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## Knowledge Distribution of Business and Science for Development of Packaging from Water Hyacinth

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### Abstract

**Purpose:** The work aimed to integrate and distribute the knowledge of marketing and chemistry for product development, in which individual packaging from water hyacinth was ideal. **Research design, data, and methodology:** A customer perception was surveyed to guide the preparation process, and eco-packaging preparation followed the perception study. The satisfaction with the packaging using the 4Ps was determined. **Results:** 159 samples participated in the survey to establish their perceptions. They perceived that eco-packaging was a friendly environment with a score of 4.47. The uses of chemicals and water were less. The design for other functions than a normal function of packaging was preferred. The pulping was done using 3.0 M NaOH. The natural additives of carboxymethyl cellulose (defibering) and corn starch (adhesive) were desired. The paper was characterized according to The National Standard of Kraft paper and was equivalent to the liner board. The prototype of packaging was fabricated as individual packaging. The marketing mix was used to survey 200 samples. The satisfaction with the product was the maximum at 4.53, while the minimum was on price. The online channel was preferred to access the product. **Conclusions:** Water hyacinth could be added value as eco-packaging that the qualities of pulp were equal to the Kraft paper. Individual packaging from water hyacinth was satisfied.

**Keywords:** Marketing mix, Customer perception, Knowledge distribution, Packaging, Water hyacinth, Knowledge integration

**JEL Classification Code:** I25, M31, Q16, Q56

### 1. Introduction

Water hyacinth or *Eichhornia crassipes* is a free-floating and flowering invasive aquatic plant in the Amazon Basin, South America (Derseh, Melesse, Tilahun, Meshesha, & Dagnew, 2019), and the most widely spread across the world. It is thus not surprising that water hyacinth has been listed among the world's worst weeds (Datta, Maharaj,

Prabhu, Bhowmik, Marino, Akbari, Rupavatharam, Sujeetha, Alice, Anatrao, Poduvattil, Kumat, & Kleczkowski, 2021). Water hyacinth spread rapidly and was found all over the country. The water hyacinth has been considered an expensive nuisance in other countries; Egypt, China, Bangladesh, Australia, Brazil, Pakistan, Philippines, Indonesia, and Thailand (Ingole & Bhole, 2002). In Thailand, it was first introduced in 1901 by Thai royalty,

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who brought it back from a visit to Indonesia, due to its perceived strange beauty, and the name “phak tob java” was later denominated from visiting. Water hyacinth is a native plant for cultivation in various places for use as an ornamental plant and flower, subsequently, it has spread extensively in all rivers and water bodies around the country (Urantinin & Pilailar, 2015). It can completely cover lakes and wetlands, out-competing native aquatic species, reducing oxygen levels for fish, and creating ideal habitat for disease-carrying mosquitoes (Stohlgren, Pyšek, Kartesz, & Nishino, 2013). For the effects of water hyacinth on people, it was found that its effects could be seen in many aspects like 1) scenery 2) way of life and living and 3) environment (Chaiyarit, Sintarako, & Khunkha, 2020). The Chao Phraya River, the major river in Thailand, is an example of massive populations of water hyacinth through Bangkok and other provinces have obstructed transportation for boats, polluting water, blocking sunlight, choking flowing water, reducing water oxygen, and increasing the incidence of diseases, especially from mosquitoes and snails. The governments, civilian or military, or related units have always been trying to get rid of the plant, without much success. They can work a good job cleaning up, however, the plant will return after a few weeks. Because the weed can wither and destroy but its seeds can live up many years. It has been estimated that water hyacinth can grow at a rate of 0.26 tons dry of biomass per hectare per day under normal conditions (Guna, Ilangovan, Anantha-Prasad, & Reddy, 2017). Therefore, water hyacinth has more significant negative impacts on the environment, especially its effect on the quality of water.

Due to its negative impacts, researchers are trying to utilize the weed, and many beneficial uses have been reported over the years. Based on its chemical compositions, dried and cleaned water hyacinth can be used as fertilizer to solve the lacking soil minerals, as a food source for fishes and animals, as a paper board, like a protein, or as other useful substances (Ingole & Bhole, 2002). In pollution control, it was used as a natural absorber or as a bio-absorbent for toxic substances and pollutants (Pungpai, Watankornsiri, & Kangkun, 2018). Due to their abundance in nature, it was more applied for utilization as a potential source of biofuel (Bhattacharya & Kumar, 2010; Krishnan, 2020). The works on the use a dried fiber of water hyacinth as SME products in Thailand for example; handicrafts (Taweecheep, Surinya, & Phoomchan, 2016; Kansim & Mongkonsrisawat, 2018), furniture (Sangjanthai & Phirasan, 2015), and paper (Luepong, Sasithorn, & Manarungwit, 2017; Charoensopa & Ploysri, 2022), or even cushioning material in general. Moreover, it was also determined as bio-board (Rahmawati, Haryanto, & Suharyatun, 2018), lightweight concrete block (Subpa-Asa, Laokongthavorn, & Date, 2020), interlocking blocks

(Intaboot, 2018), and cellulose nanofibers (Tanpichai, Biswas, Witayakran, & Yano, 2019). However, the research has been demonstrated in the applications of science, while only a few integrated the knowledge of business and science for product development to find economic use have not much found. To the best of our knowledge, we provided the marketing- and chemistry-knowledges in the opportunity to develop products from water hyacinth for community enterprise, especially during the outbreak of the COVID-19 pandemic and in further. We took the knowledge from the laboratory for reaching the National Standard, and to the local land with customer needs. In addition, the integrated work advantaged green marketing in that the concept is the result of the governments, people, and organizational interest in the environment. Green marketing is to supply the products that can fulfill the needs of the targeted consumers as well as protect the environmental deterioration (Thakur, Gupta, & Singh, 2014). It is the organizational responsibility of the government and business units to create a better social environment in the long run.

## 2. Literature Review

The authors explained the concepts and relevant research related to customer perception and marketing mix. The perception and satisfaction toward the packaging from weeds were discussed as the basis of this research.

### 2.1. Packaging

Packaging is functional as the container for a product that represents the physical appearance of the container and includes the design, color, shape, labeling, and material used. It must attract attention and convey information in various aspects from color to shape to interact with consumer perceptions. Thus, packaging has functional and perceptual components (Hawkins & Mothersbaugh, 2014). Its functions are to protect the product, offer convenience for customers, improve containment during distribution and provide information for communication. Some marketers believe that packaging is more influential than advertising to consumers, as it directly impacts how they perceive and experience the product (Deliya, 2012). The attracts consumers at the point of sale will help them make decisions quickly in-store, and is a complete package to capture the mind setup of all groups of human beings (Pallav, 2016) Thus, the packaging is a kind of marketing tool which means it can capture consumers' attention on the product which helps to promote the product in the market.

With the rapid expansion of modern retailing in Thailand, packaging plays a critical role in merchandising and communication and is the important drive of the dynamic

competitive environment for fast-moving customer goods (Silayoi & Speece, 2004). The growth led to a lot of product and packaging innovations. In modern retailing and small and medium enterprises (SMEs) believe that packaging is one of the critical areas that SMEs need to develop more expertise, along with the market and high-quality raw materials (Silayoi & Speece, 2004). Packaging is user-friendly for all groups of people (Pallav, 2016), and to survive in the high growth, technology and innovation become very important for developing packaging, material, and processes. Understanding consumer awareness and behaviors toward packaging have importance in competitive markets. The raw materials such as agricultural wastes or weeds have been interested to fill technology and innovation in adding value to enhance packaging according to the consumer behaviors and needs to create a happy feeling in customers' minds for using eco- or green packaging. Due to presenting of the lignocellulosic group, the yield of lignin and cellulose in water hyacinth on a dry basis is 6 and 21.2%, respectively (Ingole & Bhole, 2002), and water hyacinth residue left after cellulose production could serve as a fertilizer and soil conditioner because of its nitrogen and nutrient content (Ingole & Bhole, 2002). The cellulose-based production from water hyacinth has been accomplished in papermaking for eco-packaging.

## 2.2. Customer Perception

In psychology research, brain laterality results in an asymmetry in the perception of elements in package design (Silayoi & Speece, 2004). Perception is the process by which people select, organize, and interpret sensation, i.e. the immediate response of sensory receptors (such as the eyes, ears, mouth, and fingers) to such basic stimuli as light, color, odor, texture, and sound (Madichie, 2012). However, perception in the individual selects, organizes, and interprets information inputs to create a meaningful picture of the world (Schiffman & Kanuk, 1994). Customer often judges the quality of a product or service or makes decisions based on what they perceive and a variety of informational cues. Therefore, monitoring the customer perception can spot common user pain points and improve the products or services.

## 2.3. Marketing Mix 4Ps

In 1948, the marketing mix was first developed by James Culliton. Using the concept of James Culliton, Jerome McCarthy developed the 4P's in 1964 which divided the marketing mix into four factors: product, price, place, and promotion (Harsono, 2016). It is the combination of different marketing decision variables, strategies, and tactics used by the organization's management to market its goods

and services (Thabit & Raewf, 2018). It is a set of controllable, tactical marketing apparatuses that an organization used to create a coveted reaction from its objectives market (Adnan, Idreese, & Jan, 2018).

### 2.3.1. Product

Product is the starting point of all marketing activities. Product refers to a physical product or service for a consumer who is ready to pay and it is the key element of any marketing mix (Singh, 2012) or defined as anything a consumer acquires or might acquire to meet perceived meet (Hawkins & Mothersbaugh, 2014). Products are goods or services launched in the market to be consumed or used by customers to satisfy their needs and demands (Nuseir & Madanat, 2015). Product planning involves a variety of decisions to be taken firmly to bring the product to the market. Therefore, the product-related decision also included issues of packaging, branding, and logos, which have functional and symbolic dimensions (Hawkins & Mothersbaugh, 2014). The decision concerning products is very influential on the purchase decision of the customers while technology is used to develop user-friendly new products with product differentiation or usefulness to increase the market share and to establish product differentiation in the market. Thus, product development is an important element, especially for moving SME growth. The most important aspect of the marketing mix was product development to stimulate SMEs' performance (Lubis, Lumbanraja, & Hasibuan, 2018).

### 2.3.2. Price

Price is the amount of money one must pay to obtain the right to use the product (Hawkins & Mothersbaugh, 2014) or define as the value that is charged against the service or product provided to a customer (Nuseir & Madanat, 2015). Price is the amount a consumer must exchange to receive the offering. As the price of a product depends on different elements and hence it changes constantly thus the pricing should be dynamic so that it can bear the changes over the duration (Singh, 2012). Fixing the product's price is difficult (Thabit & Raewf, 2018). It is ascertained by various factors including cost of material, product differentiation, competition, market share and the customer's perceived value of a product, government restrictions, etc. Al Badi (2018) found the most effective marketing mix element of SMEs was the price. Particularly when developing new products, SME administrations need to make more awareness of the price element (Al Samirae, Alshibly, & Alghizzawi, 2020). However, customer opinions were individual, for example, customers with different occupations and monthly incomes have different opinions on the price of 5-star OTOP products (SME products) in Ubon Ratchathani province, Thailand (Chunhapinyokul,

Konthong, Koson, & Wanthawee, 2019).

### 2.3.3. Promotion

Promotion is one of the most powerful elements in the marketing mix. It is the advertisement of a product to sell it to a customer and this process is also acknowledged as communication with customers using various means of advertising (Nuseir & Madanat, 2015). The promotion mix decides the positioning of the product in the target market (Singh, 2012). The decision concerning a promotion is related to special offers, endorsements, advertising, direct mailing, posters, and gifts. The promotion mix determines the positioning of the product in the target market (Thabit & Raewf, 2018).

### 2.3.4. Place

Place includes distribution channel, warehousing facilities, mode of transportation, and inventory control management thus it is a mechanism through which goods and services are moved from the services provider and manufacturer to the consumer (Singh, 2012). However, the concept of place includes distribution channels and location as well (Nuseir & Madanat, 2015). The process involved in transferring products from the producer to the customer, related to the places are as follows; retail, wholesale, internet, direct sales, and peer to peer. The organization must choose whether to sell directly to persons or through distributors. Finally, the overall marketing mix can result in dynamic modeling based on customer feedback for improving a product and the same can be launched as the upgrades product (Thabit & Raewf, 2018).

## 3. Research Design and Methodology

Water hyacinths were collected from the Tha Chin River, separated from the Chao Phraya River, in Suphan Buri Province, Thailand. In Suphan Buri Province, water hyacinth is one of the products of the community that has currently been distributed income and has been sold as a cushioning material. The collected water hyacinth was cleaned with water, dry in sunlight, and cut to the desired size (approximately 1 inch). Later, it was kept in a zip lock bag for work.

### 3.1. Conceptual Work and Research Hypothesis

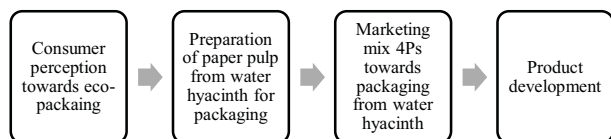


Figure 1: The research model (Source: designed by authors)

According to the problem and objectives of the research model as in Figure 1, we can specify the hypothesis of this work as follows;

- H1:** The evaluation of customer perception can support the preparation of papermaking for packaging
- H2:** The evaluation of the marketing mix gives guidance to producing and developing the packaging for a new product for the community

### 3.2. Study of Customer Perception Towards Eco-Packaging

This study was objected to evaluate customer perception towards eco-packaging by which surveyed 159 respondents through a questionnaire. The results were a guide to the preparation of a prototype of eco-packaging from water hyacinth. The responses were analyzed using the Likert scale with 5 points to evaluate their attitudes. The question was divided to;

Part 1 was the demographic information of respondents were presented with personal characteristics example as; gender, age, education level, occupation, income, and so on.

Part 2 was the static data were evaluated under the 3 criteria of packaging, consisting of design-, preparation- and pattern criteria of production, and interpreted using the Likert scale following as

- |      |                |                         |
|------|----------------|-------------------------|
| [1]. | Mean 4.51-5.00 | means strongly agree    |
| [2]. | Mean 3.51-4.50 | means agree             |
| [3]. | Mean 2.51-3.50 | means neutral           |
| [4]. | Mean 1.51-2.50 | means disagree          |
| [5]. | Mean 1.00-1.50 | means strongly disagree |

### 3.3. Preparation of Water Hyacinth Pulp for Packaging

#### 3.3.1. Preparation of Water Hyacinth Pulp

We integrated knowledge of marketing in terms of perception to guide pulp preparation from water hyacinth. The matchings work in product development gave support to the community to provide an alternative income, especially during the outbreak of the pandemic COVID-19. The paper from water hyacinth has experimented with marketing knowledge. We developed a paper pulp from water hyacinth pulp with the use of natural additives that the community could be followed.

The pulping process was started by the weighting of 12.0 g of dry-weight water hyacinth to separate and treat a pulp by breaking the bond between lignin to cellulose using a 3.0 M sodium hydroxide solution. The mixture was boiled for 2 hours at 90-100 °C, and the paper pulp was obtained and later washed with water. (The draining was adjusted to pH 7

with hydrochloric acid before releasing). The natural additive was mainly emphasized following the survey of perception that we found corn starch as adhesive and carboxymethyl cellulose, CMC as defibering were suitable. The mixture additive solution of 1.0 wt.% corn starch and 1.0 wt.% CMC with a ratio of 70:30 was optimal to use and filled into the pulp. The mixture was blended for 3 min to obtain a homogeneous flask of ice. The water hyacinth paper pulp was prepared by panning on the sieve and dried in air for 1-2 days. Under the optimal conditions, the water hyacinth paper pulps were characterized according to the National Standard as Thai Industrial Standard (TIS) No. 170. The results were used to design the packaging prototype.

### 3.3.2 Preparation of Individual Packaging from Water Hyacinth Pulp

The larger screen was used with a size of approximately A4 paper by setting the weight of the water hyacinth at 30 g/cm<sup>2</sup>. The water hyacinth paper pulp was prepared following the optimal condition in 3.1. Cutting the paper size at 11x19 inch<sup>2</sup> and sewing with a paper holder were steps following the pattern design.

### 3.4. Characterization of Water Hyacinth Pulp Paper

According to the Thai Industrial Standard (TIS) No. 170 for Kraft paper, it is the National Standard of paper for packaging (Thai Industrial Standard Institute, 2016). The water hyacinth paper pulp was prepared and sent to the Department of Science Service (DSS), Ministry of Higher Education, Science, Research, and Innovation for characterization. (DSS is a government organization that provides science and technology services to fulfill the customer's needs and help improve the customer's competitive edge). The results obtained from DSS were a concept for the packaging design. The conclusion of the work was provided for community enterprises to develop packaging further.

### 3.5. Study of Marketing Mix Towards Eco-Packaging from Water Hyacinth

This study objected to asking the customers about their purchase preferences using the 4Ps marketing mix towards eco-packaging from water hyacinth. The data were collected from 200 informants through an online questionnaire. The Likert scale with 5 points was applied to the customer perception study that was divided to;

Part 1 was the demographic information of respondents

Part 2 was that the static data were evaluated under 4Ps marketing mix including; product, price, place, and promotion.

## 4. Results and Discussion

### 4.1. Study of Customer Perception Towards Eco-Packaging

The authors designed and distributed questionnaires using purposive sampling and evaluated the perception of eco-packaging using the Likert scale with a rank of 5 possible opinions. The general information of 159 samples was female at 77.1% of the sample. The samples were more than a half from generations Y and Z, aged 31-40 years at 51.65%. Their marital status was single at 91.1%. The perspective was evaluated upon 3 factors, consisting of attribute-, preparation- and function criteria towards eco-packaging. Regarding the study, the informants noticed that eco-packaging was friendly to the environment and reduced pollutants. They perceived that the preparation consumes a small number of chemicals, energy, and water. The pattern should create to use other functions than a general function of the product. The perception on attribute criteria was the highest score (4.47±0.39) that eco-packaging was a friendly environmental product and can reduce pollutants. The study of customer perception of eco-packaging was in Table 1.

**Table 1:** The perspective of customers on eco-packaging (n=159)

Factor	Mean	Interpretation
1. Criteria of attribute	4.47±0.39	agree
- easy to decompose	4.48	agree
- be friendly to the environment	4.52	strongly agree
- reduce pollutions	4.51	strongly agree
- do not reduce resources	4.36	agree
- can be recycled	4.47	agree
2. Criteria of preparation	4.31±0.35	agree
- raw materials do not influence by the environment	4.34	agree
- consume a small number of chemicals	4.43	agree
- be produced from local materials	4.28	agree
- consume a small amount of water and treated water before draining	4.41	agree
- be efficiently consume energy	4.35	agree
- be possible to recycle waste product	4.28	agree
3. Criteria of functions	4.25±0.34	agree
- be able to hold a weighty material	4.06	agree
- do not apply more ink or color	4.26	agree
- be able to use it for a long while to reduce supply	4.30	agree
- be able to use other functions	4.39	agree

Concluding, eco-packaging has been recognized by groups of samples. Consuming a small number of chemicals was preferred in the preparation step, while the pattern of

packaging should be efficient that can be able to use other functions.

## 4.2. Preparation and Characterization of Water Hyacinth Paper Pulp for Packaging

### 4.2.1. Preparation of Water Hyacinth Paper Pulp

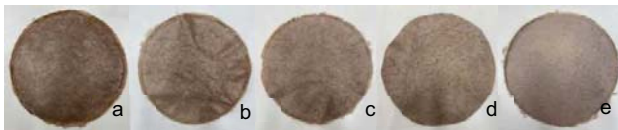
According to the perception study, the preparation of packaging was emphasized by using local materials and consuming a small number of chemicals. The local material, water hyacinth in the canal connected to the Tha Chin River, was collected from Suphan Buri Province. It was prepared and sold as a cushioning material as in Figure 2. The water hyacinth sample was cleaned up before pulping and the preparation step of raw material was performed as in Figure 3. The pulping conditions under alkaline solution (NaOH) in various concentrations (0.25-3.0 M). We found that increasing the concentration of NaOH enhanced the brightness of paper pulp, and the fineness of fiber remained up with alkaline concentration due to lignin removal were resulted as in Figure 4a-4e. A higher concentration than 3.0 M was stopped to avoid the environmental problem and reduce cost. A 3.0 M NaOH at 90-100°C for 2 hours was preferred, and cellulose yield under these conditions was obtained at  $18.80 \pm 2.90\%$ .



**Figure 2:** Water hyacinth raw material (Source: compiled by authors)



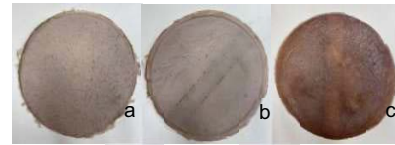
**Figure 3:** Preparation step of raw material on the laboratory scale (Source: compiled by authors)



**Figure 4:** Effect of NaOH concentrations; a) 0.25 M, b) 0.5 M, c) 1.0 M, d) 2.0 M, and e) 3.0 M (Source: compiled by authors)

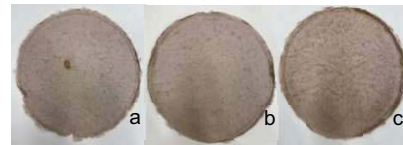
The additives were also studied for improving a feature of paper pulp which we aimed to use the natural additive according to perception study. Carboxymethyl cellulose

(CMC) was selected as a defibering. By adding CMC (0.0-3.0 wt.%) to a pulp in the blending step, the dispersion of pulp was related to the increase in CMC amount. It was easy to spread the pulp as thinly and evenly across the sieve, however, the brightness of the paper pulp decreased with concentration which resulted in Figure 5a-5c. Moreover, increasing CMC provided more toughness to paper pulp. Thus, a 1.0 wt.% CMC was chosen for dispersion of the pulp as a defibering agent.



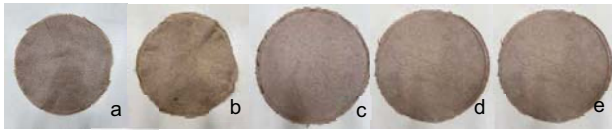
**Figure 5:** Effect of CMC concentrations; a) 0.0 wt.%, b) 1.0 wt.%, and c) 3.0 wt.% (Source: compiled by authors)

The natural adhesive was also studied to improve the strength and bonding of pulp. The corn starch concentrations in the range of 0.0 to 3.0 wt.% were determined. The starch adhesive is relatively low cost, readily available in biodegradable, and has good heat resistance. The result showed that the higher corn starch concentration increased the strength and hardness of pulp, while the brightness was not significantly different which resulted in Figure 6a-6c. A 1.0 wt.% corn starch was concluded to use as adhesive.



**Figure 6:** Effect of corn starch concentrations; a) 0.0 wt.%, b) 1.0 wt.%, and c) 3.0 wt.% (Source: compiled by authors)

The CMC and corn starch were additives. However, we found that higher CMC affected to gelation of the mixture, while corn starch increased the toughness of pulp. The mixture of additives at 70% CMC and 30% corn starch gave better brightness, hardness, and fineness properties. The results of the effecting of CMC and corn starch were in Figure 7a-7e. This ratio was optimal for paper pulp in the papermaking for packaging. However, the bleaching of paper pulp was disregarded in the work because consuming a small number of chemicals was emphasized following perception evaluation.



**Figure 7:** Effect of ratio of CMC and corn starch; a) 100% CMC, b) 100% corn starch, c) 50:50 of CMC and corn starch, d) 30:70 of CMC and corn starch, e) and 70:30 of CMC and corn starch (Source: compiled by authors)

**4.2.2. Characterization of Water Hyacinth Paper Pulp**

Under the optimal condition for preparation of the paper pulp, the characterization of water hyacinth should be indicated to represent the quality of paper for packaging. The National Standard (TIS) No. 170, presented with ISBN. No. 978-974-292-281-8 is the national standard for Kraft paper, and packaging was utilized. Kraft paper is covered for various packaging such as cement, food, chemical, consumer goods, flour bag, and also benefits the envelope, Gift wrapping, and so on. The samples were prepared and sent to the government testing unit, the Department of Science Service. The testing results for water hyacinth paper and the test methods were in Table 2.

**Table 2:** Characterization results of water hyacinth paper pulp according to TIS. No.170

Parameter	Results	Test method
Grammage, g/m <sup>2</sup>	177	ISO 536: 2012
Moisture content, %	9.9	ISO 287: 2017
Water absorption, sec./0.05cm <sup>2</sup>	24.0	TAPPI T835 Om-14
Bursting strength, kPa	640	ISO 2759: 2014
Tensile strength, kN/m	5.07	ISO 1924-2: 2008
Internal tearing resistance, mN	1,667	ISO 1974: 2012

Compared to the type of Kraft paper, the quality of water hyacinth paper was similar to a liner-board as the results in Table 3 in which the grammage and moisture were equivalents. The water adsorption was lower, while the strength and resistance were higher than a liner-board. Regarding the results, the quality of water hyacinth paper as possible for packaging. Hence, we ideal to prepare an individual packaging from water hyacinth paper. The preparation on a larger scale for a prototype of packaging was obtained, and the steps of preparation were shown in Figure 8.

**Table 3:** Comparison of results of paper pulp from water hyacinth to Kraft paper

Parameter	Water hyacinth paper	Kraft paper (liner-board)
Grammage, g/m <sup>2</sup>	177	175
Moisture content, %	9.9	10
Water absorption, sec./0.05cm <sup>2</sup>	24.0	30 - 400
Bursting strength, kPa	640	110 - 170
Tensile strength, kN/m	5.07	1.50 - 2.10
Internal tearing resistance, mN	1,667	590 - 830



**Figure 8:** Step for packaging preparation (Source: compiled by authors)

A prototype sample of packaging from water hyacinth was accomplished as presented in Figures 9a and 9b. A designed logo was pumped into a prototype as in Figure 9c and used for the survey under the 4Ps Marketing mix concept to develop the community’s product to meet the need of customers.



**Figure 9:** Packaging prototype from water hyacinth for the survey (Source: compiled by authors)

**4.3. Study of Marketing Mix Towards Eco-Packaging from Water hyacinth**

A total of 200 completed online questionnaires were collected. The most age of the sample, 56.50% of distribution, was 20-30 years old that was the age group of 18-34 years old are more likely to be seeking out health in consumer products, doing so across multiple platforms, and tend to perceive brands and content more positively (Gupta & Patra, 2018). Thus, the positioning of eco-packaging in the market might be focused on younger (18-34 years old). The demographics of 200 informants were presented in Table 4.

**Table 4:** Demographics of informants (n = 200)

Descriptive demographics		Frequency	Percentage of distribution
Gender	Male	105	52.50
	Female	95	47.50
Educational degree	Undergraduate	40	20.00
	Diploma	26	13.00
	Bachelor's Degree	95	47.50
	Master's Degree and Higher	39	19.50
Age (year)	>50	7	3.50
	41-50	17	8.50
	31-40	42	21.00
	20-30	113	56.50
	<20	21	10.50
Marital Status	Single	153	76.50
	Married	36	18.00
	Divorced	11	5.50

Monthly income (THB)	>30,000	17	8.50
	20,001-30,000	28	14.00
	15,001-20,000	44	22.00
	<15,000	111	55.50

The results show that the 4Ps marketing mix was significantly impacted for the product, however, its variable has proven to be significant toward the customer. Promotion is a pull strategy. According to the result, the water hyacinth paper seems to be sustainable for packaging that meets market criteria for performance and uses natural raw material. The satisfaction on product criteria was shown in Table 5 with a mean score of  $4.53 \pm 0.11$  which means strongly agreed with the packaging. The use instead of conventional packaging was most preferred, while the comfortable carrying was less preferred.

The agreement on price was at a score of 4.20 which resulted in Table 6 because the price was most effective for purchasing. The price of packaging should not be different compared to plastic packaging. The price should not be higher than the normal package even though the packaging has to be useful as conventional packaging. The packaging from water hyacinth can reduce waste and environmental problems. It can be easily eliminated, reused, recycled, reformed, and decomposed. Thus, the customer thought that the production cost of eco-packaging was not expensive due to the natural raw material for preparation. Its price should not high, however, it could be slightly more expensive than plastic packaging. Customers perceived the advantage of environmental issues. The perception was a psychological price. The producer should concern that the setting of product pricing must be below. The psychological price of customers is important because of the purchase cost. The

consumer's price is not only their financial expense, but it is also the time spent, the energy used, and the risk associated with the purchasing. Therefore, the price can also be covered production costs without excessive profit.

The satisfaction in place was at a score of  $4.39 \pm 0.22$ , with the agreement in the place of distribution, shown in Table 7. The channel of distribution through online purchasing was most preferred, while the distribution through kiosks was not convenient for access. Distribution through online channels was the highest satisfaction because consumers believe online distribution channels are convenient to buy products from sellers and allow consumers to shop anywhere and anytime. Avoiding the trouble of opening hours and purchasing distance compared to purchasing through a retail store or kiosk. However, today's consume consumers are constantly switching their behavior towards accessing products via and offline channels. Thus, the producer must be careful to open the multi-channel for customers.

The satisfaction on promotion criteria was the highest level of satisfaction of  $4.51 \pm 0.04$  which means strongly agreed with the promotion. The promotion by sampling and free premiums were most preferred, while the price-offs were less preferred. Promotion is a strategy of the producer or entrepreneurs to promote the products or business. The evaluation was detailed in Table 8. Moreover, supporting the use of eco-packaging is one of the activities of corporate social responsibility, CSR of business to make a marketing promotion. Therefore, free packaging or couponing should be focused on marketing communication strategies to make the consumer understand and build a credible corporate image.

**Table 5:** The 4Ps-Product Towards Eco-packaging from Water hyacinth

Satisfaction of Water hyacinth packaging toward the product criteria	Frequency of each score					Mean	Interpretation
	1	2	3	4	5		
use instead of conventional packaging			6	47	147	4.71	Strongly agree
durable for temperature change		1	21	41	137	4.57	Strongly agree
looks stylish and beautiful		1	18	58	123	4.52	Strongly agree
convenient and easy to use		1	19	57	123	4.51	Strongly agree
reduce waste and environmental problems		1	17	47	135	4.58	Strongly agree
easy degradable		3	19	55	123	4.49	Agree
easy to carrying	1	6	28	57	108	4.33	Agree
The average score on the Product criteria						$4.53 \pm 0.11$	Strongly agree

**Table 6:** The 4Ps-Price Towards Eco-packaging from Water hyacinth

Satisfaction of Water hyacinth packaging toward the price criteria	Frequency of each score					Mean	Interpretation
	1	2	3	4	5		
Valuable for money		1	19	65	115	4.47	Agree
Willing to buy even if the price is higher than the plastic bag	18	24	29	54	75	3.72	Agree
is less than 20 THB	3	10	44	52	91	4.09	Agree
Price is the most effective buying decision			24	53	123	4.50	Strongly agree
The average score on the Price criteria						$4.20 \pm 0.37$	Agree



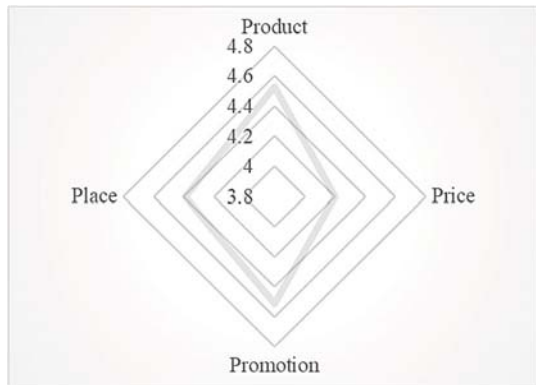
**Table 7:** The 4Ps-Place Towards Eco-packaging from Water hyacinth

Satisfaction of Water hyacinth packaging toward the place criteria	Frequency of each score					Mean	Interpretation
	1	2	3	4	5		
Retail		8	29	36	127	4.41	Agree
Online		1	17	41	141	4.61	Strongly agree
Kiosk	3	14	32	50	101	4.16	Agree
The average score on the Place criteria						4.39±0.22	Agree

**Table 8:** The 4Ps-Promotion Towards Eco-packaging from Water hyacinth

Satisfaction of Water hyacinth packaging toward the promotion criteria	Frequency of each score					Mean	Interpretation
	1	2	3	4	5		
Free premiums		1	17	55	127	4.54	Strongly agree
Price-offs		2	21	62	115	4.44	Agree
Sampling		3	19	44	134	4.55	Strongly agree
Couponing		1	20	58	121	4.50	Strongly agree
The average score on the Promotion criteria						4.51±0.04	Strongly agree

In concluding the 4Ps values, the satisfaction with the product was most preferred, while the price was less preferred. It seems to be not significantly different. However, the price was the most concerned criterion when the radar curve was plotted as in Figure 9.



**Figure 9:** Radar graph of 4Ps towards eco-packaging from water hyacinth (Source: compiled by authors)

**5. Conclusions**

The distribution of business and science knowledge was integrated for product development from water hyacinth. The importance of product strategy in a business requires marketing knowledge based on a consumer concept and the development & design of products to meet the needs of consumers. The evaluation of customer perception can help producers to prepare papermaking for packaging Leaving the preparation aspects to the community enterprise in Suphan Buri Province to add the value of water hyacinth and create a new product for the community. The evaluation of the marketing mix can help the producer to produce

packaging for the development of a new product for the community. The designs of packaging and the marketing strategy have been continuously studied for further work.

**References**

Adnan, A., Idreese, M., & Jan, M. F. (2018). Relationship between marketing mix strategies and fashion consumer’s purchase intention. *International Journal of Scientific & Engineering Research*, 9(12), 262-274.

Al Badi, K. S. (2018). The impact of marketing mix on the competitive advantage of the SME sector in the Al Buraimi Governorate in Oman. *SAGE Open – Research Paper*, July-September 2018 (pp.1-10). <https://doi.org/10.1177/2158244018800838>.

Al Samirae, Z., Alshibly, M., & Alghizzawi, M. (2020). Excellence in drawing up marketing mix strategies for small and medium enterprises (SMEs) and their impact on the marketing performance. *Business, Management and Economics Research*, 6(3), 30-36. <https://doi.org/10.32861/bmer.63.30.36>.

Bhattacharya, A., & Kumar, P. (2010). Water hyacinth as a potential biofuel crop. *Electronic Journal of Environmental Agricultural and Food Chemistry*, 9(1), 112-122.

Chaiyarit, A., Sintarako, A., & Khunkha, N. (2020). The guidelines for participative problem solving on the water hyacinth of the Theppharat sub-district community, Ban Pho district, Chachoengsao Province. *Journal of Local Governance and Innovation*, 4(2), 35-50.

Charoensopa, K., & Ploysri, W. (2022). Make paper from water hyacinth for products and home decorations. *Journal of Positive School Psychology*, 6(2), 5916-5921.

Chunhapinyokul, N., Konthong, J., Koson, D., & Wanthawee, N. (2019). Service marketing mix influencing consumers’ purchasing decision process for five star OTOP products in Ubon Ratchathani province. *Journal of Management Science Ubon Ratchathani University*, 9(2), 18-37.

Datta, A., Maharaj, S., Prabhu, G. N., Bhowmik, D., Marino, A., Akbari, V., Rupavatharam, S., Sujeetha, J. Alice. R. P.,

- Anatrao, G. G., Poduvattil, V. K. Kumart, S., & Kleczkowski, A. (2021). Monitoring the spread of water hyacinth (*Potederia crassipes*): Challenges and future developments. *Frontiers in Ecology and Evolution*, 9, 1-8. <https://doi.org/10.3389/fevo.2021.631338>.
- Deliya, M. (2012). Consumer behavior towards the new packaging of FMCG products. *National Monthly Refereed Journal of Research in Commerce & Management*, 1(11), 199-211.
- Derseh, M. G., Melesse, A. M., Tilahun, S., Meshesha, A. A., & Dagne, D. (2019). *Chapter 19-Water hyacinth: Review of its impacts on hydrology and ecosystem services-lessons for management of Lake Tana*. Extreme Hydrology and Climate Variability; Monitoring, Modelling, Adaptation and Mitigation (pp. 237-251). <https://doi.org/10.1016/B978-0-12-815998-9.00019-1>.
- Guna, V., Ilangovan, M., Anantha-Prasad, M. G. & Reddy, N. (2017). Water hyacinth: A unique source for sustainable materials and products. *ACS Sustainable Chemistry & Engineering*, 5(6), 4478-4490. <https://doi.org/10.1021/acsschemeng.7b00051>.
- Gupta, P., & Patra, S. (2018). Importance and awareness of health factor in consumer purchase decision specific to fast moving consumer durable sector. *International Journal of Marketing and Management Research*, 9(6), 32-51.
- Harsono, R. (2016). The impact of marketing mix (4P's) on customer loyalty towards Toyota Avanza. *iBuss Management*, 4(1), 1-7.
- Hawkins, D. I., & Mothersbaugh, D. L. (2014). *Consumer behavior: Building marketing strategy*. International edition. NY: McGraw-Hill Education.
- Ingle, N. W., & Bhole, A. G. (2002). Utilization of water hyacinth relevant in water treatment and resource recovery with special reference to India. *Journal of Water Supply: Research and Technology-AQU*, 51(5), 283-295.
- Intaboot, N. (2018). Mechanical properties and thermal conductivity of interlocking block made from sludge and water hyacinth. *Journal of Thailand Concrete Association*, 6(1), 10-19.
- Kansim, P., & Mongkongsrisawat, S. (2018). Potential development of handicraft occupational group a case study of water hyacinth handicraft group Ban Pho, Mueang district, Nakhon Ratchasima province. *Dhammathas Academic Journal*, 18(1), 167-176.
- Krishnan, S. (2020). Bioethanol production from lignocellulosic biomass (water hyacinth): a biofuel alternative. *Bioreactors: Sustainable design and industrial applications in Mitigation of GHG emissions* (pp.123-143). <https://doi.org/10.1016/B978-0-12-821264-6.00009-7>.
- Lubis, A., Lumbanraja, P., & Hasibuan, B. (2018). Stimulating SMEs Performance based on marketing mix approach: A study of featured SMEs in Medan. *Proceeding of the International Conference of Science and Technology, Engineering, Environmental and Ramification Research-Volume 1: ICOSTEERR, ISBN 978-989-758-449-7* (pp.1425-1431). DOI: 10.5220/0010080714251431. Retrieved July 20, 2022 (actual access date), from <https://www.scitepress.org/Papers/2018/100807/>
- Luepong, K., Sasithorn, N., & Manarungwit, K. (2017). Kraft paper preparation from water hyacinth, pineapple leaves and leaf sheath of banana tree. *RMUTP Research Journal*, 11(1), 15-22.
- Madichie, N. O. (2012). *Consumer Behaviour: Text & Cases, Chapter 7: Customer perception*, Tata McGraw Hill (pp.154-175). Retrieved June 6, 2022 (actual access date), from [https://www.researchgate.net/publication/328676646\\_Consumer\\_Perception](https://www.researchgate.net/publication/328676646_Consumer_Perception).
- Nuseir, M. T., & Madanat, H. (2015). 4Ps: A strategy to secure customers' loyalty via customer satisfaction. *International Journal of Marketing Studies*, 7(4), 78-87. <https://doi.org/10.5539/ijms.v7n4p78>.
- Pallav, P. (2016). Impact of packaging on customer buying behaviour. *International Journal of Marketing and Management Research*, 7(10), 1-6.
- Pungpai, P., Watankornsiri, W., & Kangkun, N. (2018). Comparison of absorptive efficiency of oil spill dispersants using naturally nano-technologically porous materials. *Koch Cha Sarn Journal of Science*, 40(1), 38-49.
- Rahmawati, W., Haryanto, A., & Suharyatun, S. (2018). Development of biodegradable board using water hyacinth (*Eichornia crassipes*). *International Journal of Environment, Agriculture, and Biotechnology*, 3(1), 170-174. <https://doi.org/10.22161/ijeab/3.1.21>.
- Sangjanthai, A., & Phirasan, J. (2015). Product development of water hyacinth furniture of Ban Wong Klong group, Lankrabue district, Kamphangphet province, Art and Architecture. *Journal Naresuan University*, 6(2), 165-178.
- Schiffman, L. G., & Kanuk, L. L. (1994). *Consumer Behavior*. (5th ed.). Engle wood Cliffs, NJ: Prentice-Hall International.
- Silayoi, P., & Speece, M. (2004). Packaging and purchase decision: An exploratory study on the impact of involvement level and time pressure. *British Food Journal*, 106(8), 607-628.
- Singh, M. (2012). Marketing mix of 4ps for competitive advantage. *IOSR Journal of Business and Management*, 3(6), 40-45.
- Stohlgren, T. J., Pyšek, P., Kartesz, J., & Nishino, M. (2013). Globalization effects on common plant species. *Encyclopedia of Biodiversity* (2nd ed.) (pp.700-706). <https://doi.org/10.1016/B978-0-12-384719-5.00239-2>.
- Subpa-Asa, P., Laokongthavorn, L., & Date, S. (2020). The study on effect of lightweight concrete block by water hyacinth adding. *Proceeding of the 6th International Conference on Advance Engineering and Technology (ICAET 2019)*, 811(1): 012014 (pp.1-6). DOI:10.1088/1757-899X/811/1/012014. Retrieved July 20, 2022 (actual access date), from <https://iopscience.iop.org/article/10.1088/1757-899X/811/1/012014>.
- Tanpichai, S., Biswas, S. K., Witayakran, S., & Yano, H. (2019). Water Hyacinth: A sustainable lignin-poor cellulose source for the production of cellulose nanofibers. *ACS Sustainable Chemistry & Engineering*, 7(23), 18884-18893. <https://doi.org/10.1021/acsschemeng.9b04095>.
- Taweecheep, N., Surinya, T., & Phoomchan, P. (2016). Development of water hyacinth handicrafts vocational training program for senior citizens. *Kasetsart Journal of Social Sciences*, 37(3), 279-290.
- Thabit, T. H., & Raewf, M. (2018). The evaluation of marketing mix elements: A case study. *International Journal of Social Sciences and Educational Studies*, 4(4), 100-109. <https://doi.org/10.23918/ijsses.v4i4p100>.

Thai Industrial Standard Institute. (2016). Thai Industrial Standard, TIS. Number 170-2016. Retrieved July 20, 2022 (actual access date), from <https://service.tisi.go.th/standard-shop/web/index.php?r=site/view&tid=908>.

Thakur, K. S., Gupta, S., & Singh, K. (2014). Green marketing mix

and customer receptiveness of green product. *Pacific Business Review International*, 6(10), 74-80.

Urantinin, A., & Pilailar, S. (2015). Effect of water hyacinth on open-channel water flow behavior: Laboratory scale. *Kasetsart Journal Natural Science*, 49(6), 913-923.