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# Water Hyacinth Transformation of Wet Garbage in Households into Environmentally-Friendly Products

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***Abstract***

*The research has the following objectives: 1) To develop the transformation of water hyacinths together with wet waste, 2) to design environmentally friendly products, and 3) to assess satisfaction in terms of using environmentally friendly products. The research scope is as follows: The population comprised 1,124 people who chose to buy plants at Chatuchak Market, located in Bangkok, Thailand, while the sample group comprised 150 consumers who chose to buy products in the area for selling plants at Chatuchak Weekend Market in Bangkok, Thailand, (simple random sampling). In addition, the research tool was a structured questionnaire on satisfaction with newly designed products using a 5-level questionnaire scale (Cronbach's Alpha = 0.815, 0.839).In this case, it was found that the effective ingredient formula was 42.50% water hyacinth, 42.50% artificial soil from wet garbage, and 15% ash husk, which provided nutrients that were suitable for plants. In the same way, the creation of a prototype for a new organic pot product was carried out. What is more, it was found that 7 variables affected the emergence of satisfaction among consumers when the prototype was evaluated with consumers, including 1) Environmental Awareness, 2) Product image, 3) Product story, 4) Standard products, 5) Responsibility, 6) Communication, and 7) Price level. All 7 variables will work together to affect the level of consumer satisfaction with new products produced from water hyacinth combined with wet waste. Thus, it is capable of checking for factors affecting consumer decision-making to purchase environmentally friendly products arising from 4 elements: Feeling element, Product element, Awareness element, and Price element. In this case, the consistency index was at the level* $X^2$*= 33.185, df = 27, relative* $X^2$*= 1.229, p =.191, RMSEA =.039, RMR = .025, GFI = .965, AGFI = .900, NFI = .953, TLI = .977.When consumer satisfaction was evaluated, it appeared that the influence of all 3 factors, arranged from highest to lowest, included the product appearance factor (.306), the product price factor (.270), and the feeling factor (.187). In summary, the prediction equation is* $\hat{y} = 1.493 + .187(X1) + .306(X2) + .270(X3)$ *and* $Z = .296(X1) + .316(X2) + .312(X3)$*, and consumers have a demand for environmentally friendly product characteristics, which can be demonstrated as follows: 1) The product has an environmentally friendly appearance; 2) The product has a price level that is consistent with the utility that consumers want; 3) The product demonstrates a production process that has a low impact on the environment. If these three new characteristics are applied, the chance of success in responding to consumers will be at a level of 35.1%.*

***Keywords****: Design factors, Water hyacinth, Transformation, Environmentally-friendly products, Product design*

## Introduction

Nowadays, water hyacinth is quickly propagated in the rivers of Thailand, affecting communication and creating waterfront environmental problems. This results in problem s in irrigable areas, fishing areas, water, transportation and tourism areas, and others. Additionally, the physical attributions of water hyacinth are growing naturally and contributing to the severe environmental problems. Thus,

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using the water hyacinth with good benefits by transforming it into fresh green manure, fermented fertilizer, and plant materials might improve the physical and soil biochemistry properties with good effectiveness. In addition, it should promote agriculturists to turn to learning the application method of water hyacinth to increase the economic value as the Thai government guidelines with the economic direction according to the Twelfth National Economic and Social Development Plan (2017-2021). In this case, the focus is on applying local effectiveness for increasing the economic value and integration on science; it can gain more opportunity to have income from their own potential, especially for water hyacinth to collect the biomass with 20 grams per day with quick growth ratios of 1.5 percent per day. Thus, water hyacinth has negative effects on the environment and small creatures if not dealt with in suitable ways. In the same way, it was found that the problems from the increasing of water hyacinth in 2018 resulted in 3,874,717 tons and in 2019 with the increase to be 17,705,637 tons or 78.12%. Additionally, according to the epidemic of the water hyacinth growth problem, it showed expansion with the growth ratios of industrial factories and large agricultural areas to release chemical and chemical fertilizer into water sources (Holliman et al., 2019). Therefore, the result is the water hyacinth having quick growth ratios affecting the ecology system in seventeen river basins and five large swamps in Thailand, causing environmental condition problems in the future. Further, the researchers have brought the concept of using invaluable things into the valuable ones back into the sustainable environment, including applying the guidelines for using materials to create environmentally-friendly products. Thus, research can be conducted to determine the factors or check for the product design factors of environmentally-friendly products in the case of water hyacinth with wet garbage plots for designers or entrepreneurs. As a result, they can respond to customer requirements with effectiveness, including the increase of economic value with the new normal in our creative society, together with the modernity to respond to the new lifestyles of our modern age in the near future.

## Objectives

1. To develop water hyacinth transformation procedures for the organic tree plots
2. To determine organic plot product design from water hyacinth
3. To conduct an assessment of satisfaction towards new water hyacinth plot products

## Research Framework

### Conceptual Framework for the Water Hyacinth Transformation Process with Household Wet Waste

The objective framework to develop the water hyacinth transformation procedure as organic tree plots is based on the water hyacinth transformation procedure with wet garbage as the organic fertilizer in Thailand (Habte & Alexander, 1977; Mubashra et al., 2021). In this case, it involves the development of a forming procedure for organic tree plots based on the welding of plastic (Aboulam et al., 2006; Egwutvongsa et al., 2022; Deen et al., 2022) as well as compost used in the plot works for planting environmentally-friendly trees.

### Conceptual Framework to Identify Design Factors for Organic Potted Products from Water Hyacinth

According to the objective framework to determine the product design factor to be organic plots from water hyacinth, it is based on applying the concept by considering the overall decision in the case study, consisting of: 1) Information and Details of Problems in each case

study, 2) Representation of the Case Study, and 3) Information Collection for Details in Each Case Study (Maher et al., 1995; Kijmongkolvanich et al., 2023).

### Conceptual Framework for the Cost-Effective Application of Existing Natural Resources

According to the objective framework to conduct a satisfaction assessment of new water hyacinth plot products with the concept of Thailand 4.0, it is based on the application of natural resources to create easy and environmentally-friendly products. In this case, it can reduce the quantity of waste while the customer is applying equally to 0 (ZERO=0) or without environmental effect, including to promote benefits by making the requirement trend of environmentally-friendly product market (Zhu & He, 2017; Turco, 2021), especially in the case study of water hyacinth plots with wet garbage as the high pollution problem in communities for the present day.

## Scope Research

The main aim of this research is to identify the characteristics of new environmentally friendly products made from raw materials such as water hyacinth and wet household waste, which are leftover and useless waste materials in communities throughout Thailand. Moreover, the researchers experimented with creating a prototype for a new environmentally friendly potted product to evaluate consumer satisfaction with new products. Then, the results of the evaluation were classified into three issues that need to be studied: 1) Studying the design factors that can stimulate the opportunity to make increased purchasing decisions; 2) Studying the characteristics of new products that promote satisfaction in consumers after use; 3) Studying guidelines for making use of various types of water hyacinth and wet household waste, which are found in large amounts throughout the local areas of Thailand, to allow for effective application.

According to the results of the research, a method can be created for using water hyacinth and wet household waste by producing environmentally friendly products that create economic opportunities, including income generation and additional career creation for people in the community. Finally, sustainable development in terms of the economy, environmental and social aspects, and other factors can also be created.

### Methods for Testing the Mixture between Water Hyacinth and Wet Household Waste

According to objective scope 1, it was developed for the water hyacinth transformation procedure to turn wet garbage into environmentally-friendly products by testing with the analytical process of N, P, K, pH, EC and Moisture, GI. In this case, it was made from water hyacinth and wet garbage before using three formulas of materials with each one kilo to be analyzed with seven lists of examples. In this case, the research tool is the testing standard of N, P, K, pH, EC, Moisture, and GI values in the accredited testing room. Then, the analysis makes a comparison of N, P, K, pH, EC, Moisture, and GI values from the materials of three formulas in the procedure: 1. Water hyacinth with 100.00%, 2. Water hyacinth with 85.00% and ash husk with 15.00% and 3. Water hyacinth with 42.50%, artificial soil from wet garbage with 42.50%, ash husk with 15.00%, and others.

### Methods for Studying Factors of Product Design

According to objective scope 2, it tested the product design factor of the newly designed organic plot model to confirm the observed variables of the customer group. Additionally, the population comprised a selected group of products at Chatuchak Market in the area of flowering trees with users amounting to 1,124 people. In this case, the group sampling includes the interested group of environmentally-friendly products to buy the products at the flowering area in Chatuchak Market with 150 people by using Simple Random Sampling. It is according to the input standard to set up for variables with confirmatory factor analysis as the reliability was 90% and the chance of discrepancy with 10% from Taro Yamane (Suksawang, 2014). Thus, the research tool it related with the questionnaire in the title of consideration for buying environmentally-friendly products for the customer group. In this case, it used a structured questionnaire to set up the questions with noticed variables from a 5 rating Likert scale as Cronbach's Alpha = 0.815 showing the excellent level; the questionnaires are reliable to study with real samplings. Thus, according to the analysis it involves the Exploratory Factor Analysis: EFA and Confirmatory Factor Analysis: CFA as the testing procedure with the information and friendly environmental design model from the noticed variables in the EFA technique (Borowik & Wyszkowska, 2016), including basic theory checking with component analysis and design component factor explored with SPSS program and AMOS program.

### Methods for Evaluating the Satisfaction of Prototype Products

According to objective scope 3, it has taken the satisfaction assessment for new model products to reflect the future expectations with the user group of products or customers. Additionally, the population is a selected group of products at Chatuchak Market in the area of flowering trees with users amounting to 1,124 people. In this case, the group sampling is the interested group of environmentally-friendly products to buy the products at the flowering area in Chatuchak Market with 150 people by using Simple Random Sampling. The input standard is sued to set up for variables with confirmatory factor analysis as the reliability with 90% and the chance of discrepancy with 10% from Taro Yamane (Suksawang, 2014). According to the research tool, therefore, it is related to the questionnaire in the title of consideration for buying environmentally-friendly products for the customer group. In this case, it used structured questionnaires to set up the questions with observed variables from a 5-rating Likert scale as Cronbach's Alpha=0.815 showing the excellent level (Kaplan, 2000). The questionnaires are reliable to study with real samplings. According to the analysis, therefore, it involves Multiple Linear Regression to analyze the relationships between the independent variables or the design factor of environmentally-friendly products with the dependent variables or the satisfaction level of the customers to study the linearity relationship of more than one independent variable with one dependent variable.

## Results

### Results of Development for the Water Hyacinth Transformation Procedure into Organic Tree Plots

The process of transforming hyacinths into organic potted plants and checking the nutrient value for plants: The researcher tested the plant nutrient's value from the water hyacinth transformation procedure with wet garbage; it is easily found in the local area with increasing nutrient values from the fermenting procedure within 60 days before the testing of the soil value.

**Table 1:** Analysis Result to make Comparison for Fermented Fertilizer in Water Hyacinth

within 60 Days.

| Mixing Ratio | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| [1] Water Hyacinth 100% | 54.22 | 30.67 | 7.15 | 32.48 | 15.96 | 1.09 | 0.34 | 16.76 |
| [2] Water Hyacinth 85% and ash Husk 15% | 48.67 | 31.75 | 7.03 | 33.68 | 15.15 | 1.35 | 0.42 | 17.76 |
| [3] Water Hyacinth 42.50%, artificial soil from wet garbage 42.50% and ash Husk 15% | 49.62 | 32.13 | 7.07 | 33.76 | 15.77 | 1.44 | 0.41 | 18.29 |

A=Density(%); B=Temperature (°C); C=Acidic Alkalin; D=Organic Matter; E=Carbon Value per Nitrogen; F=Nitrogen; G=Conductivity Value (mS/cm); H=Carbon(%)

When carrying out a comparison for the essential nutrient values of plants, it was found that the phosphorus value (P205). (%) was equal to [1] 0.83, [2] 0.88, [3] 0.89, the potassium value (K20) (%) was equal to [1] 0.34, [2] 0.71, [3] 0.77, the calcium value (CaO) (%) was equal to [1] 1.51, [2] 2.17, [3] 2.23, the magnesium value (MgO) (%) was equal to [1] 0.31, [2] 0.39, [3] 0.37, and the sulfur value (%) was equal to [1] 0.20, [2] 0.26, [3] 0.25. Moreover, the comparison of values used the third formula with the transformation step by producing the main material from water hyacinth and wet garbage environmentally-friendly plots because of the higher level of essential nutrients than other formulas. Additionally, the researcher brought water hyacinth at 21.25 kg to mix with artificial soil from wet garbage in households together with ash husk at 7.5 kg and molasses at 1.00 kg and then sprayed with microorganisms continuously when picking up every three days. In addition, the internal temperature was quite high during the first thirteen to fifteen days for stimulating the microorganism to grow fast. However, it was found that the materials from the fermenting procedure had an internal density of only 21.65 kg or a reducing weight of 56.70 percent after 60 days. Later, materials were dried until reaching a remaining weight of only 6.54 kg or a reducing weight of 30.21 percent. As a result, it can be concluded that if organic fertilizer is produced from water hyacinth with wet garbage at 50 kg, it will create a successful organic material with 6.45 kg or 12 percent.

(Water Hyacinth and Wet Garbage Transforming Machine) (Transformed Wet Garbage from Household) (Finished Material Ready for Molding)

**Figure 1:** Material Production Process for Water Hyacinth Environmentally-Friendly Products in Plots.


(Friendly Environmental Design Products) (Water Hyacinth and Wet Garbage Plots) (Packaging and Selling Shelf)

**Figure 2:** Design of Environmentally-Friendly Products in Case Study of Water Hyacinth and Wet Garbage Organic Plots.

**Study On Design Factors of Organic Potted Products from Water Hyacinth**

Analysis Results to Determine Product Design Factors from Water Hyacinth Organic Plot: According to the analysis results, it can be classified into two steps: The first step is to analyze information from the customer groups by setting up the variables with EFA or Exploratory Factor Analysis, while the second step is to analyze with Confirmatory Factor Analysis (CFA), and the third step is to analyze with first or second order. Thus, the researcher brought the variable groups to be tested with the relationships affecting the decision to purchase environmentally-friendly products per these details:

Step 1: Information from customers used to setup variable groups by analyzing from Exploratory Factor or EFA by gathering information from customer requirements to find the variables of purchasing selection and customer satisfaction.

**Table 2:** Values of KMO and Bartlett's Test from Group Samplings with Use Requirements of Environmentally-Friendly Products.

| **KMO and Bartlett's Test of Sphericity** | |
|---|---|
| Approx. Chi-Square | 2076.222 |
| Df. | 741.000 |
| Sig. | .000 |
| Katser-Meyer-Olkin Measure of Sampling Adequacy | .730 |
| *Significance 0.050 | |

According to the analysis of KMO and Bartlett's Test, it can be shown that Kaiser-Meyer-Olkin = 0.730 with a value more than 0.50. In this case, it can be concluded that the gathered information shows the feeling for environmentally-friendly products with suitable information to be analyzed for the Exploratory Factor or Chi-Square = 2076.222; Significance =0.000. As a result, it can be concluded that the variable factor 39 is correlated to analyze all information with the Exploratory Factor.

According to the factor results, it showed that the researcher determined seven factors from the expectations of the rotate and interpret factors, and then it reduced with the eighth, ninth, tenth, eleventh, and twelfth factors due to the minor factors that cannot be matched for more than two factors. In this case, it showed the result with the Total Variance Explained: Method for Extraction that there are thirty-nine variables to be classified with seven factors. In this case, based on the weighing value, it was found that the first factor is the most important to explain the variance of information at the percentage level of 9.348 followed by the second factor at the percentage level of 9.146, the third factor with the percentage level of 8.862, the fourth factor with the percentage level of 6.316, the fifth factor with a percentage level of 6.316, the sixth factor with a percentage level of 5.648, and the seventh factor with a percentage level of 4.812, and others. After that, it analyzed the Scree Plot to show the Eigenvalue value from thirty-nine variables, which found that all seven factors were at a suitable level, while thirty-nine variables can be matched at an excellent level with the good curve of a graph from the first factor to the seventh factor.

**Table 3**: Rotation Weight Factor Verimax Method and Setting up for the Element Weight Value of 0.05 or Higher.

| | Research Variable Axis Rotation | Factor | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Factor 1. Environmental Awareness | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
| X3 | The need to create a sustainable future for society and communities. | .688 | - | - | - | - | - | - |
| X5 | Knowing about "the currents of the world that humans have turned their attention back to in the environment even more." | .678 | - | - | - | - | - | - |
| X6 | The need to "be a part of taking responsibility for the global environment" | .651 | - | - | - | - | - | - |
| X4 | The need to reduce the burden or impact on the environment from living | .623 | - | - | - | - | - | - |
| X13 | Express feelings of "wanting to be a part of environmental conservation" | .532 | - | - | - | - | - | - |
| X1 | A sense of the need to conserve the environment | .447 | - | - | - | - | - | - |
| X2 | Feel the danger of natural disasters caused by changes in the current environment | .439 | - | - | - | - | - | - |
| | Factor 2. Product Image | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
| X28 | The colorful patterns on the packaging of products "can show the environment" clearly. | - | .679 | - | - | - | - | - |
| X18 | Must be a product with "colors that reflect nature" | - | .588 | - | - | - | - | - |
| X27 | Boxes and packaging so that products "can show the environment" | - | .586 | - | - | - | - | - |
| X14 | Understand the laws and social rules that affect your choice of environmentally-friendly products | - | .533 | - | - | - | - | - |
| X29 | The image that appears on the product packaging "can show environmental protection" clearly. | - | .530 | - | - | - | - | - |
| X23 | Must be a product that "society and other people are interested in" | - | .509 | - | - | - | - | - |
| X24 | It has to be a product that is beautiful and can show environmental protection from the shape of the product. | - | .459 | - | - | - | - | - |
| X20 | It must be a product that represents an "environmentally responsible manufacturer". | - | .433 | - | - | - | - | - |
| X22 | Must be a product that demonstrates "Environmentally-friendly production processes" | - | .388 | - | - | - | - | - |
| | Factor 3. Product Story | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
| X36 | I love using environmentally-friendly products. | - | - | .666 | - | - | - | - |
| X37 | Feel that you are the new generation, and the new generation must always care about the environment. | - | - | .626 | - | - | - | - |
| X35 | Desire to use the most environmentally-friendly products in daily life. | - | - | .613 | - | - | - | - |
| X39 | It is important to choose products in everyday life that are environmentally friendly. | - | - | .557 | - | - | - | - |
| X7 | Feeling proud every time you use "Environmental products" | - | - | .533 | - | - | - | - |
| X34 | Always separate waste and consider environmental friendliness before purchasing. | - | - | .490 | - | - | - | - |
| X19 | It must be a product with a "story and content" that represents nature. | - | - | .401 | - | - | - | - |
| X15 | The environmental conservation model influences your choice of environmentally-friendly products. | - | - | .369 | - | - | - | - |
| | Factor 4. Standards Products | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
| X16 | It must be a product that uses natural materials. | - | - | - | .721 | - | - | - |
| X21 | It must be a product that has been certified with "Environmentally-friendly Standards" | - | - | - | .558 | - | - | - |
| X17 | It must be a product that has an "identity that represents environmental protection" | - | - | - | .535 | - | - | - |
| X10 | Observe the changes in the global environment. and be aware of the impact on society | - | - | - | - | .778 | - | - |
| X9 | Notice the change in the global environment and be aware of the impact on you | - | - | - | - | .730 | - | - |
| X11 | Notice the change in the global environment. and be aware of the impact on the world | - | - | - | - | .611 | - | - |
| | Factor 5. Responsibility | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
| X8 | Expectations of taking responsibility for the environment by reducing disturbances on natural resources | - | - | - | - | .470 | - | - |
| X12 | Acknowledging the impact of current and future environmental changes | - | - | - | - | .446 | - | - |
| | Factor 6. Communication | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
| X30 | Characters appearing on the product "can show environmental protection" | - | - | - | - | - | .657 | - |
| X32 | Taking into account after using the product will not affect the environment. | - | - | - | - | - | .600 | - |
| X31 | The shape of the product can show its environmental friendliness. | - | - | - | - | - | .557 | - |
| X33 | There is always a plan to recycle waste. | - | - | - | - | - | .506 | - |
| | Factor 7. Price Level | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
| X25 | Set the price level for eco-friendly products that use good materials and are expensive | - | - | - | - | - | - | .752 |
| X38 | Environmental responsibility is a duty that must be performed. | - | - | - | - | - | - | .524 |
| X26 | Determine the price level for eco-friendly products that use moderate materials and are cheap. | - | - | - | - | - | - | .461 |

According to the classification of variables, it is related to environmental product design factors, which are brought into the process of Confirmative Component Analysis (CFA) by controlling 39 observable variables. Then, it showed that there were twelve variables with a high correlation between observable variables and brought into the next step of variable confirmation.

Step 2: Verified data prior to conducting the CFA analysis for statistical agreement with the probabilities of applicable data for examination of KMO. According to Bartlett's Test, it was found that the observed variables were appropriate because KMO = .765 and Bartlett's Test of Sphericity = 688.622 (Sig. = .000), which is a sufficient correlation for the CFA analysis.

**Table 4:** Analysis of Anti-Image Matrices (Measures of Sampling Adequacy: MSA).

| Variable | W1 | W2 | W3 | W4 | W5 | W6 | W7 | W8 | W9 | W10 | W11 | W12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W1 | 1.000 | - | - | - | - | - | - | - | - | - | - | - |
| W2 | .197 | 1.000 | - | - | - | - | - | - | - | - | - | - |
| W3 | .031 | .024 | 1.000 | - | - | - | - | - | - | - | - | - |
| W4 | .063 | .159 | .252 | 1.000 | - | - | - | - | - | - | - | - |
| W5 | .098 | .000 | .047 | .047 | 1.000 | - | - | - | - | - | - | - |
| W6 | .133 | .227 | .152 | .244 | .290 | 1.000 | - | - | - | - | - | - |
| W7 | .256 | .169 | .121 | .048 | .092 | .071 | 1.000 | - | - | - | - | - |
| W8 | .304 | .136 | .019 | .006 | .167 | .108 | .061 | 1.000 | - | - | - | - |
| W9 | .111 | .031 | .027 | .119 | .145 | .027 | .046 | .034 | 1.000 | - | - | - |
| W10 | .043 | .156 | .073 | .056 | .125 | .042 | .093 | .102 | .135 | 1.000 | - | - |
| W11 | .120 | .031 | .886 | .260 | .006 | .098 | .028 | .065 | .114 | .002 | 1.000 | - |
| W12 | .152 | .248 | .146 | .149 | .098 | .089 | .191 | .017 | .191 | .054 | .172 | 1.00 |
| Bartlett' Test=688.622, Sig=.000, KMO=.765, MSA Between=.653 to .888 | | | | | | | | | | | | |

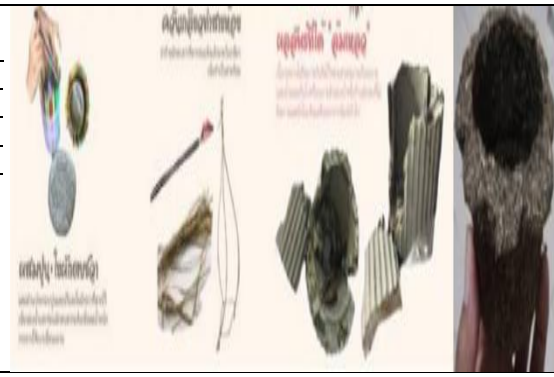
In this case, the results of checking for the correlation between the variables were studied by Bartlett's Test, which showed that all variables were statistically significant at .05. The suitability of the variables for the confirmation component was analyzed by the Kaiser-Meyer-Olkin method. Moreover, it showed that the MSA value was at .781, and the variable was between .653 - .888, which was greater than .50 (Hair et al., 2019). Therefore, it can be concluded that the variable is suitable for corroborative component analysis, especially for reviewing individual factor measurement models based on observed variables to carry out measurements for each relevant factor. Thus, the researcher has tested the measurement model on four factors affecting the selection of environmentally-friendly products. In the case of water hyacinth pots, it was found in these details: 1) the feeling variable is measured from the observed variables using Feeling1, Feeling2, and Feeling3, 2) the product variable is measured from the observable variable with Product1, Product2, and Product3, 3) the awareness variable is measured from the observed variables with Awareness1, Awareness2, and Awareness3, and 4) the price variable is measured from the observed variable with Price1, Price2, and Price3.

Step 3: First-order analysis showed that the factors affecting consumer choices were tested from the measurement model of four factors by the choice of environmentally-friendly products. In the case of water hyacinth pots with wet waste in the co-influence analysis of the observed variables, it involved the effect of the selection.

**Table 5**: Analysis of Second-Order Component (First Order).

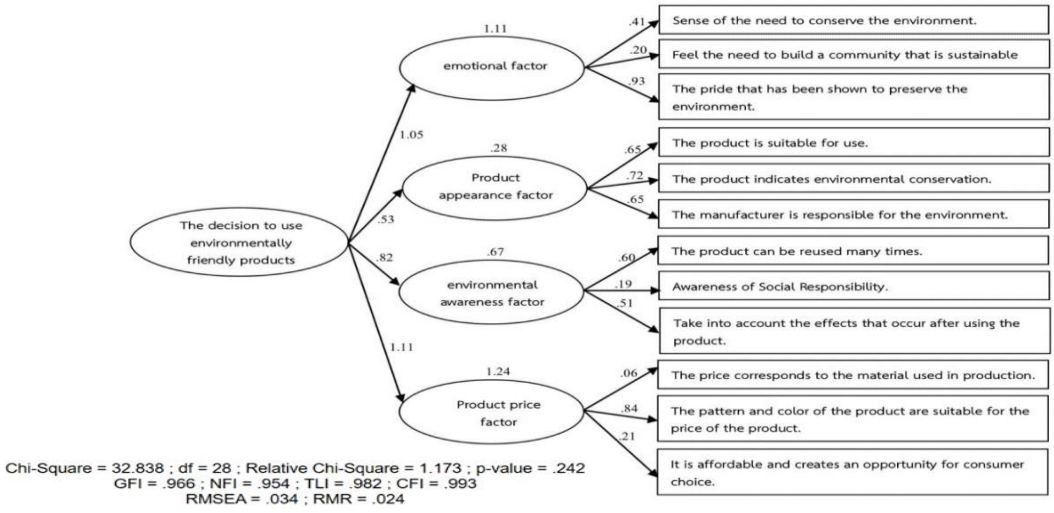
| latent variable / observable variable | Feeling | | | Product | | | Awareness | | | Price | | | $r^2$ | Reliability |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\beta_i$ | $b_i$ | SE | $\beta_i$ | $b_i$ | SE | $\beta_i$ | $b_i$ | SE | $\beta_i$ | $b_i$ | SE | | |
| W1 (Feeling1) | .409 | .381** | .071 | - | - | - | - | - | - | - | - | - | .167 | .408 |
| W2 (Feeling2) | .196 | .192* | .079 | - | - | - | - | - | - | - | - | - | .038 | .194 |
| W3 (Feeling3) | .930 | 1.000 | - | - | - | - | - | - | - | - | - | - | .865 | .930 |
| W4 (Product1) | - | - | - | .649 | .978** | .236 | - | - | - | - | - | - | .421 | .648 |
| W5 (Product2) | - | - | - | .723 | .902** | .198 | - | - | - | - | - | - | .523 | .723 |
| W6 (Product3) | - | - | - | .650 | 1.000 | - | - | - | - | - | - | - | .423 | .650 |
| W7 (Awareness1) | - | - | - | - | - | - | .604 | 1.000 | - | - | - | - | .365 | .604 |
| W8 (Awareness2) | - | - | - | - | - | - | .159 | .294* | .178 | - | - | - | .025 | .158 |
| W9 (Awareness3) | - | - | - | - | - | - | .511 | .849** | .182 | - | - | - | .261 | .510 |
| W10 (Price1) | - | - | - | - | - | - | - | - | - | .055 | .081* | .1000 | .003 | .054 |
| W11 (Price2) | - | - | - | - | - | - | - | - | - | .843 | 1.000 | - | .711 | .843 |
| W12 (Price3) | - | - | - | - | - | - | - | - | - | .214 | .305** | .104 | .046 | .214 |

| latent variable | Green Product Design | | | $r^2$ | Reliability |
|---|---|---|---|---|---|
| | $\beta_i$ | $b_i$ | SE | | Trust |
| Feeling | 1.052 | 1.000 | - | 1.106 | 1.021 |
| Product | .526 | .484** | .112 | .277 | .526 |
| Awareness | .820 | .458** | .069 | .672 | .819 |
| Price | 1.114 | .953** | .052 | 1.240 | 1.113 |



$X^2$=33.185, df=27, relative $X^2$=1.229, p=.191, RMSEA=.039, RMR=.025, GFI=.965, AGFI=.900, NFI=.953, TLI=.977 [*P<.05; **P<.01]

**Table 6**: Factor Structure Equation Model Influencing the Selection of Environmentally-Friendly Products (Water Hyacinth Pot).



According to the results of the second corroborative component analysis under the title "Green Product Purchase Decisions", it used the Amos Program (AMOS) obtained from the Schumacker and Lomax Model Compliance Index (Schumacker & Lomax, 2010). Moreover, it showed $\chi^2$= 33.185, *df* = 27, relative $\chi^2$= 1.229, $p$ = .191, RMSEA = .039, RMR = .025, GFI = .965, AGFI = .900, NFI = .953, TLI = .977 where the conformance index meets the specified criteria, relative$\chi^2$ less than 2 indexes RMSEA and RMR was less than .05, and GFI, AGFI, NFI, and TLI were greater than .95, with AGFI greater than .90. Thus, it conforms to the concept of Diamantopoulos and Siguaw (2000) and Kelloway (2015), which concluded that decisions to buy environmentally-friendly products consisted of 4 main components, namely feeling factor (Feeling), product appearance factor (Product), environmental awareness factor (Awareness), and product price factor (Price), as well as others.

**Satisfaction Assessment of Organic Plant Potted Product Model from Water Hyacinth**

Results for Satisfaction Analysis of Organic Plot Products from New Water Hyacinth: For the relationship between satisfaction with newly-developed water hyacinth pot products according to the variable group, it was observed that all four factors with the design of environmentally-friendly products should be studied and created.

**Table 7:** Examining the Descriptive Values of the Consumer Satisfaction Phenomenon and the Reliability of the Predictive Equation.

| R | R Square | Adjusted R Square | Std. Error of The Estimate | Durbin-Watson |
|---|---|---|---|---|
| .592 | .351 | .333 | .378 | 2.101 |

In this case, it showed that the R-value was equal to .592, and the design factor of the product is environmentally friendly for all four design factors. Moreover, the satisfaction level of the consumer group can be explained at 59.200%, R Square = .351, and the new design factor model can explain the phenomenon of consumer satisfaction at a level of .351. In the same way, it can consider the reliability from the prediction equation of Durbin-Watson to be equal to 2.101 according to the standard set between 1.500-2.500 and the four factors in the analysis with acceptable differences.

**Table 8**: Examining the Relationship between Variables Affecting the Design Factor Prediction Equation.

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 11.223 | 4 | 2.806 | 19.608 | .000* |
| Residual | 20.748 | 145 | .143 | | |
| Total | 31.971 | 149 | | | |

According to the correlation of the prediction equation, it has Sig. = .000, so it is assumed that the equation has at least one factor indicating the relationship between consumer satisfaction with environmentally-friendly products and the new hyacinth pot case.

**Table 9**: Multiple Regression Correlation Coefficients to Forecast Variables Affecting Consumer Satisfaction.

| Forecast Variable (*P < .05) | B | S.Eb | B | T | Sig. |
|---|---|---|---|---|---|
| 1 (Constant) | 1.493 | .346 | - | 4.313 | .000* |
| Sensitive Factor (X1) | .187 | .046 | .296 | 4.097 | .000* |
| Product appearance factor (X2) | .306 | .069 | .316 | 4.441 | .000* |
| Product Price Factor (X3) | .270 | .059 | .312 | 4.568 | .000* |
| Environmental Awareness Factor (X4) | -.073 | .053 | -.101 | -1.384 | .169 |

According to the multiple regression coefficients of variables, it involves the prediction of consumer satisfaction for environmentally-friendly products. Moreover, it was found that 1) the emotional factor (X1) was involved with a regression correlation coefficient of .187 and referred to the environmental responsibility factor in one unit of importance. In this case, it is in relation to consumer satisfaction for environmentally-friendly products to be increased with 0.187 units 2) Product Appearance Factor (X2) with gaining a coefficient of the regression correlation to be equal to .306 in one unit, including consumer satisfaction towards environmentally friendly products, to be increased with 0.306 units, 3) Product Price Factor (X3) to have a regression correlation coefficient of .270 by focusing on the price factor in one unit, and consumer satisfaction towards environmentally-friendly products to be increased with 0.270 units, 4) Environmental awareness factor (X4) to have a regression correlation coefficient of -.073 by focusing on the environmental awareness factor in one unit, and consumer satisfaction with environmentally-friendly products to be decreased with 0.073 units. Moreover, it was found that the feeling factor product with appearance factor and product price factor has a statistical effect on the level of satisfaction that occurs among consumers when considering the Sig. <.05. Additionally, it was shown that the influences affecting the level of satisfaction of consumers in descending order are the appearance factor of the product (.306), the price factor of the product (.270), and the feeling factor (.187), among others. Therefore, the forecast equation can be displayed in a raw score format as follows: $\hat{y}$ = 1.493+.187(X1)+.306(X2)+.270(X3) while the forecast equation can be displayed in a standard score format as follows: Z=.296(X1)+.316(X2)+.312(X3).

## Discussion

This research is based on the study of data from variables in the research, including four factors: 1)Emotional Factor, 2)Product Price Factor, 3)Product Appearance Factor, and 4)Environmental Awareness Factor, consisting of the dependent variable consumer satisfaction with products from water hyacinth and wet waste. Besides, it was found that differences in the level of importance arose among consumers, which can be divided into two phases in terms of consumer interaction with new products, comprising 1)the phase for deciding to purchase a newly developed product, and 2)the phase for considering satisfaction after actual use and other aspects with different influencing factors in the two phases as follows:

1) Deciding stage for purchasing a newly developed product: Consumers will primarily focus on the selling price of the product and will consider their feelings concerning the appearance of the product in terms of whether or not it is environmentally responsible. Then, decision-making will shift consideration when deciding to buy new products during this period, and consumers will pay more attention to the environmentally friendly image of the product.


**Figure 3:** Factors Affecting Purchasing Decisions and Satisfaction that Occurs after Use.

2) Period for considering satisfaction after actual use: Consumers will evaluate the satisfaction they feel after using a new environmentally friendly product. Moreover, consumers will use elements that work together to influence the level of satisfaction that occurs after use. In this case, the consumers will place importance on feelings in considering the product's ability to express responsibility for the environment in terms of the materials used in production as well as the selling price level regarding whether or not it is appropriate with the utility that is received (Lim et al., 2019). As a result, the need to express awareness of environmental responsibility should not have any effect on the satisfaction that is felt after use (Diamantopoulos & Siguaw, 2000; Tenko & Marcoulides, 2006; Piromgarn et al., 2023).

Then, the factors that have a significant influence on both phases of consumer interaction are the product price factor and the emotional factor, both of which are considered the main elements that help stimulate consumers to have positive feelings towards products made from water hyacinth and wet waste from the household as follows:

1) Product Price Factor: Consumers will give importance to the price level of products as they must demonstrate the use of quality materials that are consistent with the price level. If the price level is too low, it will affect the confidence in the minds of consumers, who may see that the materials are of poor quality and not environmentally friendly.

2) Emotional Factor: Consumers will place importance on the image communicated through the physical characteristics of new products, which should indicate an environmentally friendly identity in terms of colors, materials, production, and packaging. Thus, the aim is to respond to the feelings that arise in the minds of consumers who want to feel that they are part of expressing responsibility for the global environment.

The feelings of consumers will appear to change with different influencing factors. Moreover, according to the difference in the level of importance for each factor, it will affect the level of the value connected to the feelings of consumers, called "satisfaction" (Kelloway, 2015; Karakolidis et al., 2016). Besides, it will result in positive feelings towards new types of environmentally friendly products to be increased when consumers are influenced by those factors.

The research raises a hypothesis from four variables consisting of 1) Product Price Factor, 2) Emotional Factor, 3) Environmental Awareness Factor, and 4) Product Appearance Factor, which has a positive influence on the level of satisfaction that consumers have with environmentally friendly products made from water hyacinth and household wet waste.

The four factors emerged from a study of consumer demand for environmentally friendly products arising from thirty-nine questions, which can be summarized as factors in a relationship between each other into seven elements: Environmental Awareness, Product Image, Product Story, Standards Products, Responsibility, Communication, and Price Level. Subsequently, the relationships between similar elements can be grouped until only four factors remain: 1) Product Price Factor for price level elements, 2) Emotional Factor for product story element, 3) Environmental Awareness factor for product Image and environmental awareness elements, and 4) Product Appearance for standard products, responsibility, and communication elements as well as others.

When considering the opportunity for deciding to purchase environmentally friendly products made from water hyacinth and household wet waste, it was found that the Product Price Factor, Emotional Factor, Environmental Awareness Factor, and Product Appearance Factor had a

positive influence on the decision-making process for selecting to buy consumer products (Nasimi, Saleh & Humbatova, 2021; Ratikul et al., 2023). Besides, it is different from the level of consumer satisfaction that had a positive influence on the three factors with an increased level of satisfaction, consisting of Emotional Factor, Product Price Factor, and Product Appearance Factor, as well as others (Zhu & He, 2017; Egwutvongsa & Setvisat, 2021; Lertchamchongkul & Egwutvongsa, 2022).

According to the research, it was found that the environmental awareness factor will only affect the decision to purchase a new product. Further, when consumers have already received a new product to use, the satisfaction that arises within their minds will not be influenced by the Environmental Awareness Factor. In addition, it was shown that, during the satisfaction assessment after using the product, consumers do not use the Environmental Awareness Factor when considering creating value within their own minds (Graedel et al., 1995; Egwutvongsa et al., 2021; Seviset et al., 2018; Kijmongkolvanich et al., 2023).

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