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Profiling Green Consumers with Data Mining

Alireza Ziaei-Bideh and Mahsa Namakshenas-Jahromi

Abstract

Concern about the environment has led to a new segment of consumers called green consumers. Because not all the consumers are equally green, using target marketing for persuading them to buy green product is essential. The first step in target marketing strategy is to segment the market and then develop profiles of the resulting market segments. This study aims to identify distinct green market segments based on demographic, psychographic, and behavioral variables and also investigate the relationship between each variable and green consumer behavior. This study uses self-organizing maps (SOM) to segment and then develop profiles of Iranian green consumers. Based on the results, four market segments have been identified and were named intense greens, potential greens, egoist browns, and intense browns based on profiles of consumers in each segment. The results of this study also indicate that the level of education and income together with egoistic value and environmental unfriendly habits correlate negatively with the greenness (intent and intense of green behaviors) of Iranian consumers and the age of consumers together with environmental attitude and knowledge, biospheric and altruistic values, and religiosity correlate positively.

Keywords: green consumers, market segmentation, profiling, data mining, self-organizing maps

1. Introduction

Increase of environmental pollution and damage, together with the increase in public concern about the surrounding natural environment, has so far influenced the purchase and consumption behaviors, and thus, has led to emergence of a new group of consumers called green consumers [1, 2]. Even though there is no universally accepted definition of the green consumer [3], the most adopted is that green consumers or environmental friendly consumers are those who consider the impact of manufacturing process and consumption of environmental resources while making purchase or participating in other market related activities and make their decisions accordingly [4].

Due to the increase in the number of green consumers, green marketers have started to target green segments of market to exploit the opportunities existing in these segments. Green marketing and promoting environmental friendly consumption behavior are necessary in two ways: first, acceleration in the trend of exploitation and destruction of natural resources essential for human life such as water, oil, and forests is a serious threat for human being. The main causes of this

destructive trend include population growth and detrimental consumption habits. This trend highlights the importance of encouraging people to promote environmental friendly or the so-called green behaviors [5, 2].

Second, public concern about environmental issues is arising; thus, everyday more consumers are willing to purchase and consume products introduced as environmental friendly. In order to respond to this growing need, it is essential to develop and implement green marketing strategies [6].

Consumers are not equally green and the levels of their willingness to purchase green products are not equal [7]. Therefore, to market green products effectively, it is essential to implement targeted marketing strategies rather than mass marketing. The initial step in implementation of targeted marketing strategy is market segmentation and determination of the unique characteristics of each segment. Profitability and performance of market segmentation depend on the accuracy of consumer profiling in each segment because imprecise prediction of market segment members reduces efficiency of marketing strategies [8].

Similarly, in Iran, according to evidence, the public concern about environmental issues has increased among consumers, and green segments have emerged in markets. Researchers have come to the conclusion that attitudes toward environmental issues and environmental friendly behaviors and factors that encourage consumers to purchase green products are not the same in all cultures [9]. Hence, due to the unique cultural norms and values of Iranian citizens, it is necessary to conduct appropriate studies to determine profile and characteristics of Iranian green consumers. However, despite the increasing number of green consumers in Iran and thus the importance of segmenting them and determining their profiles, no significant study has so far been conducted in this area. Focusing on the need for research in this field, the aim of this study is segmenting and profiling green consumers using data mining approach. Other objectives of this study are to determine the role of each demographic, behavioral, and psychographic variable in the behavior of Iranian green consumers.

2. Customer segmentation variables

The first step in market segmentation is to determine variables by which the segmentation should be performed. Researchers have used various demographic, psychographic, and behavioral variables for market segmentation and profiling of green consumers. Utilization of variables that have the greatest impact on consumers' green behavior and thus can best determine the segments of green markets will lead to favorable results in segmentation [6]. The variables that have been used in previous studies to determine green segments of market and have been proven to affect environmental friendly behavior of consumers will be discussed next.

2.1 Demographic variables

Diamantopoulos et al. reviewed the results of previous researches about the impact of various demographic variables on knowledge, attitude, and behavior of green consumers. In previous researches, as their study results show, age, gender, education, and income are emphasized among demographic variables, and their effectiveness is confirmed [7].

Do Paco et al. segmented green consumers based on their environmental attitude and knowledge and then studied demographic characteristics of each segment. These researchers segmented green market into three segments named: the uncommitted, the greens activists, and the undefined. Their results show that

the green activists are highly educated consumers with high income within the age groups 25–34 and 45–54, who have positive attitudes toward environmental friendly activities and practice green behaviors more than other consumers [6].

Abeliotis et al. in their research among Greek people came to the conclusion that women tend to have an environmental friendly behaviors more than men, also that income is negatively associated with the tendency of people toward green behaviors. The results of their study indicated no significant relationship between education level and green behavior of consumers [10].

A summary of the results of other studies conducted on the effects of demographic variables on behavior and attitude of green consumers is given in **Table 1**.

2.2 Psychographic variables

Psychographic variables are one of the most beneficial and widely used variables in segmentation of consumers, especially green consumers [6]. Based on previous studies, the psychological variables associated with the values and beliefs of consumers, which have the greatest impact on consumers' attitudes and behaviors, have been identified. These variables will be discussed below:

Personal values: one of the most common theories in predicting green behavior of consumers is the value-belief-norm theory [5, 20–24]. Based on this theory, as Stern [4] describes, personal values including altruistic, biospheric, and egoistic are the most important variables influencing people's environmental friendly behaviors. People with higher levels of altruism base their behavior on the perceived costs and benefits for other people in society. Biospheric people consider the effects of their actions on environment and living organisms and decide accordingly. Those, whose egoistic value is stronger, review the costs and benefits of environmental friendly behaviors only for themselves. Hence, if the earned benefits of such activities are more than their cost, they will act environmental friendly; otherwise, they will have negative attitude toward these activities. Researchers have found that the levels of consumers' altruistic and biospheric values positively correlate with green behavior, but selfishness correlates negatively [5, 21].

Religiosity: another psychographic variable which, despite its less emphasis in previous researches, is expected to have a positive impact on the behavior of Iranian

Variables	Research result	Reference
Gender	Women are greener	[10–13]
	Men are greener	[14]
	Without effect	[1, 15, 16]
Age	Positive effect	[6, 7, 10, 16]
	Negative effect	[12, 17]
	Without effect	[15, 18]
Education	Positive effect	[5, 10, 12, 17–19]
	Negative effect	[1, 6, 15]
	Without effect	[7]
Income	Positive effect	[1, 5, 11, 13, 15, 16]
	Negative effect	[10, 17]
	Without effect	[7]

Table 1.
 Role of demographic variables in green behaviors of consumers.

consumers is religiosity or religious values. Rice in a research on Egyptian Muslim consumers proved that the level of religiosity of consumers directly and significantly correlates with their intention to pro-environmental behavior [25]. Also, Biel and Nilsson concluded that people who believe nature is holy are more willing to behave pro-environmentally and green [26].

2.3 Behavioral variables

Segmenting green consumers by behavioral variables is based on their environmental knowledge and attitude as well as their tendency to demonstrate environmental friendly behaviors [6]. The most effective behavioral variables, which their effect on consumers' environmental friendly behavior has been confirmed in previous studies, will be discussed below:

Environmental attitudes: social psychology researchers have addressed attitude as the most important variable in predicting behavior and behavioral intentions [27]. In respect with marketing and green consumers, numerous studies have been conducted on the impact of environmental attitudes on environmental friendly behaviors [28, 29]. For example, Mostafa concluded that consumers' attitudes toward purchasing green products and also advertisements by manufacturers of green products have a positive effect on consumers' purchase intention [8].

Environmental knowledge: environmental knowledge can be defined as a general knowledge of facts, concepts, and issues related to the environment [30]. Researchers have identified two different types of environmental knowledge: abstract knowledge about environmental problems, causes and solutions to these problems and concrete knowledge about the behaviors that can be done in those situations. Comparing people who actively participate in pro-environmental activities with those who show less intention in this regard, researchers concluded that the difference in level of their environmental knowledge is the main reason of the different behaviors among these two groups of people [1, 14, 18, 31].

Personal habits: another behavioral variable that is proven to play a role in consumers' green behavior is personal habits [5, 21, 24, 29, 32, 33]. Typically, behavior change includes giving up an old habit and replacing it with a new one. Habits affect person's willingness and intention to change their behavior and to convert attitudinal factors into actual behavior [5]. Previous researchers have concluded that personal habits affect people's tendency to perform green behaviors such as recycling, reducing energy consumption and using green energy sources. In order to give up a habit and act oppositely, Thogersen and Moller believe it is necessary that the desired behavior is repeated and rewarded frequently [34]. Hence, it is expected that consumers' habits related to environmental unfriendly behaviors will affect negatively on their willingness to perform green activities.

3. Methodology

This study is an applied research in terms of objectives and a survey-analytic research in terms of methodology. Also, since this study examines the data associated with a specific period of time, it is a cross-sectional study.

3.1 Sample and sampling method

The target population of this research is consumers in Yazd province. A convenience sampling method was used to select the respondents. So that, the interviewers randomly selected passers-by, asked them to take part in the study

and to complete the standardized, self-administered questionnaire. A total of 300 initial responses have been received. After eliminating the confounding questionnaires, the number of final sample analyzed was 252, resulting in a response rate of 84%. Among the 252 respondents, 60% were male and 40% female. About 92% of the respondents have a bachelor's degree or less and 76% aged from 18 to 35 years. Also, most respondents (43%) had a medium income of between 5,000,000 and 8,000,000 Rials.

3.2 Survey instrument

A questionnaire was used to collect the required data. All measures have been adopted from previous studies, and also, they were assessed by three marketing professors so that respondents would understand the questions correctly. Cronbach's alpha was used to determine the reliability of the questionnaire. **Table 2** shows the Cronbach's alpha values and researches that the measures have taken from.

3.3 A review on self-organizing maps

Self-organizing map (SOM) is a method based on neural networks, which provides a powerful and fascinating tool to display multidimensional data in spaces with lower dimensions (usually one or two). Research experiments show that utilizing new methods such as neural networks and self-organizing maps for segmenting consumers and predicting their behavior lead to better and more accurate results compared with conventional statistical methods [8, 37, 38].

Self-organizing maps are a kind of neural networks with unsupervised learning capability that are suitable for analyzing complex spaces. This model of neural networks was first introduced by Kohonen in 1981. SOM is effective at clustering and visualizing essential features of complex data and has a unique structure that allows multivariate data to be projected nonlinearly onto a rectangular grid layout with a rectangular or hexagonal lattice.

The structure of self-organizing maps is composed of two distinct layers: an input layer and an output layer which is called map layer as shown in **Figure 1**. The map layer is usually designed as a two-dimensional arrangement of neurons that maps n-dimensional input to two dimensions, preserving topological order. Each neuron in the map layer corresponds to an information node with dimensions equal

Variable	Reference	Cronbach's alpha
Biospheric value	[29]	0.71
Altruistic value	[29]	0.68
Egoistic value	[29]	0.76
Religiosity	Authors	0.73
Green behavior	[35]	0.80
Environmental knowledge	[8]	0.78
Environmental attitude	[36]	0.69
Green behavior intent	Authors	0.73
Nongreen habits	[5]	0.76

Table 2.
 Reliability and sources of questionnaire measures.

to the dimensions of the analyzed space [39]. The two-dimensional map network consists of one layer of strongly interconnected neurons. Each neuron is connected to the n-dimensional input via a set of n weights.

After training the self-organizing network, a number of weight nodes are obtained, each of which represents a portion of the analyzed space. Also, the number of obtained weight nodes is the same as the number of neurons. Hence, if appropriate number of neurons is selected and the network is trained properly, the weighted display corresponding to neurons of each network can well represent the analyzed space. In the output of self-organizing maps, corresponding to the value of each attribute in the weight node, an RGB vector and thus a color will be considered in a way that all values can be visualized using color spectrum ranging from dark blue (the lowest value) to dark red (the highest value).

The SOM algorithm repeatedly repositions records in the map until a classification error function is minimized. Records that have similar characteristics are adjacent in the map, and dissimilar records are situated at a distance determined by degree of dissimilarity. In particular, SOM consists of a layer of input vectors and a two-dimensional grid of output nodes. Each output node is connected to all the input vectors through the link of weights. When an input vector is presented, the closest match (most similar) of the output node is identified as the winning node. The input vector is thus mapped to the location of the winning node. The weights of the winning node and its neighborhoods are then updated closer to the original input vector. This process repeats until weights are stabilized, and all input vectors are mapped onto the output array. In this way, input vectors with similar data patterns are located into adjacent region, while dissimilar vectors are situated at a distance in the output map. Therefore, it will be possible to identify clusters on the map visually. Various software packages are available to analyze data using self-organizing maps. In this study, Viscovery SOMine version 5.0 was used.

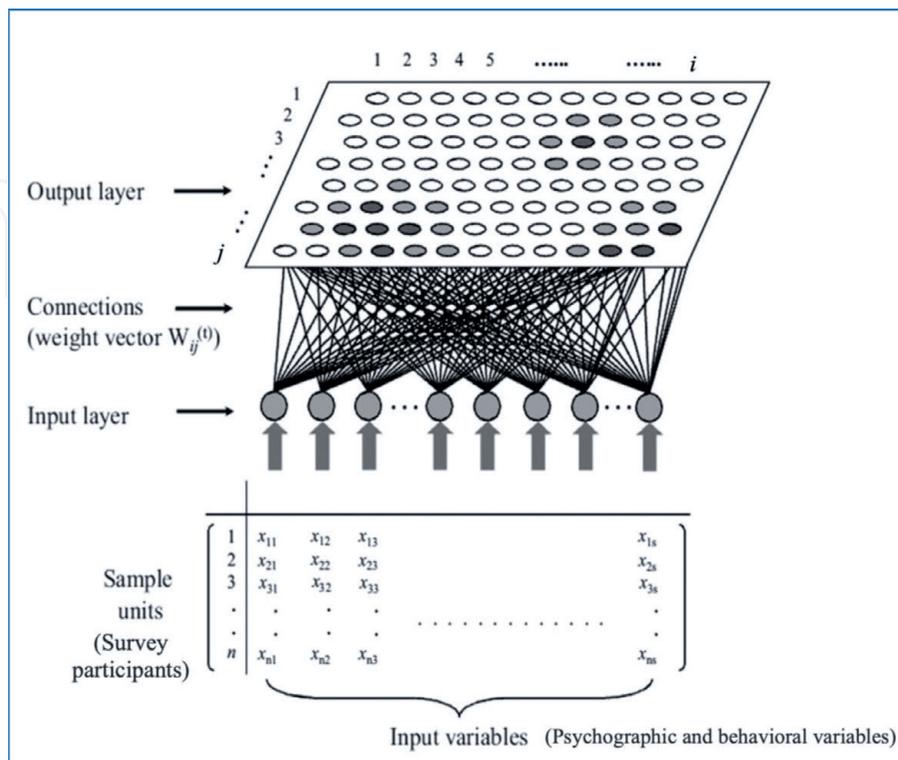


Figure 1. Basic structure of self-organizing map (SOM) (adapted from [40]).

4. Data analysis and results

4.1 Network training and evaluation

Several experiments have been carried out with different combinations of parameters and selected the better neural architecture based on the following criteria: average quantization error, the meaningfulness of clusters, the visual interpretability, and the SOM-Ward cluster indicator. The resulting best segmentation is obtained through 551 neurons in the output layer (19×29 matrix). SOMine software, automatically selects the best dimensions for the map network based on the selected number of neurons in the output layer. After testing various dimensions and training the network, the software chose network dimensions equal to 19×29 . Training schedule is set in a way that the software can autonomously provide maximum accuracy for the training of the network. Also, the tension level of the network training is set to 0.5. Training data of network constitute 252 (sample size) nine-dimensional vectors (psychographic and behavioral variables). Data associated with demographic factors was not used in training. After training the network and final segmentation, demographic characteristics of green consumers in each segment will be investigated.

Quantization error is used as a measure to evaluate the accuracy and validity the self-organizing maps. Quantization error, which is a value between 0 and 1, shows the level at which output maps are able to visualize input data on a two-dimensional space, where quantization error value close to (0) shows more accuracy of the network [41]. The final value of quantization error for the network used in this research was equal to 0.1898.

4.2 Analyzing output maps and final segmentation

Most researchers use U-Matrix which is one of the outputs of self-organizing maps for final clustering and determining the boundaries of each segment or cluster. Since, this method does not define exact and clear boundaries for each segment [8, 36], therefore in this study, a hierarchical cluster analysis method called SOM-Ward clusters is used to determine the boundaries of each segment and also to determine the optimal number of clusters. Final segmentation of green consumers in four clusters or segments is shown in **Figure 2**. This two-dimensional hexagonal grid shows clear division of the input pattern into four clusters. The clusters divide the input data into disjoint areas containing similar vectors. Since the order on the grid reflects the neighborhood within the data, features of the data distribution can be read off from the emerging landscape on the grid. The application of the SOM algorithm brought together samples by resemblance. The more similar the samples are, the closer they are positioned in the output space.

After defining boundaries of segments, the characteristics of consumers in each segment should be investigated. **Table 3** shows the average of psychographic and behavioral variables in each of the segment.

Another output of self-organizing maps is feature maps which show vector distribution of each of the segmentation variables in the whole analysis space. At the bottom of each of these maps, a color spectrum, ranging from blue to red, is shown that indicates various values of the variables. Via these maps, the situation of variable in each of the market segments can be studied, and also, the correlation between the different variables can be examined by visually comparing the pattern of shaded pixels for each map [36]. The feature maps reported for each segmentation variable are shown in **Figure 3**. On these maps, the nodes which share similar information are organized in close color proximity to each other. **Figure 3** shows the feature maps for every cluster and for all input attributes.

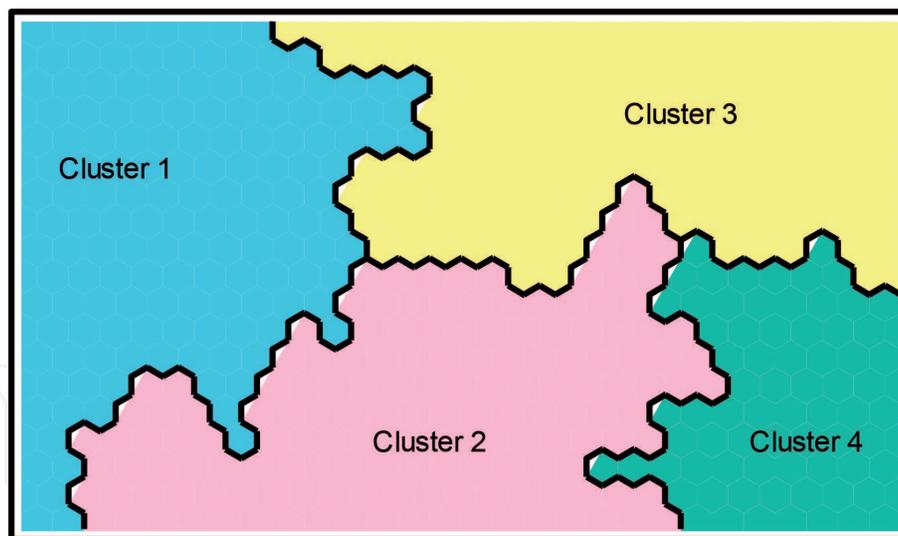


Figure 2.
Final segmentation map.

	Green behavior	Env. know.	Attitude	Intent	Habit	Egoistic	Altruistic	Bio spheric	Religio sity
Seg. 1	4.25	3.92	4.49	4.26	1.66	3.01	4.39	4.77	4.21
Seg. 2	3.54	3.44	4.02	3.35	1.96	3.52	3.84	4.52	3.50
Seg. 3	3.29	3.25	4.25	3.48	3.10	2.98	4.37	4.88	3.73
Seg. 4	2.66	2.60	3.54	2.74	3.75	3.34	3.56	4.20	3.21

Table 3.
Average of psychographic and behavioral variables in each segment.

As shown in **Figure 3**, the analysis space has nine dimensions. By comparing these maps, the following results can be obtained:

- Variables of attitudes, knowledge, intent to pro-environmental behavior, and green behavior are positively correlated with each other, because wherever one variable is red (high value), the other variables have almost the same value. Level of correlation between the variables can be observed from the intensity of the color similarity.
- Among psychographic variables, biospheric, altruistic, and religion values are positively correlated to each other and also to behavior variables including attitude, intent, knowledge, and green behavior, while egoistic is negatively correlated to other variables.
- The variable habit is negatively correlated to other behavioral variables, especially green behaviors, and also to variables such as biospheric and altruistic.

Besides the feature maps reported for psychographic and behavioral variables, the status of demographic variables in each segment can also be studied through feature maps provided by the software. **Figure 4** shows these feature maps.

Figure 4 shows that consumers with different gender, age, education, and income are scattered in all sectors. At first glance, it appears as no specific relationship exists between demographic variables and behavior of green consumers.

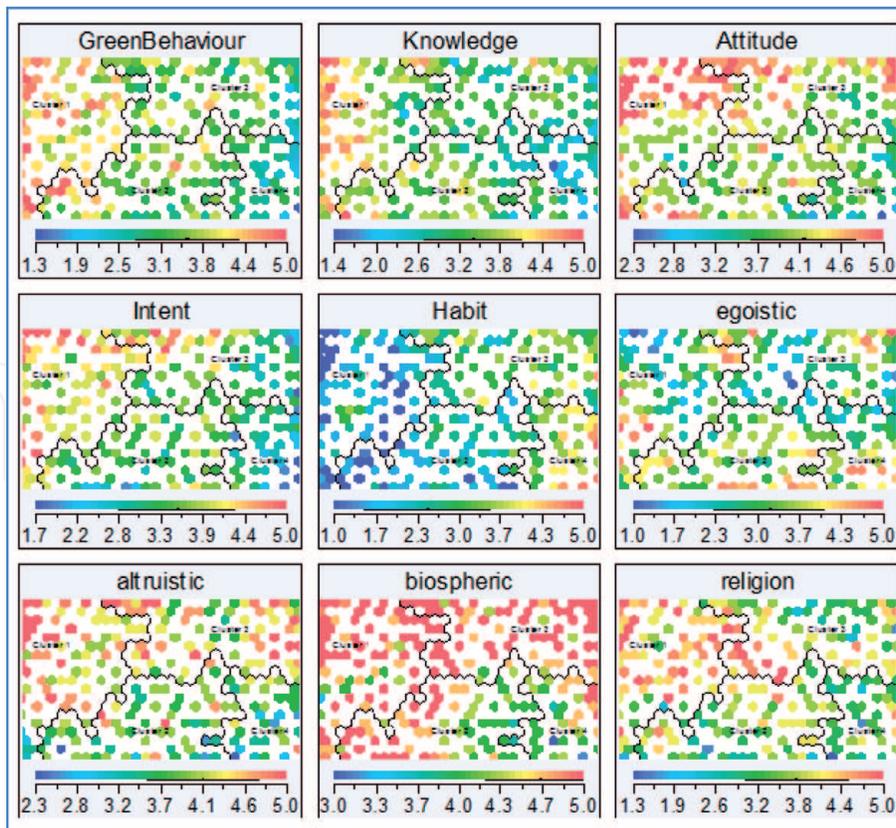


Figure 3.
 Feature maps for psychographic and behavioral variables.

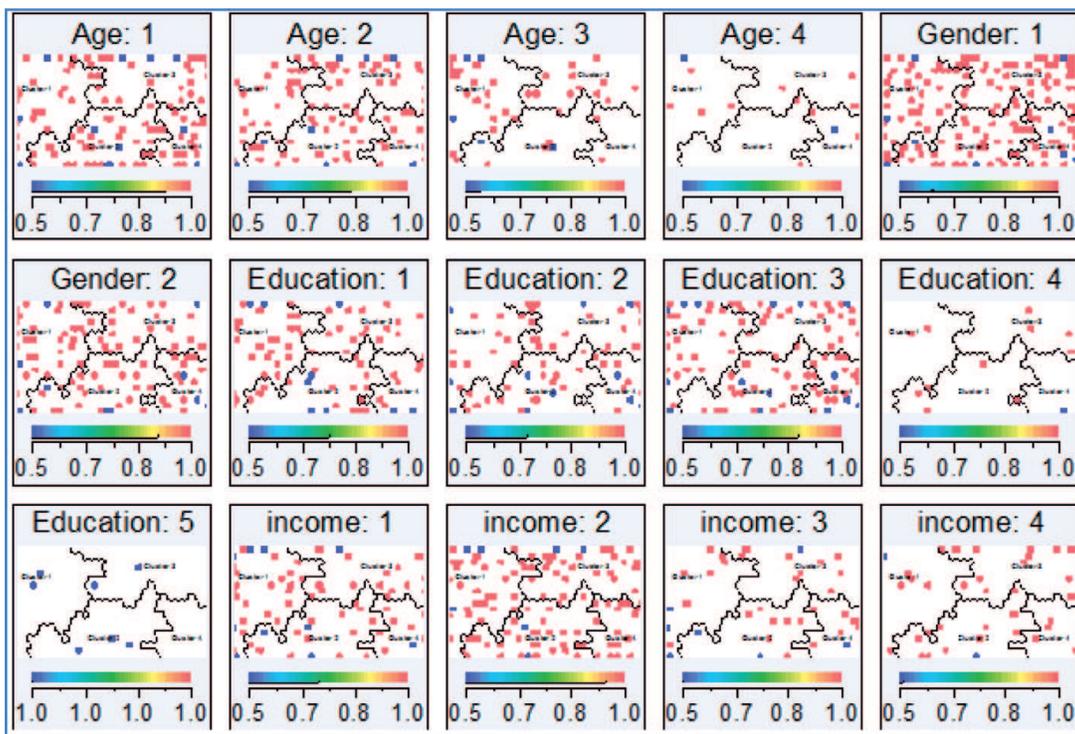


Figure 4.
 Feature maps for demographic variables.

However, according to **Figure 5**, which shows the importance of each demographic variable corresponding to other variables in that segment and also relative to importance of that variable in other segments, different results can be deduced.

The following results can be obtained from **Figure 5**:

- Consumers within the age group 18–24 are mostly scattered in segments 2 and 3 of the market, and most of the consumers in the segment 1 are within the age group 35–49. Consumers at other ages are scattered in different market segments.
- In the segment 1 of the market, aggregation of women is more than men, while in segments 2 and 3, aggregation of men is more than women.
- Most of the consumers with no graduate education are in the segment 1, and most of the consumers in segment 4 have postgraduate education.
- Most of the consumers in segment 1 of the market have incomes less than 5,000,000 Rials, and high-income consumers are mostly in segments 4 and 5.

4.3 Naming and describing market segments

Once market segments are identified, they should be named and described based on their consumer profiles. Marketers and producers of environmental friendly products can use this information to identify their target market and then to utilize suitable marketing strategies and marketing mix based on characteristics of that segment. To provide a better description for each segment, SOMine draws a diagram for psychographic and behavioral variables in each segment like that drawn for demographics. The diagram is shown in **Figure 6**.

According to **Figures 5 and 6** and **Table 3**, which show the importance of psychographic, behavioral, and demographic variables in each market segment, market segments can be named as follows:

Intense greens (segment 1): this segment that includes 29.37% of total consumers can be assumed as the greenest segment of the market. In terms of demographic characteristics, most consumers in this segment are within the age group 35–49, and aggregation of women is more than men in this segment. In terms of education, most of the extreme greens are nongraduates. In terms of psychographic characteristics, extreme greens are biospheric, altruistic, and religiosity consumers

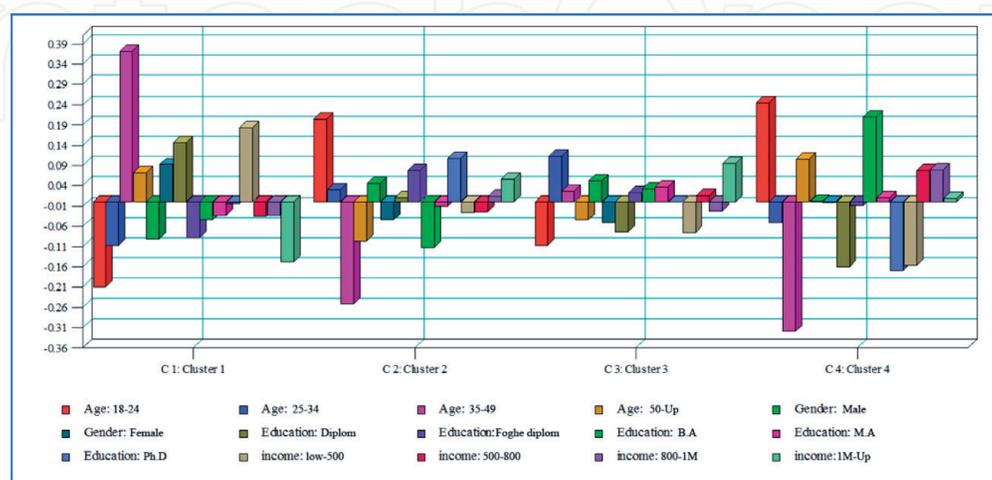


Figure 5.
Importance of demographic variables in each market segment.

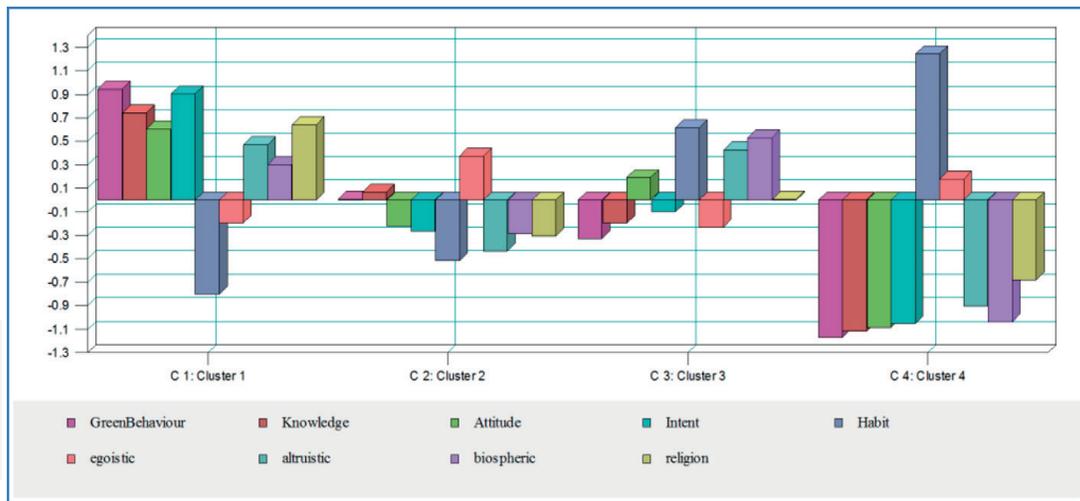


Figure 6.
 Importance of psychographic and behavioral variables in each market segment.

with low level of egoistic value. In terms of behavioral characteristics, these consumers have high level of knowledge about environmental issues and positive attitude toward green behaviors. Also, their willingness to purchase green products and behave in an environmental friendly manner is higher than the rest of the consumers. Nongreen habits are very rare in this segment.

Egoistic browns (segment 2): this segment of the market includes 26.19% of total consumer. In terms of demographic characteristics, people of this segment are within the age group 18–24, and most of them are with an income level of above 10 million Rials. Consumers in this segment of the market mostly have undergraduate education. In terms of the psychographic characteristics, the level of altruistic, biospheric, and religiosity values is very low among this group of consumers, which is one of the main reasons for their negative attitudes toward green behaviors. In terms of behavioral characteristics, although these consumers claim that they have some knowledge about environmental issues and environmental friendly products, but their egoistic is the main reason for their low tendency toward green behavior.

Potential greens (segment 3): this segment includes 28.57% of total consumers. In terms of demographic characteristics, most of the consumers in this segment are within the age group 25–34, with an income above 10 million Rials. Most of the potential greens are men. No specific educational pattern can be found in this segment. In terms of behavioral characteristics, although these consumers have positive attitudes toward environmental friendly behaviors, frequency of green behaviors in their daily life is very low, and they show environmental unfriendly habits. In terms of the psychographic characteristics, due to the high level of altruistic and biospheric values, these consumers have the potential to become true greens.

Intense browns (segment 4): this segment of the market that is the smallest and the nongreen part of the market, includes 15.87% of total consumers. Most of the intense browns are within the age group 18–24 with graduate-level education, and their income is between 5 and 10 million Rials. In terms of behavioral characteristics, these consumers' environmental knowledge and attitude and thus their tendency to green behavior and purchase of green products are very low. In contrast, they show nongreen behaviors. In terms of psychographic characteristics, altruistic, biospheric, and religious values in this group are very low, and they are egoistic consumers.

5. Conclusions and practical implications

In this research, Iranian green consumers were segmented based on their psychographic and behavioral characteristics with the use of a self-organizing map algorithm. Then the demographic characteristics of consumers in each segment were investigated. In the following sections, first the effects of each segmentation and demographic variables on behavior of green consumer are discussed. Then based on the results, practical suggestions on targeting each market segment are presented.

5.1 Role of demographic variables in pro-environmental behaviors

Gender: the results show that in the segment 1 which is occupied by extreme greens, most of the consumers are women, and in other segments of the market where tendency to green behaviors and frequency of environmental friendly activities are low, population of men is greater than women. Previous researchers including Memery et al. [12] and Abeliotis et al. [10] also concluded that women are generally greener than men.

Age: since most egoistic browns and intense browns are within the age group 18–24 years and also most intense greens are at older ages, 25–49, it can be concluded that age correlates positively with the greenness (environmental friendliness) of the consumers. Dsouza et al. [16] and Abeliotis et al. [10] also obtained a similar result.

Education: although no definite conclusion about the education can be deduced, it seems that level of education is negatively correlated with the greenness of consumers, because the abundance of uneducated people is the highest in the greenest segment of the market. Also, most of the intense browns have high education levels. Do Paco et al. [1, 6] also found similar results in their studies.

Income: based on the results of this study, it can be concluded that the income level has negative effect on greenness of consumers. The number of consumers with high income level in the brown segments of the market is higher than the other segments, which shows that consumers with higher income have lower intent to environmental friendly activities. Previous researchers, Banyte et al. [17] and Abeliotis et al. [10] also found the same result.

5.2 Effects of behavioral and psychographic variables on pro-environmental behaviors

Personal values: the importance of personal values in each of the market segments shows that biospheric and altruistic have positive effect and egoistic has negative effect on the level of greenness of consumers. The majority of consumers in the green segments of the market, such as intense greens and potential greens, are altruistic and biospheric consumers with low level of egoistic value. Previous researchers including Johnson et al. [9] and Cordano et al. [21] also obtained similar results.

Religiosity: as expected, due to the Islam's advice about holiness of nature and importance of green behaviors such as avoiding damage to environment, dissipation, and protection of organisms, religiosity has positive effect on greenness of Iranian consumers. Rice [25] also achieved similar results in a study on the Egyptians.

Green knowledge and attitude: according to the results of this study, consumers' knowledge about environmental issues and green products and also their attitude toward green purchase and behavior have positive effects on consumers' greenness. Most of the previous researches achieved similar findings.

5.3 Practical recommendations on targeting each market segment

Intense green targeting: this segment includes the best group of consumers for the target market. Since most of the extreme greens are within the age group 35–49 and have low education levels, marketers can use marketing strategies appropriate to these consumers. It is noteworthy that extreme greens are not individuals with high income; thus, determining appropriate and reasonable prices to encourage these consumers to purchase green products is necessary. Also, because biospheric, altruistic, and religiosity are very high in this market segment, therefore marketers can emphasize on these values in their advertisements in order to encourage these consumers to purchase green products.

Egoistic brown targeting: at the first glance, egoistic browns do not seem to be suitable market segment for green products. However, if marketers can make these consumers aware of the dangers of environmental problems for themselves and also of the long-term benefits of environmental friendly products, they may be able to encourage this group of consumers to purchase green products and practice environmental friendly behaviors.

Potential green targeting: due to the strong values of altruistic and biospheric, potential greens can be a suitable target market for green products. The main cause for their low tendency to green behaviors is their low environmental knowledge. Consequently, marketers that target this group of consumers can encourage them to purchase green products by increasing their knowledge about the functions and benefits of green products and about threats of environmental issues.

Intense browns: this segment of the market that consist of consumers with higher level of income and from lower age groups relative to other segments is not a suitable target for marketing environmental friendly products.

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