Evaluation and extraction of factors of Plant Factory for Chinese customers based on consumer value study

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Abstract: It is identified that the value of Plant Factory in China is not recognized by Chinese customers, in order to target the marketing pitches and expand the Plant Factory in Chinese market, the local customer value should be analyzed. In this paper, HPF (Home Plant Factory) as a possibility of the technology of plant factory in China is raised and questionnaire survey by Likert Scale for Chines customers is carried out. The basic situation of Chinese customer is cleared from the result of the survey and the customer value is discussed by analyzing the attitude to the Home Plant Factory from Chinese customer and their life style with the help of factor analysis. The following factors of customer life style are extracted, "Quality of vegetables factor", "Information factor", "Attractive factor", "Environmental factor", and "Price factor". The value of plant factory shows up in the quality of vegetables factor, attractive factor, and environmental factor, so the target customer who would value the three factors most can be predicted. By comparing means of One Way ANOVA, a group is confirmed as our target user who would potentially agree with the value of plant factory and their attribute was analyzed.

Key words: Plant factory, Consumer value, Factor analysis, Lifestyle

1. Background and purpose

Plant factory is a facility that aids the steady production of high-quality vegetables all year round by artificially controlling the cultivation environment (e.g., light, temperature, humidity, carbon dioxide concentration and culture solution), allowing growers to plan production [1]. It can produce vegetables about two to four times faster than by typical outdoor cultivation. There are many advantages over traditional farming and greenhouses. Instead of being planted in the ground, crops are grown in trays in multilayer cultivation shelves, with artificial lights installed above and nutrient solutions supplied directly to their roots [2]. There are 3 types of plant factories, one with complete artificial lighting in a totally-enclosed environment, another with combined use of solar and artificial lighting, and the other with solar lighting alone [3]. The home plant factory (HPF) is a field of application with the use of combined solar and artificial lighting, and that makes it reality that people could harvest vegetables at home.

Customer value is identified as one of the top research agendas by marketing academics in the resent years. Driven by the realization that the total solution is what offers value to the customers, technology-based companies are increasingly selling "customer value" instead of products [4]. It is critical for these technology-based companies to gain an accurate understanding of the potential value of their offerings and learn how this value can

be further enhanced [5]. A company can bring to the customer as a subjective evaluation from the company's perspective [6]. As to plant factory, customers would not buy the high price vegetables only because of security and safety [7]. Now plant factory in China is still at the research and development stage, they will not go on the market in large quantities. It is said that the price of vegetables cultivated in "plant factories" is high and few people can afford them [8]. Considering those problems, the idea of home plant factory was supposed to be a promotion of the technology of plant factory in China in this paper.

In this paper, by analyzing the result of investigation directed against Chinese customers, we can identify the evaluation of home plant factory. Customer value will be used as a principle in market segmentation, and the targeted Chinese users with their attribute will be identified.

2. Research respondents and method

2.1 Basic situation of respondents

An investigation was held from August to October in 2012 mainly in the coastal city of China and 240 questionnaires were distributed. Questionnaires with uncompleted answers or suspected unreal answers were excluded and 213 questionnaires with detailed content were collected with the 88.75% effective rate. 42.7% (91) of the samples are male, 57.3% (122) of them are females. The mean age of the people is 42.24, and the ratio of over fifty aged is 47.89% (102). Respondents were asked, "Do you know about plant factory? " only 14.6% of them answered Yes, although this result is better than expected. The rate of people who don't know about plant factory is up to 85.4%. That means most of Chinese never heard about plant factory. Though the investigation is held mainly in urban, more than a half of the respondents have the experience of growing vegetables at home. The frequency of buying vegetables is also investigated, and most of the respondents buy vegetables once everyday (39.4%), but buying vegetables once every two days and once more than three days is up to 28.6% and 28.2% respectively.

2.2 Image research and Factor analysis

In order to investigate the image of home plant factory，considering the unknown about HPF, the explanatory text as well as inspirational typical image is presented before doing the questionnaire. The research made use of a five-point Likert item in Likert Scale to evaluate the variables for home plant factory [9, 10]. The format from 1 to 5 is: Strongly disagree, disagree, not sure, agree and strongly agree.

In order to extraction the customer value and identify the target user population, first, factor analysis [11] is used to decline dimension in the study of customer life style, and Principal Component Analysis with a Varimax rotation of 17 questions from this attitude survey questionnaire was conducted on data gathered from 213 participants. Then according to cluster analysis, the 213 respondents are separated into different groups. Last, we used the One-Way ANOVA to analysis the difference among the groups [12], and the corresponded value of target user and plant factory can be found by the comparison.

3. Evaluation of home plant factory

The evaluation of home plant factory was mainly investigated by the following 14 variables, trust safety, vegetables are more healthy, trust quality of plants, bring health life, convenient life, would pay money on health consult, life style will be better, would pay money on seeding, want to own one, want to buy one, seems advanced, high tech product, high price and modern life feeling. Before answering, we inserted color image of home plant factory and explanation.

As we can see from Figure 1, the respondents were most impressed by the technology of home plant factory. Seems advanced, High tech product and Modern life feeling also gain the best evaluation. Their means are more than 4, which occupy the top three slots. 73.2% of the respondents express their interest on paying money on their health when answer "Would pay money on health consult". As to the variables of "Trust safety" "Vegetables are more health" "Trust quality of plants" and "Bring health life", a substantial proportion of respondents feel not sure about that. Two means of variables are below 3.5, "Want to buy" and "Would pay money on seeding", and that means the Chinese customer are cautious in spending money. By the way, the ratio of those who would buy HPF is 33.4%, while those who would like to own HPF reach up to 53%. The home plant factory can be seen optimistically because most of variables get a positive review.
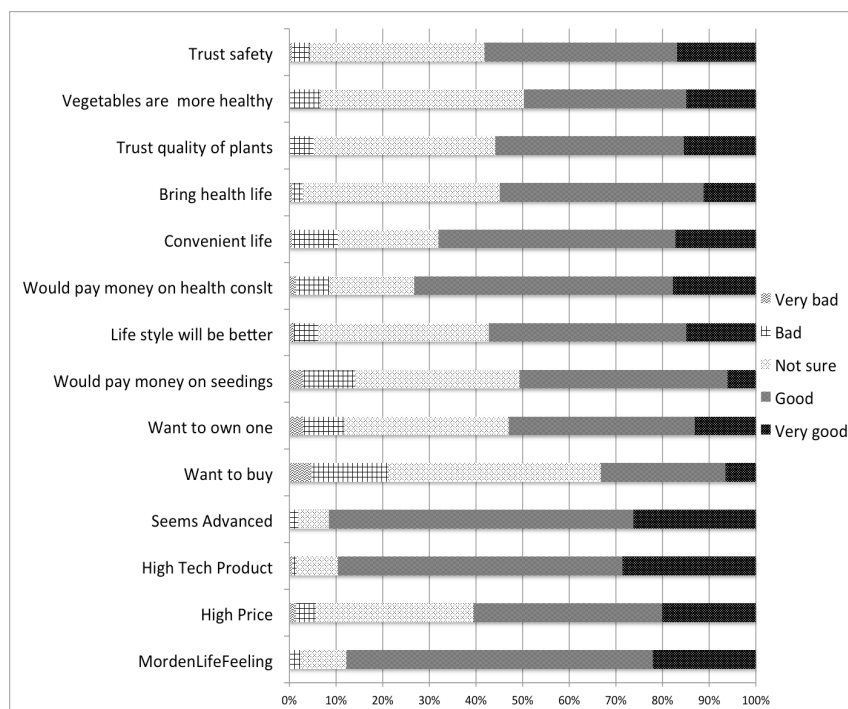

Figure1. Evaluation of home plant factory

4. Extraction of customer value attitude

4.1 Result of factor analysis and cluster analysis

With the extraction method of Principal Component Analysis, 5 components are extracted. Table 1, it shows the rotated component matrix with rotation method of Varimax. As we can see five factors were extracted. For the five factors, the first factor is called "Quality of vegetables factor" because items like "Safety of plants", "Freshness", "Health" and "Delicious" load highly on it. The second factor might be called "Information factor" because items like "Word of the mouth", "Packaging", "Brand", "Trustiness", "Origin" and "Service" load highly

on it. The "Wash simply", "Easy to cook" and "Cleanness" load highly on vegetables' special attribute so the third factor is named "Attractive factor". The fourth factor is named "Environmental factor" as "Distance", "Weight" and "Variety" load on it. The fifth factor is named "Price factor". So the names of five factors are suggested to be "Quality of vegetables factor", "Information factor", "Attractive factor", "Environmental factor" and "Price factor". Table 1 also shows the cumulative percentage of variance accounted for by the current and all preceding factors in which the fifth row shows a value of 66.573. This means that the five factors together account for 66.573% of the total variance. So we can make use of these five factors to explain the attitude of Chinese customers to vegetables in daily life.

The respondents were separated into three groups through the scores of the five factors, and three groups were considered to be suitable with method of K-means cluster. These three groups are represented by C1, C2 and C3. There are 87 respondents in C1, 77 in C2 and 49 in C3.

Table 1. Rotated component matrix of consumer attitude

		Component				
		Factor1 Quality of vegetables	Factor 2 Information	Factor 3 Attractive	Factor 4 Environmental	Factor 5 Price
Safety Of Plants		.792	-.052	.236	.054	.279
Freshness		.760	.058	.022	.110	-.039
Health		.704	.047	.133	.186	.419
Delicious		.520	.116	.171	.489	-.048
Word Of The Mouth		.408	.738	-.101	.077	.007
Packaging		-.295	.694	.390	.035	.078
Brand		-.350	.679	.359	-.065	.087
Trustiness		.493	.635	-.056	.209	-.006
Origin		.025	.631	.343	.092	-.188
Service		.151	.570	.334	-.060	.208
Wash Simply		.161	.202	.780	.162	.035
Easy To Cook		.001	.212	.740	.050	-.072
Cleanness		.194	.112	.687	.240	.042
Distance		.106	-.129	.258	.765	.005
Weight		.036	.103	.022	.727	.454
Variety		.411	.326	.129	.591	-.105
Price		.170	.031	-.034	.077	.857
Rotation Sums of Squared Loadings	Total	2.888	2.870	2.339	1.912	1.309
	Variance (%)	16.989	16.881	13.759	11.245	7.699
	Cumulative (%)	16.989	33.870	47.629	58.874	66.573

4.2 Compare means by One-way ANOVA

Comparing means by One-way ANOVA can found the means of the five factors among the three groups. In Table 2, we use "A", "B" and "C" to indicate the priorities to the five factors for the three groups. For example, about the "Quality of vegetables factor", respondents from C2 imply they care most, so C2 is "A". C3 do not value this factor as the other two groups do, so C3 is "B". In Table 2, three factors get A in C2, and the three factors are "Quality of vegetables factor", "Attractive factor" and "Environmental factor". "Price factor" is valued

most by C1 and "Information factor" is valued most by C3. Considering "Quality of vegetables factor", "Attractive factor" and "Environmental factor" can well reflect the value brought by plant factory, we preliminarily conjectured that people like C2 are target users of home plant factory. Then the attribute of C2 is analyzed through income, gender, and profession. By comparison of income, 55.9% in C2 earn more than 80000yuan (105000Yen), higher than 42.3%, which is the whole ratio. This number in C1 is 41.3%, and 22.5% in C3. The proportion of highest-income is more than the other groups and the lowest-income proportion is least in the three groups. About the gender ratio in C2, 64.9% is female which is higher than the whole average, 57.3%. Profession of C (White collar), F (Retired) in C2 account for 40.3% of the professions.

So we can speculate the attribute of target users like C2 preliminarily, they earn higher incomes or pensions, and the retired and white collar are the main consumers. Besides, women consumers are the most active protagonists in the home plant factory market. They are of special function in buying the activity.

Table 2. Five factors comparing means for the three groups

	C1	C2	C3
Quality of vegetables factor	A （0.2646513）	A （0.4146043）	B （-1.1214121）
Information factor	B （-0.2438984）	B （-0.0215956）	A （0.4669800）
Attractive factor	A （0.0405881）	A （0.2571009）	B （-0.4760802）
Environmental factor	B （0.3920097）	A （0.5706570）	B （-0.2007294）
Price factor	A （0.7043800）	C （-0.6817494）	B （-0.1793134）

5. Conclusion

The research shows an optimistic result that most of the Chinese customers give positive comments on the evaluations of home plant factory. People were impressed by the technology of home plant factory. They also believed that home plant factory is advanced and it brings a modern life feeling. But a substantial proportion of people felt not sure about the safety and health. By analyzing the customer's value attitude, five factors are extracted: "Quality of vegetables factor", "Information factor", "Attractive factor", "Environmental factor" and "Price factors". This paper also identified the targeted Chinese users whose consumer value might meet the value of plant factory, and most of them are retired people with higher pensions and white collar with high income according to the analysis of their attribute. The study also found that women consumers are supposed to be the most active protagonists. This result can help us to reveal the relationship between design requirement and consumer buying activity in the targeted users by structural equation modeling.

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