

# Understanding how to increase hydroponic attractiveness: Economic and ecological benefit

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**Abstract.** As one of the sustainable food, hydroponic vegetables begin to attract consumer attention. Previous studies focus on how to increase the willingness to pay (WTP). The cost of growing hydroponic might cause it as higher than traditional (soil agriculture) that drives higher prices. Instead of only focus on WTP, attitude and purchase intention are two constructs that important to estimate actual purchase behavior. However, a study about the antecedents of hydroponic vegetable' purchase intention is still limited. This study aims to identify factors that can enhance purchase intention, group respondents based on those factors, and profile each respondent's group. By online survey, 981 respondents were collected, and multiple regressions and cluster analysis analyzed further data. The result shows eight factors that could drive purchase intention (attitude, subjective norm, perceived behavioral control, perceived quality, price, availability, health consciousness, and knowledge), while environmental concern was not significant. Cluster analysis generates 3 clusters of respondents that have different profiles based on all factors and demographics variables. This study contributes to portraying respondents' responses toward hydroponics that could deliver implications for entrepreneurs or marketers to attract target consumers based on all factors and develop a strategy based on their profiles.

## 1 Introduction

In a pandemic situation, people are more concerned about their health and how to increase and maintain their immunity to spared and survive from Covid-19 or other diseases. Even though people have paid more attention to nutrition and food quality, this issue becomes everyone's priority and does a healthy lifestyle. As guidance to drive this healthy lifestyle, someone needs to consume healthy food by eating fruit and vegetables, minimizing sugar, and exercising regularly [1].

To produce such quality food, people more critical against the use of pesticides in agriculture and more concerned about ecological food. Consumers feel they had to protect the environment by choosing products that create less pollution or more environmental concern [2], saving the planet that is green products [3]. When someone considers green

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food, consumers concern about pollution and ecological knowledge, these environmental products were expensive, so customers feel unfair and influence willingness to pay [4]. Considering sustainable food consumption, more consumers change their choice to address environmental issues: organic food [5-7]. Premium price-as economic factor is one of the challenges of organic food because it could lower repeat purchases [8]. From the producer perspectives, as organic food relies on organic farming, it is vulnerable to pests that make crop yield unstable and affect the supply chain and distribution [9]. Furthermore, organic crops grow without chemical pesticides but sometimes use fertilizer from animal manure potentially contaminated with bacteria.

Unlike organic crops or vegetables, another product concerned with environmental sustainability and healthy food is hydroponic. In this condition, the plant can be grown without soil but other nutrient media and water [10]. Agriculture that relies on nutritional water is considered more manageable and can be done at any time regardless of the seasons. This way is very different from agriculture, using the soil as a growing medium, which requires various preparations, such as cultivating the ground and other practices. The hydroponic system also does not use pesticides so that it can produce healthier vegetables and fruits. Besides, farming with this system can be done at any time, regardless of the seasons. The global market of hydroponic is expected to grow in 2025 [11]. In the Asia Pacific, an increasing population will require an agricultural strategy to provide adequate food and population growth.

This case is related to the growing need and as a potential market for hydroponic vegetables. Hence, it is crucial to understand the characteristics of the target market of hydroponic vegetables that can enhance their purchase intention, product attributes, and individual pro-environmental behavior. Previous studies in hydroponic not as many as studies in organic food, and focus on willingness to pay (WTP). Investigation of [12] showed consumers' knowledge and perception towards the health benefits that influence WTP of hydroponic tomatoes in Trinidad. Moreover, an experimental study of [13] revealed if participants k about some services of hydroponics growing of lettuce, such as environmental, clean, and local benefits, their WTP would increase. The cost of increasing hydroponic may cause these researchers interested in WTP as higher than traditional (soil agriculture) that drive higher price [14], and expect WTP as the antecedent of purchase intention as WTP reflected the price of products. Instead of only focus on WTP, attitude, and purchase intent are constructs that important to estimate actual purchase behavior [15]. However, a study about the antecedents of hydroponic vegetable' purchase intention is still limited.

The study of [16] exhibits the importance of knowledge to develop a positive attitude. When hydroponic is grown by artificial light in Japan, learning about the product will lead to a positive attitude toward hydroponic [16] and an attitude toward hydroponic that uses LED light to enhance purchase intention [17]. Other factors were pricing, sensory evaluation, and perceived benefit as the antecedents of willingness to buy or purchase the meaning of hydroponically grown broccoli microgreens in Alabama [18].

Organic food's popularity drives many researchers to study organic food, particularly identifying the antecedents that influence consumers' responses [3, 4, 6, 19]. However, The study about consumer response to hydroponic vegetables is still limited. This study will build a research framework concerning previous research on organic food due to the little research on hydroponic purchase intention.

In Indonesia, hydroponic has not attracted much attention to entrepreneurs. Unlike organic food's popularity, the household still manages hydroponic plants to fulfill their household's or relatives' needs. Likewise, it is unclear how consumers respond to hydroponic and how to increase their intention to buy hydroponic vegetables. Considering that there is still limited research on consumer behavior related to hydroponics, this study

aims to identify what factors could influence hydroponic vegetables' purchase intention and develop target consumer clusters. For this reason, this research initially attempts to identify factors (economic and ecological) that could affect the purchase intention of hydroponic vegetables. Further, this research wants to discover the consumer profiles in each cluster. Besides, this research attempt to examine the faces of each segment.

## **1.1 Hydroponic**

Hydroponics is a method of growing plants. It uses different materials to support the plant's roots and grow crops directly in nutrient-rich water [10]. Plant attain all their nourishments via nutrient-enriched water [12]. In terms of increasing hydroponic, there are some approaches in the hydroponic system [20], namely fresh water, oxygen, root supports, light, and nutrients. So, hydroponic operations may usually create sustainability advantages relative to soil plants [21]. Hydroponic could produce higher yields than soil-based agriculture, no pesticide use, and food cleaner [22], eco-friendly, and highly productive method [23].

Nowadays, concerning environmental issues, hydroponic systems have been considered to be consumed. However, there is some concern about this system because the different hydroponic characteristics delivered the other responses. Hydroponic has some limitations, such as higher overhead cost, microbiological contamination, need for electricity, and water quality [14]. There was also concern with the willingness to pay [12, 21]. The study of [18] showed respondents perceived differences in appearance between farm-soil vs. farm-hydroponic microgreens, even though similar smell and taste.

## **1.2 Theory of planned behavior**

Theory of Planned Behavior (TPB) explains the determinant of the formation of behavior intention, namely attitudes, subjective norms, and perceived behavioral control [15]. These antecedents drive individual choice to perform given behavior. Preferences were assumed as motivational factors that indicate an effort to complete the action. In sustainability products or services, some researchers use these factors to affect purchase intention for green products [24-26], green restaurant [27], organic food [28-30], and energy-saving sense [31]. Attitude toward the behavior refers to how the right individual to conduct specific action. Subjective norm refers to the perceived social pressure to perform or not to perform the behavior. Lastly, perceived behavioral control refers to how individuals can control their behavior, including perceived ease or difficulty performing a specific action, reflecting the experience and anticipated impediments and obstacles.

Therefore, in the context of the hydroponic product, this study hypothesis:

- H<sub>1</sub>: Attitude has a positive effect on the intention to purchase of hydroponic vegetables.
- H<sub>2</sub>: Subjective Norm has a positive effect on the intention to purchase of hydroponic vegetables.
- H<sub>3</sub>: Perceived Behavioral Control has a positive effect on the intention to purchase of hydroponic vegetables.

## **1.3 Product attributes**

Product quality is related to some attributes and characteristics that could develop positive perception as good quality indicates how well and reliable the product performs its functions [32]. It is not the only perception. Perceived quality will lead to a purchase decision [33]. Some studies demonstrated the positive influence of organic food quality on

purchase intention [32, 34, 35]. Other factors that could have an impact on consumer decision making are pricing and availability. Price is related to what a customer must give up to get the firm's benefits regarding the amount of money charged for the product/services [36]. In organic food, price is essential because it certifies organic foods are more expensive [26]. Therefore, the price could deter the purchase of organic food [34]. However, if the consumer will show a positive response toward price, they perceive price according to the benefits and quality [26], and fair based on the higher production [4].

The next factor is product availability. Availability means how easy customers buy the products related to where they can buy the product, consider when and how much they need it [36]. Consumers need to spend more time searching and finding the work, making them provide time or money to buy and consume the products. Therefore, consumers prefer to have access quickly to decrease their aid to purchase the products. In this situation, the availability of product increase purchase intention.

In the context of the hydroponic product, this study hypothesizes:

- H<sub>4</sub>: Product Quality has a positive effect on the intention to purchase of hydroponic vegetables.
- H<sub>5</sub>: Price has a positive effect on the intention to purchase of hydroponic vegetables.
- H<sub>6</sub>: Availability has a positive effect on the intention to purchase of hydroponic vegetables.

#### **1.4 Consumer characteristics**

Hydroponic has some advantages, specifically ecological and economic benefits [14]. Considering ecological service, hydroponic is the product that does not use pesticides or other chemicals to harm the environment and healthy to consume. Hence some consumers who concern about those issues could support the production of hydroponic. Environmental concern is related to how they aware of support issues to protect the environment [37]. There were inconsistent results concerning the effect of the ecological crisis on to purchase intention of organic food. The study of [5] showed environmental concern enhances purchase intention. Otherwise, [37] exhibit an insignificant result.

In terms of packaging aspects, environmental concern positively affects intention to choose ecologically responsible packaging [38]. Hence, there is still needed to study its role as altruistic motives to purchase hydroponic vegetables. It is concerning buying organic food as pro-environmental behavior [37], as well as hydroponic vegetables.

H<sub>7</sub>: Environmental Concern has a positive effect on the intention to purchase of hydroponic vegetables

Some studies also revealed how individual health consciousness contribute to purchase intention. Health consciousness is related to how they concern about their health in daily activities. Therefore they had a positive attitude toward organic food [29] and will consume healthier products [39], including organic food [4, 37]. Hydroponic can be categorized as a healthy product because it is not a pesticide crop. Hence, this study hypothesizes:

H<sub>8</sub>: Health Consciousness has a positive effect on the intention to purchase of hydroponic vegetables.

To reduce uncertainty and risk when consuming a new product, consumers will collect some information to develop their understanding of product value compared to other outcomes [33]. Consumers also need to know what they purchase to satisfy their needs and wants [29].

H<sub>9</sub>: Knowledge has a positive effect on the intention to purchase of hydroponic vegetables.

## 2 Method

A cross-sectional survey in Indonesia collected data. By self-administered online questionnaires, 981 respondents were selected by purposive sampling, with criteria they know hydroponic vegetables and have not purchased it yet. The questionnaire is developed by conducting a literature review and adaptation from previous research. There are 38 items in questionnaires to measure ten constructs that consist of 4 items of attitude [25, 30, 39], 3 items of subjective norm [6, 25, 30, 39], 3 items of perceived behavioral control [25, 30, 39], 3 items of price [29], 6 items of perceived quality [32], 5 items of knowledge [6, 29, 39], 4 items of health consciousness [29, 39], 3 items of availability [29], 3 items of environmental concerns [25, 32], and 4 items of purchase intentions [6, 30, 32]. Then, we conduct multiple regression to test the hypothesis and K-means cluster analysis to identify respondents' profiles based on ten constructs.

## 3 Results and discussion

### 3.1 Profile and descriptive statistics

More than half of the respondents are female. In terms of marital status, the majority are married or widow/widower. However, the proportion of age is almost similar between younger and above 30 years old. Interestingly, more than 90% live with three and more family members. Even though only 65 have a child or more. The respondent profile is shown in Table 1.

**Table 1.** Profile Respondents.

<b><i>Gender</i></b>	<b>n</b>	<b>%</b>
Male	359	36.6
Female	622	63.4
<b><i>Marital Status</i></b>	<b>n</b>	<b>%</b>
Single	327	33.3
Married	630	64.2
Widow or Widower	24	2.5
<b><i>Age</i></b>	<b>n</b>	<b>%</b>
30 years old and less	492	50.2
Above 30 years old	489	49.8
<b><i>Family Member</i></b>	<b>n</b>	<b>%</b>
1-2 persons	77	7.8
3-4 persons	549	55.9
above four persons	355	37.2
<b><i>Number of Children</i></b>	<b>n</b>	<b>%</b>
No child	345	35.2
1 Child	223	22.7
2 Children	278	28.3
3 Children	103	10.5
Above three children	32	3.3

All constructs and item are valid (factor loading > 0.5) and reliable (cronbach alpha > 0.6), except PP1 (item 1 of pricing) because the factor loading = 0.47. This item was deleted for further analysis (Table 2).

**Table 2.** Descriptive statistics.

Construct	Number of items	Loading Factor	Cronbach alpha	Minimum	Maximum	Mean	Std. Deviation
Attitude	4	0.70 – 0.91	0.89	1.00	5.00	4.43	0.68
Subject Norm	3	0.88 – 0.91	0.92	1.00	5.00	3.60	1.03
Preceived Beavioral Control	3	0.58 – 0.87	0.75	1.00	5.00	4.06	0.83
Price	2	0.94	0.86	1.00	5.00	4.33	0.76
Knowledge	5	0.59 – 0.68	0.75	1.00	5.00	4.15	0.70
Preceived Quality	6	0.73 – 0.79	0.89	1.00	5.00	3.96	0.84
Availability	3	0.67 – 0.93	0.81	1.00	5.00	3.57	0.97
Environmental Concern	3	0.65 – 0.89	0.68	1.00	5.00	4.69	0.51
Health Conciouness	4	0.79 – 0.87	0.89	1.00	5.00	4.53	0.61
Purchase Intention	3	0.83 – 0.92	0.93	1.00	5.00	4.02	0.91

### 3.2 Hypothesis testing

Multiple regression was used to test 9 hypotheses (Table 3). This research uses factor score as a composite score in regression analysis, and the result demonstrated H<sub>7</sub> is not significant ( $\alpha=5\%$ ).

**Table 3.** Multiple regression analysis.

	$\beta$	t-value	Sig.	Conclusion
<b>Dependent Variable</b>				
Purchase Intention				
<b>Independent Variables</b>				
H <sub>1</sub> : Attitude	0.118	4.267	0.000	H <sub>1</sub> supported
H <sub>2</sub> : Subject Norm	0.171	6.325	0.000	H <sub>2</sub> supported
H <sub>3</sub> : Preceived Beavioral Control	0.069	2.434	0.015	H <sub>3</sub> supported
H <sub>4</sub> : Product Quality	0.230	8.108	0.000	H <sub>4</sub> supported
H <sub>5</sub> : Price	0.182	66.80	0.000	H <sub>5</sub> supported
H <sub>6</sub> : Availability	0.071	3074	0.002	H <sub>6</sub> supported
H <sub>7</sub> : Environmental Concern	0.039	1.825	0.068	H <sub>7</sub> not supported
H <sub>8</sub> : Health Conciouness	0.100	4.022	0.000	H <sub>8</sub> supported
H <sub>0</sub> : Knowledge	0.116	3.595	0.000	H <sub>0</sub> supported

### 3.3 Cluster analysis

This section aims to develop a cluster of respondents based on their similarities in terms of factors that influence purchase intention. In defining the number of groups, first, we run hierarchical cluster analysis. Using the dendrogram and agglomeration matrix, we identify the number of clusters in range 3-5. Refer to [40]. In this research, three clusters are meaningful, so we conduct K-Means 3 clusters (Table 4). The cluster analysis result showed that respondents were grouped into three distinct clusters based on their response to all factors that could influence purchase intention and purchase intention. A respondent

with "High Supported-High Interested," "Quite Supported-Quite Interested," and "Not Supported-Not Interested." All groups have an almost similar high mean score of health consciousness and environmental concern representing all groups that balance altruistic motives and health' motives. The difference is seen in the subjective norm, perceived quality, and availability. Cluster 1 illustrates a group of respondents highly supported by their family (mean score of the personal standard is 4.35). Otherwise, this score is lowest in cluster 3. So is the mean score of purchase intention representing how interested in purchasing hydroponic vegetables. Cluster 1 has the highest mean score. Conversely, cluster 3 has the lowest mean score of purchase intention.

In an attempt to clarify more enriching each cluster's profile, Table 5 shows that respondents with High Supported-High Interested (cluster 1) are mostly females (66.7 percent). Married (67%), almost the same age proportion between less than 30 years old and above (around 50%), mostly live with 3-4 family member (57.6%), and no children (33%). Interestingly, in terms of education, cluster 1 has the lowest proportion of respondents with undergraduate and above (38.8%) compare to cluster 2 (51.5%) and cluster 3 (58.9%), likewise the gender proportion. Cluster 1 has the lowest proportion of male respondents (33%) compare to cluster 2 (38.7%) and cluster 3 (41.1%).

**Table 4.** The cluster of respondents.

Construct	Cluster 1	Cluster 2	Cluster 3	F-value	Sig.
Attitude	4.84	4.35	3.50	458.366	0.000
Subject Norm	4.35	3.27	2.26	635.088	0.000
Preceived Beavioral Control	4.66	3.80	3.00	601.961	0.000
Preceived Price	4.81	4.22	3.27	530.562	0.000
Knowledge	4.69	3.87	3.27	705.062	0.000
Preceived Quality	4.51	3.79	2.82	523.674	0.000
Availability	4.25	3.14	2.65	389.529	0.000
Environmental Concern	4.86	4.59	4.43	61.794	0.000
Health Consciousness	4.83	4.39	4.02	161.341	0.000
Purchase Intention	4.70	3.79	2.66	900.949	0.000
Number of Respondents	451	367	163		

**Table 5.** Demographic profile in each cluster.

Demographics	Cluster 1: <i>High Supported-High Interested</i>		Cluster 2: <i>Quite Supported-Quite Interested</i>		Cluster 3: <i>Not Supported-Not Interested</i>	
	N=451		N=367		N=163	
	(45.9%)		(37.5%)		N=163 (16.6%)	
<b>Gender</b>						
Male	150	33.3%	142	38.7%	67	41.1%
Female	301	66.7%	225	61.3%	96	58.9%
<b>Marital status</b>						

Single	138	30.6%	126	34.3%	63	38.7%
Married	302	67.0%	231	62.9%	97	59.5%
Widow or Widower	11	2.4%	10	2.7%	3	1.8%
<b>Age</b>						
Less than 30 years old	238	52.8%	175	47.7%	79	48.5%
Above 30 years old	213	47.2%	192	52.30%	84	51.5%
<b>Family member</b>						
1-2 persons	28	6.2%	27	7.4%	22	13.5%
3-4 persons	260	57.6%	203	55.3%	86	52.8%
above 4 persons	163	36.2%	137	37.3	55	33.8%
<b>Number of Children</b>						
No children	150	33.3%	126	34.3%	69	42.3%
1 child	106	23.5%	84	22.9%	33	20.2%
2 children	144	31.9%	93	25.3%	41	25.2%
3 children	34	7.5%	53	14.4%	16	9.8%
above 3 children	17	3.8%	11	3.0%	4	2.5%
<b>Education</b>						
Junior School	25	5.5%	11	3.0%	0	0.0%
High School	207	45.9%	134	36.5%	60	36.8%
Diploma	44	9.8%	33	9.0%	7	4.3%
Bachelor	150	33.3%	152	41.4%	74	45.4%
Master and Doctoral	25	5.5%	37	10.1%	22	13.5%

### 3.4 Discussion

Our findings indicate all antecedents in the Theory of Planned Behavior are significant. The more positive attitude toward purchasing hydroponic, the higher supporting by relatives, and the higher control of purchasing hydroponic, the higher intention to purchase it. When respondents perceived they have control over purchasing hydroponic, it leads to buy the products [41]. In the organic food context, attitude, subjective norm, and perceived behavioral control positively influence purchase intention directly [4, 39]. As hydroponic is no pesticide plant, these products are healthy products, like organic food. These characteristics of hydroponic will provide benefits for people who care about their health as the respondent's belief that his work safe to consume [13], reliable [16], enhance positive attitude [29]. It is supported by the significant influence of health consciousness toward purchase intention as well. This result in line with the study of [4, 29, 39] in terms of



organic food. Higher health consciousness of respondents will lead to higher intention to purchase hydroponic.

Other useful drivers of purchase intention hydroponic are perceived quality, price, availability, and knowledge. When respondents believe that hydroponic deliver higher quality than organics and conventional, it intends to purchase it. From now on, if the price of hydroponic consistent with quality and benefit, easy to find and available in many places, and respondents have higher knowledge about hydroponic in terms of process and the characteristic (attributes), this situation will encourage purchase intention. This study showed similar results on how perceived quality increased purchase intention [32], price and knowledge indirectly influence purchase intention [29].

Interestingly, this study exhibits environmental concern is not significant to enhance purchase intention. Even though respondents have a high mean score of the ecological crisis that reflects their relationship with humans' importance to protect the environment, these altruistic motives could not lead them to purchase hydroponic vegetables. A study of [4] in three countries showed a mixed result. There was a positive relationship between environmental concern and purchase intention in Pakistan, but Turkey and Iran did not prove it. The research revealed that instead of altruistic motive (environmental concern), economic or egoistic reason (quality, price, availability, knowledge) has a higher impact on hydroponic purchase intention.

## 4 Conclusion

This study has two main objectives: 1) to identify what factors could influence the purchase intention of hydroponic vegetables, and 2) develop target consumer clusters based on those factors. The result demonstrated attitude, subjective norm, perceived behavioral control, product quality, price, availability, health consciousness, and knowledge could enhance the intention to purchase hydroponic vegetables. Product quality and price are two factors that have a higher impact on purchase intention. Meanwhile, environmental concern as an altruistic motive does not impact on purchase intention.

There are three clusters when we consider respondents profile: highly supported-highly interested, quite supported-quite interested, and not supported-not interested. These clusters differ mostly in terms of the level of support by relatives and intention.

Our study contributes theoretically by identifying and using the logic of model development by previous researchers on organic food. These eight factors can enhance the purchase intention of hydroponic as a pro-environmental or ecological product. These research findings suggest that product quality and pricing are two factors that contribute to strengthening purchase intention. Different purchase intention levels and the other three clusters' profiles will guide entrepreneurs to target their hydroponic vegetables optimally. If they focus on single, male, and older target consumers, entrepreneurs have to design more initiatives to increase purchase intention by focusing on quality and price. This cluster 3 is less support by their relatives. Therefore entrepreneurs must consider influencing and develop their belief about the value of hydroponic vegetables directly, not mediated by their relatives.

This study only concerns the direct effect of these antecedents to purchase intention, and there is no significant effect of environmental concern as hydroponics is a pro-environmental product. This result less congruent with the importance of altruistic motives in explaining consumer responses. Further study should consider these factors' potential indirectly affecting purchase intention, as an antecedent of attitude or as moderator of all aspects.

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