by offering alternatives based on consumer purchase habits. The research was conducted by analyzing shopping path data obtained through radio frequency identification (RFID) from a major retail store in Seoul, South Korea. Khan and Hossain [9] investigated the impact of the green marketing mix on consumers' buying decisions in Bangladesh through quantitative analysis. Data from 200 respondents, collected via Convenient and Judgmental Sampling, were analyzed using frequency, mean, standard deviation, and regression analysis. Le [10] conducted research aimed at exploring the impact of green marketing on students' food purchasing decisions in Ho Chi Minh City, Vietnam. A mix of qualitative and quantitative research methods was employed on a sample of 400 students, and the data were analyzed using SPSS. More recently, Lopes et al. [11] investigated the key factors of green marketing influencing young Portuguese consumers' decisions to purchase eco-friendly products and examines their relationships. Data were collected from 708 young Portuguese consumers through an online questionnaire, and analyzed using the partial least squares (PLS) method.

This work introduces a fuzzy cognitive map (FCM) and an intuitionistic fuzzy cognitive map (IFCM) techniques to determine the importance degrees of factor influencing customer behavior in the buying processes of green products. Interrelations between pair of criteria, and lack of crisp data lead to employ FCM as an appropriate methodology for assessing factors of customer behavior. In addition, the presence of hesitation in data shows that IFCM is a suitable tool to compare the outcomes of FCM.

The remaining part of the study is organized as follows. FCM is explained in Section 2. IFCM is delineated in Section 3. Section 4 illustrates the case study. Conclusions are provided in the last section.

II. FUZZY COGNITIVE MAPS

Fuzzy cognitive map (FCM) is a causal information-based tool that combines fuzzy logic and neural networks. The extension of the tool is provided by including fuzzy

numbers or linguistic variables for expressing the causal links among concepts in the map. These concepts represent an entity, a state, a variable or a characteristic of a system, a behavior of the information-based system is denoted by concepts in FCM [12]. Concept nodes and weighted arcs are the elements of FCM which can be graphically showed with feedback. Signed arcs indicate the sign of causality: whether the causal relationship is positive, negative or null; and connected nodes produce causal relationships among concepts [13]. $C = \{C_1, C_2, \dots, C_n\}$ is the set of concepts, arcs demonstrate how concept C_j causes concept C_i , and are used for causal relationships between concepts. The weights of causality links range can be represented with linguistic variables such as "negatively medium", "zero", "positively medium", etc. The value of each concept is computed, taking into account the effect of the other concepts on the under-evaluation concept, by applying the following iterative formulation.

$$A_i^{(k+1)} = f \left(A_i^{(k)} + \sum_{j=1}^N A_j^{(k)} w_{ji} \right) \quad (1)$$

Where $A_i^{(k)}$ is the value of concept C_i at k^{th} iteration, w_{ji} is the weight of the connection from C_j to C_i and f is a threshold function.

III. INTUITIONISTIC FUZZY COGNITIVE MAPS

Intuitionistic fuzzy cognitive map (IFCM) technique includes intuitionistic fuzzy numbers into cognitive maps in order to determine the power of cause-and-effect relationships [12]. First, concept nodes and power of causal links among them are defined by obtaining experts' opinions. Second, the power of causal links is represented by intuitionistic fuzzy numbers that are associated with intuitionistic fuzzy scale. Hence, membership, non-membership, and hesitation values are identified. Finally, $N \times N$ weight matrix is formed by employing the information collected from the experts.

The following iterative formulation of IFCM is run until the system will be stabilized, in other words, all factor weights will converge [12]. In this way, the concepts' values are computed.

$$A_i^{(k+1)} = f \left(A_i^{(k)} + \sum_{j=1}^N A_j^{(k)} w_{ji}^{\mu} - A_j^{(k)} w_{ji}^{\pi} \right) \quad (2)$$

where w_{ji}^{μ} and w_{ji}^{π} denote the weight matrices that show membership values and hesitation values of causal links, respectively, and f is a threshold function, which is considered as sigmoid function for this work.

IV. CASE STUDY

This work presents FCM and IFCM approaches for buying processes in green marketing. The case study is conducted in a marketing department of a firm performing in cosmetics sector through three experts' opinions. Initially,

factors that are determined by interviewing the decision makers, are delineated in Table I.

TABLE I: FACTORS INFLUENCING CUSTOMER BEHAVIOR

Label	Factor
C_1	Environmental consciousness
C_2	Green advertising
C_3	Green product
C_4	Price
C_5	Green place
C_6	Ecoliteracy
C_7	Social influence

The decision-makers indicate the direction of causal relationships in three categories: positive, negative, null. Afterwards, experts decide the degree of causal links by using linguistic variables; subsequently linguistic variables are transformed into fuzzy numbers. In this study, five linguistic terms are used as zero (z), positively weak (pw), positively medium (pm), positively strong (ps), positively very strong (pvs). The corresponding triangular fuzzy numbers for these linguistic variables are reported in Table II.

TABLE II: SCALE OF FUZZY NUMBERS [12]

Linguistic term	Triangular fuzzy number
z	(-0.25,0,0.25)
pw	(0,0.25,0.5)
pm	(0.25,0.5,0.75)
ps	(0.5,0.75,1)
pvs	(0.75,1,1)

The matrix of power of causalities according to the experts are given in Tables III, IV and V.

TABLE III: POWER OF CAUSALITIES ACCORDING TO EXPERT 1

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0	0	ps	0	0	ps	0
C_2	pvs	0	0	0	0	pm	pvs
C_3	ps	pw	0	pm	pm	pm	0
C_4	0	0	0	0	0	0	0
C_5	ps	0	pw	0	0	pw	pw
C_6	pvs	0	0	0	0	0	0
C_7	0	0	0	0	0	pm	0

TABLE IV: POWER OF CAUSALITIES ACCORDING TO EXPERT 2

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0	0	ps	0	0	ps	0
C_2	ps	0	0	0	0	pm	ps
C_3	pm	pw	0	pm	pm	pm	0
C_4	0	0	0	0	0	0	0
C_5	ps	0	pm	0	0	pm	pm
C_6	ps	0	0	0	0	0	0
C_7	0	0	0	0	0	pm	0

TABLE V: POWER OF CAUSALITIES ACCORDING TO EXPERT 3

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0	0	pvs	0	0	pvs	0
C_2	ps	0	0	0	0	pm	ps
C_3	pm	pw	0	pm	pw	pw	0
C_4	0	0	0	0	0	0	0
C_5	pvs	0	pm	0	0	pm	pm
C_6	ps	0	0	0	0	0	0
C_7	0	0	0	0	0	pm	0

The linguistic data collected by the experts are converted into triangular fuzzy numbers according to the fuzzy scale given in Table II. The matrices of power of causalities that are transformed into triangular fuzzy numbers with regard to three experts. Afterwards, these triangular fuzzy numbers are aggregated via MAX aggregation, and then defuzzified by using center of gravity (COG) method, and the weight matrix is obtained as in Table VI. MATLAB fuzzy toolbox is used for these operations.

TABLE VI: WEIGHT MATRIX

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0	0	0.798	0	0	0.798	0
C_2	0.798	0	0	0	0	0.5	0.798
C_3	0.625	0.25	0	0.5	0.375	0.375	0
C_4	0	0	0	0	0	0	0
C_5	0.798	0	0.375	0	0	0.375	0.375
C_6	0.798	0	0	0	0	0	0
C_7	0	0	0	0	0	0.5	0

The iterative formulation of FCM is run via FCMapper software for obtaining the importance degrees of factors influencing customer behavior in the buying processes of green products. The resulting importance values are listed in Table VII.

TABLE VII: IMPORTANCE VALUES

Label	Importance degree
C_1	0.969132
C_2	0.718412
C_3	0.872751
C_4	0.769583
C_5	0.745038
C_6	0.957693
C_7	0.845267

In order to provide a comparative study, IFCM technique is employed. In the application of this method, the experts provide their opinions by reaching a consensus, and hence they used the linguistic scale shown in Table VIII.

TABLE VIII: SCALE OF FUZZY NUMBERS [12]

Linguistic term	Intuitionistic fuzzy number
VH	<0.95,0.05>
H	<0.70,0.25>
M	<0.50,0.40>
L	<0.25,0.70>
VL	<0.05,0.95>

The linguistic data, membership values, non-membership values, and hesitation values for causal relationships, are given in Tables IX, X, and XI, respectively.

TABLE IX: MEMBERSHIP VALUES

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0	0	0.95	0	0	0.95	0
C_2	0.95	0	0	0	0	0.50	0.95
C_3	0.70	0.05	0	0.50	0.25	0.25	0
C_4	0	0	0	0	0	0	0
C_5	0.95	0	0.25	0	0	0.25	0.25
C_6	0.95	0	0	0	0	0	0
C_7	0	0	0	0	0	0.50	0

TABLE X: NON-MEMBERSHIP VALUES

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0	0	0.05	0	0	0.05	0
C_2	0.05	0	0	0	0	0.40	0.05
C_3	0.25	0.95	0	0.40	0.70	0.70	0
C_4	0	0	0	0	0	0	0
C_5	0.05	0	0.70	0	0	0.70	0.70
C_6	0.05	0	0	0	0	0	0
C_7	0	0	0	0	0	0.40	0

TABLE XI: HESITATION VALUES

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	1	1	0	1	1	0	1
C_2	0	1	1	1	1	0.10	0
C_3	0.05	0	1	0.10	0.05	0.05	1
C_4	1	1	1	1	1	1	1
C_5	0	1	0.05	1	1	0.05	0.05
C_6	0	1	1	1	1	1	1
C_7	1	1	1	1	1	0.10	1

IFCM technique is employed and importance weights are obtained by running the formulation (2) until it will be stabilized, and the values of concepts will remain same. FCMapper software is used for these operations. The factors' values are given in Table XII.

TABLE XII: FACTORS VALUES

Label	Importance degree
C_1	0.977036
C_2	0.671575
C_3	0.874844
C_4	0.750306
C_5	0.707290
C_6	0.942071
C_7	0.833873

V. CONCLUSION

To obtain the importance weights of factors influencing customer behavior in the buying processes of green products, evaluation criteria that influence customer behavior are determined through expert opinions and then algorithm of the work is reported by considering FCM technique. Importance weights of factors are assigned by applying FCM methodology, “environmental consciousness” and “ecoliteracy” are the most effective factors however “green place” and “green advertising” are the least influential criteria.

In order to reveal a comparative analysis to demonstrate the robustness of the employed technique, IFCM method is utilized, and very similar importance values are obtained with FCM results. Future research will focus on proposing a multiple criteria decision making approach that aims to identify the most appropriate green marketing strategy alternative when data are uncertain.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Author Contributions:

Mert Unal carried out FCM and IFCM applications. Mehtap Dursun made interviews with the experts and Nazli Goker was responsible for redaction.