Article

Have You Switched to a Low-Carbon Diet? The Ultimate Value of Low-Carbon Consumerism

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Abstract: Since the 1990s many governments around the world have been encouraging their people to participate in green or low carbon living. With the background of rising consumer awareness in environmental protection, green consumption, and green marketing are receiving growing attention from consumers and enterprises. Therefore, the purpose of this paper is to identify the goals and values of 60 Taiwanese consumers in a low-carbon diet. This study uses the theory of Mean-end chain as basis, applying the "Soft-laddering" of "Laddering" to understand the perceived value of low carbon food in depth interviews. The results revealed that the attributes of users care for green living in the, order of, Less meat more vegetables, Seasonal food, Local food, Food with minimal artificial processing, Energy-saving preparation and Carbon footprint. After classifying by content analysis, we draw the Hierarchical value map (HVM) to explore that consumer's pursuit of the final value and benefits by adopting a low-carbon diet relate to healthy living.

Keywords: low-carbon diet; green living; means-end chains; customer value

1. Introduction

With global warming emerging as a pressing issue that calls for humankind's immediate attention, adequate control of greenhouse gas emissions has never been more important. In recent years, a low-carbon diet has been recognized as one of the most effective means of cutting down carbon dioxide emissions in food production, transportation, and consumption through the government policies and educational advocacy in Taiwan. A low carbon diet (especially eating less meat) and more exercise will mean less cancer, obesity, diabetes, and heart disease [1]. A low-carbon diet not only boasts health benefits for consumers but also delivers environmental protection effects (e.g., more organic, less chemicals, potentially less land clearing for livestock) on a global scale. A low carbon diet refers to making lifestyle choices to reduce the greenhouse gas emissions (GHGe) resulting from energy use [2]. A low carbon diet minimizes the emissions released from the production, packaging, processing, transport, preparation, and waste of food. Major tenets of a low carbon diet include eating less industrial meat and dairy, eating less industrially produced food in general, eating food grown locally and seasonally, eating less processed and packaged foods, and reducing waste from food by proper portion size, recycling or composting [3]. A low-carbon diet, which can be summarized as "Eat local, eat seasonal, less meat, more vegetables, and simple preparation", is a derivative of healthy diets that encourage people to opt for more local/seasonal/environmentally friendly foods/ingredients while lowering the quantity of meat consumption to mitigate the impact on the natural environment, thereby reducing CO_2 emissions [4,5]. International Energy Agency (2012) [6] reports that the total global energy combustion CO_2 emissions came to 30,326 million tons in 2010, with Taiwan produced 270.22 million tones (approximately 0.89 % of the whole). About 18% of the global greenhouse gas emissions are caused by livestock production, with the main contributors being methane (CH4) from enteric fermentation, nitrous oxide (N_2O) from manure and fertilizer, and carbon dioxide (CO_2) from land-use change and agricultural energy use [7]. Food consumption may account for upwards of 15% of U.S. per capita greenhouse gas emissions [5]. As such, the diet not only promises better health for individuals but is also the easiest way to minimize greenhouse gas emissions and save the planet. The low-carbon concept involves changing consumers' food and lifestyle behaviors and habits, and this in turn affects the methods of production and product design for manufacturers of related goods (e.g., more organic food, recyclable packaging, and lower food miles). Transportation as a whole represents 11% of GHG emissions and final delivery from producer to retail contributes 4% [8]. In other words, although a low-carbon diet stems from demand, it exerts a similar influence on supply.

In an effort to reduce greenhouse gas emissions during the transportation of food, several European nations and the United States have launched the "food miles" initiative which aims to encourage consumers to choose locally produced products sourced within 100 miles. Simms (2000) [9] indicates that one kilogram of kiwi fruit generated five kilograms of carbon dioxide from New Zealand to the United Kingdom via the air. According to Weber and Matthews (2008) [8], the amount of CO_2 emitted during transport is far less than the amount emitted during food production. Weber and Matthew estimate the average household's climate impacts related to food to be around 8.1 t CO_2e/year, with delivery "food-miles" accounting for around 0.4 t CO_2e/year and total freight accounting for 0.9 t CO_2e/year. In addition, the adjustment of consumers' dietary habits is also a critical step in

lowering carbon footprints, not to mention the fact that numerous studies have found a low-carbon diet effectively lowers blood lipid concentration and thereby reduces the risk of cardiovascular illnesses.

Many schools in Taiwan have initiated "Meatless Mondays" since 2009, the effectiveness of strategies to achieve the objectives of a low-carbon diet remains to be determined. It would also be worthwhile to examine the effectiveness of existing means of low-carbon diet promotion and how well these measures work together with related policies to change the dietary and consumption behaviors of Taiwanese consumers and ultimately mitigate the impact on the natural environment resulting from our desire for food. Most research on the topic has focused on the correlation between consumers' diets and their lifestyles, physical exercise, prevention of illness, health, and so forth, and few studies explored the ultimate value of a low-carbon diet for consumers. This study is designed to identify factors such as the values that a low-carbon diet could bring to consumers, how these values are derived from the various consequences, and their attributes, in addition to the correlations between these factors. Once these correlations have been determined, the study should serve as a useful reference for the promotion of a low-carbon diet by the government and the private sector to ultimately improve consumers' dietary consumption habits and reduce carbon emissions from food production.

The purpose of this study is to study green living, product value interests when the customer chooses green products, and final customer value. Meanwhile, the work try to study the employment of "Means-end chain theory", to find "attributes—consequences—values", to seek the contents of customer value of green living and connection mode. The study shall take the example of a low-carbon diet in Taiwan adopt the most frequently used step method in the collection of method and objective chain data, to conduct one-on-one in-depth interviews with 60 Taiwanese customers after consuming, to lead customers step by step toward the center value of green living, then conduct layered coding using the content analysis method, and then compile the value step chart. To frame the entire investigation, the Means-End Chains theory (MECs) was chosen for its efficiency in discovering consumer's terminal values in a purchasing behavior. Means-end theory has been used in several studies of consumer purchasing behavior [10–15].

2. Theoretical Framework

2.1. Low-Carbon Diet

In 2009, COP15 convened in Copenhagen raised once again people's awareness of the importance of environmental protection and prompted a re-definition of the meaning of healthy food and a low carbon diet. In response to EU politicians' urge that citizens can help reduce the carbon emission of livestock by eating less meat in one of the COP15 hearing, a new definition of health food and diet as a combination of environmental and health awareness emerged. To eat healthily now involves increasing the consumption of vegetables, reducing the consumption of meat and also reducing food miles/transportation of food. Statistics published in 2006 by the Food and Agriculture Organization of the United Nations (FAO) indicated that a one-pound cut in the consumption of meat can contribute to 36.4 pounds of CO_2 emission reduction [16]. In other words, following a healthy diet not only relieves our body of the burden of digesting meat but also helps to alleviate global warming. Other potential benefits include reducing land clearing, water and feed inputs in livestock production. The FAO

statistics also demonstrate that carbon emission reduction is no longer confined to the discussion of environmental protection or climate change. It is also a key word in the discussion of human health and eating.

A low carbon diet refers to making lifestyle choices to reduce the greenhouse gas emissions (GHGe) resulting from energy use [2]. A low carbon diet minimizes the emissions released from the production, packaging, processing, transport, preparation, and waste of food. Major tenets of a low carbon diet include eating less industrial meat and dairy, eating less industrially produced food in general, eating food grown locally and seasonally, eating less processed and packaged foods, and reducing waste from food by proper portion size, recycling or composting [3]. A low carbon diet (especially eating less meat) and more exercise will mean less cancer, obesity, diabetes, and heart disease [1]. Yancy *et al.* (2004) [17] pointed that over 24 weeks, a low-carbohydrate diet program led to greater weight loss, reduction in serum triglyceride level, and increase in HDL cholesterol level compared with a low-fat diet. These effects on weight loss and serum triglyceride level are similar to those in 4 randomized, controlled trials of the low-carbohydrate diet.

Dietary changes could therefore not only create substantial benefits for human health and global land use, but can also play an important role in future climate change mitigation policies [7]. Consumers concerned about healthy diet and environmental degradation are the most likely to buy organic food, and are willing to pay a high premium [18]. This study provides new insights into consumers' cognitions with regard to low-carbon diet, and complements previous consumer research on low-carbon diet, through investigating how specific diet attributes or benefits associated with low-carbon might be relevant to consumers' value systems. From a new product design perspective means-end chain analysis can assist product developers identify and optimize product attributes and value propositions that will ultimately satisfy consumers' personal food choice values [19].

2.2. Means-End Chain Theory

Means-end theory, originally developed for consumer marketing by Gutman (1982) [20], has been used in several studies of consumer purchasing behavior [10,21]. The means-end chain is the cognitive representation of the connections between a person's knowledge about a product attributes, consumers' perceived positive consequences, and personal values. Means-end analysis was used to identify linkages among program attributes, outcomes, and values [20]. According to the means-end chain, consumers identify products by their physical or intangible characteristics. Concrete attributes are the tangible, physical characteristics of a product, which are measurable in physical units. Abstract attributes represent intangible characteristics that are more subjective in nature related to a product. At the next level of abstraction are positive consequences, that is, consumers' personal meaning associated with product attributes. Peter and Olson (2005) [22] explained that consumers identify both functional consequences (*i.e.*, tangible outcomes of using a product) and psychosocial consequences (*i.e.*, the psychological and social outcomes of product use) related to a product. A key importance of the means-end chain is that consumers view products as bundles of benefits (consequences), rather than bundles of attributes. This perspective led to the idea of benefit segmentation where marketers divide consumers into homogenous subgroups or segments based on knowledge about perceived benefits stemming from product use [23]. Satisfactions of functional and psychosocial consequences

lead to the realization of personal values. According to the List of Values (LOV), a typology developed for measuring values in survey research [24,25], nine core values can be identified, which include a sense of belonging, excitement, warm relationships with others, self-fulfillment, being well respected, fun and enjoyment of life, security, self respect, and a sense of accomplishment [23].

An advantage of the means-end chain model is that it provides a deeper understanding of consumers' product knowledge and their motivation to consume a certain product, compared to studies focusing only on a product's attributes or benefits. The indication here is that it is crucial for managers to identify product attributes and positive consequences important to consumers, in order to develop specific marketing strategies targeted at stimulating consumers' perceived personal relevance of the product in fulfilling their desired end-goals. Managers have to understand how and why consumers view some products to be more personally relevant to the self, compared to other products in the same category.

3. Method

3.1. Data Collection and Participants

Laddering is a specific approach used to identify means-end chains. The laddering technique is described by many authors [26,27]. In view of the exploratory nature of the aims and the complexity of the stimuli under study, the soft-laddering technique was selected to conduct the interviews [11]. Using a laddering technique, respondents attended individual interview sessions, of between 45 minutes to one hour. In laddering technique, respondents are first asked questions intended to elicit the attributes of the product in question that influenced their choice and/or buying behavior. Follow-up questions are then asked in order to learn why specific attributes are important. The series of questions continues until the respondent mentions a value or cannot respond any further [28].

For the purpose of this research, a means-end chain model has been adopted as the research method. For the purpose of this study, we adopt the model that Reynolds, Dethloff and Westberg (2001) [29] proposed in their research; a minimum of 20 subjects for the ladder interview and 60 subjects who have had previous experience with a low-carbon diet have been chosen as the targets. The interview itself is designed based on the MECs structure (as shown on Appendix A) and first asks the respondent, "What attributes or features of a low-carbon diet led you to adopt such a diet?" The interview follows by continually probing the respondent for further answers by asking "Why do you feel that matters?" so as to elicit the consequences and values in a layered manner. Past studies have shown that when asked repeatedly for feedback, respondents tend to repeat consequences/attributes they have already mentioned in previous questions. To avoid this, the interviewer would prompt the respondent directly by asking questions, such as "What consequence or benefit have you gained from this attribute/feature?" and "What value did this consequence/benefit bring you?" to facilitate the interview. The process would be repeated until the respondent arrives at the value.

Since, educational institutions encourage "Meatless Mondays" in Taiwan. Hence, the study adopted purposive sampling and open call for the selection of 60 low-carbon diet enthusiasts who are currently enrolled at universities or graduate schools in Taiwan for the in-depth interviews. Using a laddering technique, respondents attended individual interview sessions, of between 45 min and 1 hour. Each

student was individually interviewed by trained researchers. Past research also showed that the extent of college students' knowledge of food and diet in general would affect their dietary attitude and behavior [30]. The majorities of subjects chosen for this study have received college or higher education and are under the age of 25 (81.66%). Gender distribution of the subjects is even (50%−50% for male and female subjects). 61.67% of the subjects have gone on a low-carbon diet for six months; 25% of them have adopted the diet for six months to three years and the remaining 11.67% have gone on the diet for more than three years.

3.2. Coding and Intercoder Reliability

Content analysis and coding of the data was performed according with the relevant literature [27]. The data collected from the interview were coded and categorized independently by three researchers who have experience of the low-carbon diet. The index of reliability was 0.904, exceeding the recommended guideline (interrater reliability = 0.70) [31] (as shown in Table 1).

Table 1. Intercoder reliability.

Researcher	A	B	C
B	0.571		
C	0.714	0.679	
D	0.714	0.714	0.821

Average of agreement = (0.571 + 0.714 + 0.714 + 0.679 + 0.714 + 0.821) / 6 = 0.702
Reliability = (4 ×0.702) / 〔1 + (4 − 1) ×0.702〕 = 0.904

4. Results and Analysis

4.1. Coding-Attributes-Consequences-Values

For the research, the technique of content analysis proposed by Kassarjian (1977) [32] has been chosen and based on Krippendroff's (1980) [33] study, the technique is further broken down into four steps of sample data collection, data concentration, deduction and data analysis to gradually sort out the feedback from respondents into nine attributes (Less meat more vegetables, Seasonal food, Local food, Food with minimal artificial processing, Minimal packaging, Appropriate amount, Energy-saving preparation, Carbon footprint, Religious beliefs), 10 consequences (Reduced greenhouse gas emissions, Enhanced economic benefits, Energy saving, Environmental protection, Health and longevity, Enhanced work performance, Improved standard of living, Better appetite, Changes in personal preferences, Stress relief) and nine values (Life of enjoyment, Sense of security, Sense of respect, Sense of self-realization, Sense of belonging, Sense of dignity, Better interpersonal connections, Thrill and excitement), coming to a total of 28 variables.

The 60 respondents generated a total of 153 value ladders (2.55 value ladders per respondent) with 349 links (on average 5.82 links for each respondent). Among the three categories of variables, the respondents identified Less meat more vegetables (n = 67) and Energy-saving preparation (n = 36) to be the most important attributes, Health and longevity (n = 80), Environmental protection (n = 32) and Reduced greenhouse gas emissions (n = 22) to be the most important consequences and Life of enjoyment (n = 76) to be the most important value.

4.2. The Implication Matrix—the Hierarchical Value Map

All the qualitative data gathered from the interview were converted into links in the format of "Attribute—Consequence", "Consequence—Consequence" and "Consequence—Value" to represent effective links between variable layers. These representations were then used for the compilation of a systematic and comprehensive Implication Matrix (IM), which consists of links (including the frequency) mentioned by respondents in their interviews. The numbers in the IM indicate the strength of links between variables; the greater the number, the stronger the link and vice versa (as shown on Appendix B).

From the study, a total of 94 effective links were identified in the IM. However, if all 94 effective links were to be used for the representation of a hierarchical value map (HVM), the correlations of the links would be too sophisticated, a thereby rendering the identification of the crucial link correlations that truly matter to low-carbon diet consumers impossible. To overcome this difficulty, the study used a cut-off value from past research as the basis of screening for representative link correlations. The screened links would then be used for the representation of the HVM. In their study, Grunert *et al.* (2001) [34] suggested that with a sample size between 30~60 subjects, the cut-off value should be no less than 3. Reynolds and Gutman (1988) [27] also pointed out that with a sample size of 50 respondents and as many as 125 value ladders, configuring the cut-off value at 4 would account for as much as 2/3 of all correlations. And as such, 4 would be the cut-off value used for the purpose of plotting the HVM for this study.

With that established, links with values below the cut-off point of 4 in the IM would be deleted from the matrix to plot the HVM that matters most to low-carbon diet adopters. In addition, in order to differentiate the most important path and the second most important path for low-carbon diet adopters so that the HVM could highlight the differences between the paths, the proposition of Gengler, Klenosky and Mulvey (1995) [35] to graphically increase the width of the links on the HVM proportionately to their frequencies was adopted. Figure 1 below illustrates the low-carbon diet HVM.

Figure 1. Low carbon diet HVM.
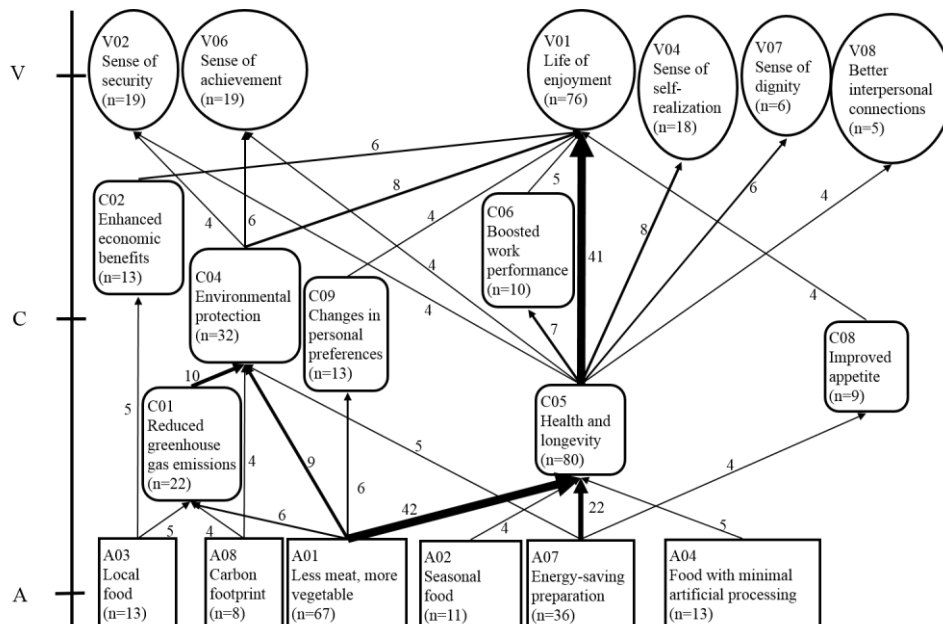
Among the layers of paths ("Attribute—Consequence—Value" or "Attribute—Consequence—Consequence—Value") illustrated based on respondents' feedback, variables including Life of enjoyment (n = 76), Sense of self-realization (n = 18), Sense of achievement (n = 19) and Sense of dignity (n = 6) were the most sought-after values for the low-carbon diet adopters. The following section will cover the most important path of links for the respondents.

4.3. Primary Path Analysis

(1) Less meat more vegetables→ Health and longevity → Enhanced work performance→ Life of enjoyment

In terms of a low-carbon diet, consumers leading "green lifestyles" believe that the attribute of *Less meat more vegetables* has both features of light food and more consumption of green vegetables and fruits, thereby leading to the consequence of *Health and longevity*. Light food is defined as food items that are low in fat, calories, grease, sugar, salt and condiments while having high amounts of dietary fiber and nutrients. Light food is a new healthy diet concept that the Taiwanese government has been aggressively promoting since 2009. Fruits and vegetables are rich in essential nutrients such as Vitamins C and E, folic acid, carotene, minerals, and dietary fiber. These nutrients have been proven to effectively lower one's risks of hypertension, stroke, cardiovascular illnesses [36], and various cancers [37]. Some of the low-carbon diet adopters also believe that *Health and longevity* would lead to *Enhanced work performance*—when one experiences improved metabolism as a result of being physically fit and energetic, he/she would benefit from being able to think more clearly and thereby improve efficiency at work and learning. Lastly, low-carbon diet adopters also maintained that having better health/work and learning efficiency would bring about a *Life of enjoyment*, which offers happiness, joy, fulfilled life, and pleasure.

(2) Less meat more vegetables → Reduced greenhouse gas emissions → Environmental protection → Sense of achievement

A low-carbon diet involves *Less meat more vegetables*—a ratio of food ingredients that enables effective reduction of food mileage from raising livestock such as chicken, pig, sheep, cow or harvesting of fish/shrimp/shellfish over great distances. This would thereby result in the consequence of *Reduced greenhouse gas emissions*. According to the data published by the Food and Agriculture Organization of the United Nations (2006) [16], each kilogram of meat product produced generates 36.4 kg of carbon dioxide that is emitted into the atmosphere. As such, consuming less meat is a way to contribute to environmental protection. Low-carbon diet adopters have some understanding of the carbon dioxide generated during the process of food production and therefore, they understand that by cutting down on the consumption and transportation of meat products, we can decelerate the rate of global warming caused by animal husbandry. Not only that, it would also reduce air pollution because of less transportation and lead to the consequence of *Reduced greenhouse gas emissions*. By contributing to *Reduced greenhouse gas emissions*, low-carbon diet adopters would also be contributing towards *Environmental protection* and those who excel in this regard would experience the ultimate value of a *Sense of achievement*.

(3) Energy-saving preparation → Health and longevity → Life of enjoyment

Low-carbon diet adopters commonly believe that *Energy-saving preparations*, such as cold dishes/steaming/broiling (as opposed to preparation methods that require deep frying, pan-frying or stir-frying), would minimize the amount of airborne grease released and lower the risk of inhalation. Numerous studies in the past have proven that airborne grease released during the heating of edible grease contains various chemicals and imposes the risk of cancer and other related illnesses [38]. And as such, *Energy-saving preparation* could bring about the consequence of *Health and longevity* for low-carbon diet adopters, the pursuit of which would ultimately lead to the objective of a *Life of enjoyment*.

It is worth noting that with regards to *Energy-saving preparation*, most respondents thought that "stir-frying" would generate a significant amount of carbon dioxide due to the heat involved and opted for "steaming" as an alternative method of cooking. However, the Environmental Protection Agency of the Executive Yuan issued a public announcement in 2011 and pointed out that "stir-frying" actually creates less CO_2 compared to "steaming", which in turn is a more eco-friendly method of cooking than other methods involving the use of appliances, such as ovens and induction stoves, because the use of such appliances requires sophisticated conversion of energy and transmission of said energy over great distances. It is apparent that while most low-carbon diet adopters demonstrate adequate awareness of *Energy-saving preparation*, their understanding of cooking methods has significant discrepancies. Male students achieve this by avoiding stir-frying as a cooking method while female respondents favor preparing their food cold or by steaming. As such, competent government agencies could reinforce relevant dissemination and help the public to foster the concept of carbon reduction by listing the quantified data of greenhouse gas emissions for a specific dish prepared in different ways.

4.4. Gender Specific HVMs

As shown in Figure 2, low-carbon diet adopters of both sexes emphasize the attributes of *Less meat more vegetables* and *Energy-saving preparation*. Both attributes were linked to the consequence of *Health and longevity*, leading to the ultimate value of *Life of enjoyment*. However, female respondents perceived *Sense of self-realization* as an added ultimate value. Respondents of both sexes acknowledge the importance of *Less meat more vegetables* to the consequence of *Health and longevity*, but each group acknowledge the attribute based on different contexts. Past research has shown that men generally dislike lanky or obese physiques and would rather become muscular through weight control [39]. With a low-carbon diet, men would reduce excessive intake of protein and fat by having *Less meat more vegetables* to achieve physical fitness. This would not only lead to a *Life of enjoyment* but also allow them to demonstrate confidence and charm, thereby benefitting from the ultimate value of a *Sense of dignity*. For healthy women of normal body weight, they would deliberately suppress food consumption in order to become slimmer [40].

Research also showed that in terms of low-carbon food consumption for women, most preferred fresh vegetables and fruits of high water content. But when it comes to meat, women would avoid meat intake as much as possible or consume quality proteins that are lighter in flavor/low in fat to achieve *Health and longevity,* thereby leading to a *Life of enjoyment*. Their pursuit of the perfect physique and body contours would also pave the way to the objective of a *Sense of self-realization.*

Figure 2. Gender specific HVMs for low-carbon diet adopters—Male (left) and Female (right).
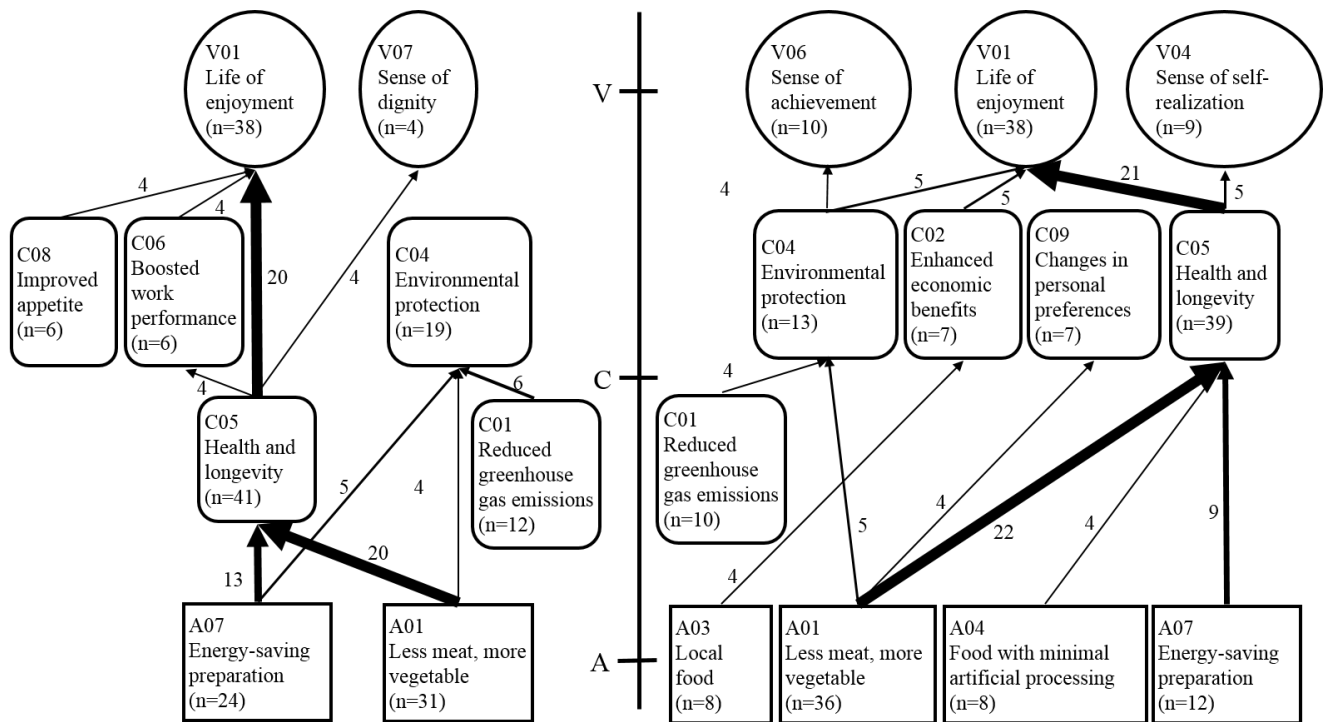
5. Conclusions and Implications

In this study, the concepts of environmental protection and a low carbon diet have been incorporated into an MEC theoretical framework to construct the correlational structure of "Attribute—Consequence—Value" for low-carbon diet/green lifestyle adopters using a soft-laddering technique. Respective HVMs have also been illustrated to offer a clear presentation of the correlations between key variables in the exploration of ultimate values that consumers leading green lifestyles pursue. The MEC theoretical framework effectively portrays a picture of low-carbon diet adopters taking on diverse "means" (attributes) in pursuit of diverse "ends" (consequences and values) while conveying the contents of various values that low-carbon diet adopters have pursued. Such presentation can serve as a useful reference for business proprietors and promoters of such diet/concept.

Based on the data gathered from the 60 low-carbon diet adopters, the six attribute variables they value most (in descending order of importance) were *Less meat more vegetables*, *Seasonal food*, *Local food*, *Food with minimal artificial processing*, *Energy-saving preparation* and *Carbon footprint*. These attributes are linked to seven consequence variables including *Reduced greenhouse gas emissions, Enhanced economic benefits*, *Environmental protection*, *Health and longevity*, *Enhanced work performance*, *Better appetite* and *Changes in personal preferences.* The consequences ultimately led to the values of *Life of enjoyment*, *Sense of security*, *Sense of self-realization*, *Sense of achievement*, *Sense of dignity* and *Better interpersonal connections*. The majority of the respondents strived to achieve *Health and longevity* through the attribute of *Less meat more vegetables*, eventually arriving at the target value of a *Life of enjoyment*.

The results of this research revealed that most low-carbon diet adopters chose to pursue individual *Health and longevity* (followed by considerations for *Reduced greenhouse gas emissions* and *Environmental protection*) through *Less meat more vegetables* and *Energy-saving preparation*. This is consistent with the theory of hierarchy of needs proposed by Maslow (1970) [41]: low-carbon diet adopters prioritize the basic physiological need of food, such as *Less meat more vegetables*, *Energy-saving preparation* and *Food with minimal artificial processing* before moving onto the level of need for safety (*i.e.*, *Health and longevity*). With basic needs satisfied, these respondents move on to the next level of need for esteem with *Enhanced work performance* before ultimately coming to the level of *self-actualization* by striving for values such as *Life of enjoyment*, *Sense of dignity and Sense of self-realization*. It is only with these values achieved that they would turn their focus to *Reduced greenhouse gas emissions* and *Environmental protection*.

With regards to gender differences, male consumers tend to consume more meat as a habit when it comes to the variable of *Less meat more vegetables*. As such, low-carbon diet adopters would have to suppress their desire for meat products by opting for a diet with less meat and more vegetables or consume a significant amount of fruits and vegetables as a replacement source of energy to achieve the goal of a low-carbon diet. In contrast, female consumers have lower demand for meat in their diet and would naturally choose green vegetables and fruits that are lighter in flavor. As for the variable of *Energy-saving preparation*, male respondents achieve this by avoiding stir-frying as a cooking method while female respondents favor preparing their food cold or by steaming. In addition, more female respondents favor organic food and unprocessed food to consume *Food with minimal artificial processing*. Lastly, female respondents also preferred *Local food* to reduce transportation costs.

Research has indicated that consumers are able to obtain information that is easy to verify or confirm from product labels and manufacturers could also benefit from higher price markups and profit margins through the communication of value or product differentiation [42]. As such, it is recommended that providers of low-carbon diet food focus more on the attributes of *Less meat more vegetables* and *Food with minimal artificial processing* by providing light food/snacks prepared with natural, and preservative-free ingredients that are beneficial to health or highlight the health benefits (such as physique improvement and the lowering of the risk of cardiovascular illness to lead to a *Life of enjoyment*) of a less meat more vegetable ratio on product packaging. In addition, information such as the origin of ingredients, method of preparation, nutritional information, calorie contents, carbon footprint and so forth could also be printed on product labels to accommodate low-carbon diet adopters' wishes to achieve *Health and longevity*. For example, in Australia, all fresh fish has to be labeled with country of origin so the consumer can select fish caught in Australia *versus* other imported fish.

The data collected from this study also revealed that female respondents have relatively higher awareness of a low-carbon diet compared to male respondents (by being more knowledgeable of the ways (attributes) to achieve a low-carbon diet). In contrast, male respondents focus more on the consequence of *Enhanced work performance* from *Health and longevity*. With this finding in mind, low-carbon food providers could better emphasize the use of highly nutritious ingredients in their products. In addition, methods of preparation that would retain the ingredients' fresh texture would also go a long way towards offering *Better appetite*, which would appeal more to male consumers. Since female consumers place more emphasis on *Food with minimal artificial processing* and fresh

Local food, government agencies could work to strengthen the dissemination of ingredient freshness for consumers while food suppliers could label the geographic and provenance origins of food ingredients so that consumers could make their purchases with confidence (and so that female consumers would be able to identify fresh and local food products) in order to achieve the target value of a *Life of enjoyment*. This would help to boost product appeal for female consumers.

As for the dissemination of a low-carbon diet, the social networking service Facebook now boasts more than 964 million users around the world [43]. There are some social media devoted to healthy living, for example, Healthy Lifestyle, Healthy Living in Hong Kong, *etc.* The service is known for its unique feature of allowing users to engage in interactive dialogues on specific topics and its marketing environment that facilitates brand exposure and marketing [44]. As such, government agencies and service providers could use Facebook as a tool to promote the benefit of *Health and longevity* that one could expect from a low-carbon diet—in addition to *Enhanced work performance*, it could also bring about *Reduced greenhouse gas emissions* and *Environmental protection*.

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Author Contributions

Yu-Ling Lin conceived of and designed the study. Hong-Wen Lin collected the data. Yu-Ling Lin and Hong-Wen Lin analyzed and interpreted the data. Hong-Wen Lin wrote the first draft of the paper. Yu-Ling Lin contributed to subsequent versions of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Appendixes

A: The In-Depth Interview Questions

(1) What attributes or features of low-carbon diet appeals to you?
(2) How are these attributes important to you?
(3) What benefits or consequences do you get from these attributes?
(4) What personal value do you get from the benefit/consequence?

B: Implications Matrix of Low-Carbon Diet

	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	V01	V02	V03	V04	V05	V06	V07	V08	V09
A01	6	2		9	42		2		6										
A02	3	3			4			1											
A03	5	5		2	1														
A04	1			1	5			3	1	2									
A05	1		1																
A06	1																		
A07	1	1		5	22	3		4											
A08	4			4															
A09									2										
C01				10	2		3				(2)	(2)		(1)	(1)	(1)			
C02							1				(6)	(1)		(2)		(1)		(1)	(1)
C03				1															
C04		2			1		3		2	1	(8)	(4)	(1)	(3)	(1)	(6)			
C05						7			2	2	(41)	(4)		(8)	(2)	(4)	(6)	(4)	
C06										1	(5)	(1)		(1)	(1)	(1)			
C07										1	(3)	(2)				(2)			
C08											(4)	(2)		(1)		(2)			
C09					3					1	(4)		(1)	(2)	(1)	(1)			
C10											(3)	(3)			(1)	(1)			