GENERALISED AHP APPROACH WITH LATENT FACTOR AND STRATUM FOR SELECTING PROGRAM OF IMPROVING THE POSITION OF THAILAND'S OTOP PROGRAM FOR ELDERLY CONSUMER MARKET

SUTTIPONG RATANAREE[1], PHANPHET SUWATTANARWONG[1], CHIMBOONMA PRASIT[1] AND CHATTINNAWAT WICHAI[2]*

[1]Department of Industrial Technology, Faculty of Science and Technology, Chiang Mai Rajabhat University, 202 Chang Puak, Chang Puak, Muang, Chiang Mai, Thailand, 50300. [2]Department of Industrial Engineering, Faculty of Engineering, Chiang Mai University, 239 Huay Kaew Road, Muang, Chiang Mai, Thailand, 50200.

*Corresponding author: chattinw@eng.cmu.ac.th

Abstract: We presented a generalised AHP technique to accommodate the proposed method of the extended AHP proposed by Suttipong *et al*. (2022) to prioritise and position the OTOP product for the elderly consumer market. This research presented the generalised formula for developing the extended methodology proposed by Suttipong *et al*. (2022) that can consider the different information of a selected group of information called latent factors. We generalise and use the matrix form and account for the consumer preferences collected from a different group of elderly consumers classified by the latent factor. This paper presented the generalised form of the extended AHP in which the stratum weights were aggregated and computed at the overall preferences of the OTOP product group. The accounting of the stratum can be used to improve planning and analyse consumer preferences. This generalised form helps the project planner apply the AHP extending across different sectors attributed to different latent factors such as consumer gender, age group, health condition and occupations.

Keywords: AHP, latent factor, OTOP.

Introduction

One of Thailand's economic developments, One Tambon One Product (OTOP) has been initiated to support the local economy and create incomes on the grass root for the locals. The OTOP, the main driver for the Thailand government has been initiated to drive the local economy. This program was adopted from the successful One Village One Product model from Japan. The OTOP was demonstrated to be one of the successful engine to drive local and country economy helping the local communities to create business opportunity, generate market and sell their local product across provinces and the countries. This OTOP platform has created significant number of local entrepreneurs and generated local works run by small and medium (SMLE) local enterprises (Natsuda *et al*., 2012). This program also helps the community economically transforming their local resources to high valued products. This drives the success

of rural area development. This program creates collaboration between local community members and generates a system of cooperatives whose business is capitalised based on local resources. This program also increases locals' skilled labour and drives community human resource development (Denpaiboon & Amatasawatdee, 2012).

The product created from the OTOP program consists of various local products grouped into five categories: Utensils, beverages, cloth, food and herbs. For example, the main utensil product group of OTOP are handicrafts, woven handicrafts, pottery, artistry items and household items. The cloth product group consists mainly of textiles, cotton clothing, silk garments and fashion accessories. The other groups of food product items, beverages and non-edible herbal products cover different and varied household items. Since the OTOP products have been made within local

communities across different regions, most of the OTOP products are traditional items made within the local communities to represent local style and flavours, which is inimitable.

Different regions create different types of special products. Nowadays, many OTOP products are produced within 7,255 sub-districts registered by the Thailand government called Tambons. Due to the overwhelming number of OTOP products, Thailand's government aims to develop a support program for the right group among those five different groups. The selection of the supporting programs such as design improvement, high speed and large volume production development can help and lifting up the business opportunity for the OTOP entrepreneurs. However, selecting the right product group must consider the alignment of the product group business, market opportunity and other important criteria.

The method of selecting the OTOP product group has been first proposed by Suttipong *et al*. (2022) using the analytic hierarchy process (AHP) technique. The method selection is not only important but also is strongly needed by the OTOP office. The right group selection can greatly support the local community economy which is the grass root of Thailand's economics. Finding a new market and new product is also important. Suttipong *et al*. (2019) reported the new market study, especially for the elderly consumer, which is different from the traditional consumer. Thus, selecting the right OTOP product groups among those five groups requires the systematic approach of multiple decision-making techniques. The current OTOP product is mainly designed for general customers but may not fit the need and demands of the new market of elderly consumers with different clusters or factors such as gender, age, health condition, etc. Thailand is projected to transition into an ageing society, resulting in different business models and opportunities for different clusters or strata of the customer. Thus, the new products and services shall be developed by accounting for different clusters or strata of customers. However, up to present research knowledge, no research explains and presents the framework

for increasing the OTOP business for this complex emerging elderly market with different strata. Several reports show that different elderly consumer strata can generate demand for the OTOP business. Thus, accounting for different consumer preferences is crucial, leading to higher OTOP product sales. Suttipong *et al*. (2022) proposed a research methodology adopted from Suttipong *et al*. (2019) called the Extended AHP that can account for the different latent factors and stratums of needs of elderly consumers.

This research aims to provide the preference ranking of the OTOP consumer under general stratums across factors such that the policy can be developed to increase the sale and value of the specific OTOP product group. The results can also be used to increase the OTOP value, which leads to the business success of the OTOP in Thailand. The new representation of the extended AHP developed in this paper can be applied to derive or determine the important preference or needs of the elderly consumer, which will drive the sale of the OTOP product for the elderly consumer market. Applying this proposed technique can lead to the greater managerial contribution of the Thailand government at the country level if the product group selection can be correctly and reasonably ranked concerning different criteria. This research adopted the same survey results of Suttipong *et al*. (2019) that identified the preferences of the target elderly population within the three provinces of the northern region in Thailand, Chiang Mai, Lumphun and Lampang. This technique helps identifying the product group that should be targeted for improvement but this top-level analysis does not take into account the information of consumer preferences, especially of different group or stratum. For the elderly consumer market, if the auxiliary information such as the needs of OTOP product groups of a different gender is available, this shall be included and used for the analysis. Phanphet *et al*. (2019) reported information on the preference of each OTOP group, which are different among male and female customers. Therefore there is a latent factor such as gender, if included, can enhance the effectiveness of

choosing the OTOP product group. The approach presented by Suttipong *et al*. (2022) in which two different strata of elderly consumers of male and female where gender is the latent factor is presented to account for gender stratum as only one latent factor. However, this paper extended one step further from Suttipong *et al*. (2022) to provide the calculation and formula of the proposed extended AHP method using matrix-based representation. This new representation can account for the aggregations of the weights at different strata and across more than one latent factor that can have different preferences of the OTOP. Therefore, the methodology presented in this paper represents the calculation under a matrix-based form which proposes generalised formula to identify, select and improve product development especially in the elderly consumer market in Thailand under the general structure of the factors and the stratums. This research demonstrated the case of two latent factors where the two stratums of the gender factor are crossed with the two stratums of the age group factor of elderly consumers. When we have more latent factors such as occupation or health condition, this new proposed representation can be applied directly and easily. This research is demonstrated as follows. The literature review on the methodology of OTOP product and selection was explained in Section 2. Then the new methodology of the extended AHP with general stratum and matrix-based representation was demonstrated in Section 3. The results of the application and the summary and discussion were given in the last section.

Literature Review

Many researchers defined success factors of the OTOP business management without accounting for the market opportunity for the different product groups. Tuamsuk *et al*. (2013) presented the knowledge management model derived from OTOP product champions' business communities. The researchers defined the knowledge management factors that can be associated with or influence the success of five-star OTOP businesses. Tuamsuk *et al*. (2013)

also identify the organisation's leader and manage culture, staff and knowledge to improve the OTOP business. Thammasang and Poonikom (2016) found that knowledge management indicators must be related to production management. Most reports indicated the success factors related to knowledge management without regarding the product priority, hence cannot be adopted to define policy for OTOP product improvement or development. Thailand's government is supporting and providing OTOP entrepreneurs with different supports. For example, the department of Industrial Promotion under the Ministry of Industry plays a key role in the OTOP product development and has continuously devised training programs and quality certification support for the new OTOP product development. The regional design centres that can work with the OTOPs help create new marketable designs and modern packages for many new products since not all traditional OTOP products in the past have been associated with the new emerging market of the elderly consumer. The OTOP supporting office needs a systematic approach that can define more precisely by accounting for different factors of the targeted group of elderly consumers. The focused group of products that matches the needs of the new market can improve and effectively enhance the effectiveness of the OTOP program (Kurokawa, 2009). With multi-criterion, the product group selection and process must be devised. The selection methodology of the OTOP group for improvement under multi-criterion has been presented using the analytic hierarchy process (AHP) and the extended AHP under general stratums and factors.

The AHP approach was developed and presented in 1970. It has been widely adopted to select alternatives under multi-objectives or multi-criteria. The process of AHP starts with identifying and then prioritising the alternatives (Battistoni *et al*., 2013). The AHP was considered a multi-objective decision-making technique. The AHP is a pairwise comparison approach where each alternative is justified under different criteria. The AHP summarises

each alternative's degree of preference or priority through the weights (Belton, 1986). The priorities represented with the product sum of those relative numerical weighting scores are typically used to identify the important values for each decision. To apply the AHP, the objective function must be first specified. Typically, a set of fixed criteria is used. The score can be computed from the sum of the product of each criterion's weights and the alternatives' weights (Saaty, 1980).

The AHP has been widely used to decide on the OTOP context such as the selection of OTOP product distribution (Choomrit *et al.*, 2011), the management and practices of OTOP supply chain and logistics (Theppitak, 2013) as well as the industrial product development (Battistoni *et al.*, 2013). The AHP was also used to improve the OTOP business (Lungtae & Noknoi, 2014) applied the AHP technique to derive the marketing strategies for the herbal product group. Several researchers analysed specific single product development such as wood handicrafts (Phriwanrat, 2014; Tarapitakwong *et al.*, 2016) and processed food (Joompha & Pianthong, 2018). The AHP can be applied to select a strategy of OTOP business management that aligns with the value and market opportunity of the OTOP product group for effective promotion. Recently Suttipong *et al.* (2019) used the AHP to prioritise and select OTOP product groups for marketing and product development by incorporating all five groups of OTOP products simultaneously. Suttipong *et al.* (2022) presented the extended version of the Suttipong *et al.* (2019), applying the AHP to extract information on opportunities and needs of the elderly consumer market and used that knowledge to prioritise the OTOP product group about business management criteria.

Generally, a single criterion may not be adequate to select or choose the OTOP group for improvement or support. For example, the single criteria based on the 5-star awarding system currently applied to grade the OTOP product has been used to determine which product group needs support. Traditionally, the OTOPs with less than 2 stars out of 5 stars are the target groups for the government to support. However, there are other criteria proposed and available. For example, Phanphet *et al.* (2019) and Suttipong *et al.* (2019) devised and used criteria called BOSE model consisting of Business (B), Opportunity (O), Self-sustainability (S) and Environment (E) aspects. To apply the AHP approach of Suttipong *et al.* (2019), first, the group of experts identified the weights representing the relative importance of each criterion of B, O, S, E under the AHP algorithm. This is represented as the column vector of $\mathbf{W} = [W_B, W_O, W_S, W_E]^T$ where $[W_B, W_O, W_S, W_E]$ present the relative weights of Business (B), Opportunity (O), Self-sustainability (S) and Environment (E) aspects. Next, each OTOP product group was evaluated with respect to each criterion. Then the potential importance or weights of each OTOP group were derived using the AHP approach.

The relative weights of each OTOP group with respect to each criterion of BOSE are derived and represented as a matrix of the weight of ith product group with respect to the jth criterion. Note that the matrix ψ can generally be of the size I by J. In the present study, the matrix is of size 5 by 4 where the total OTOP product group is 5 (utensils, beverages, cloth, food and herbs) and the total criteria is 4 (B, O, S, E). This application of the AHP under multi-criterion results in the new strategy of supporting the OTOP by considering the overall potential of the OTOP product group concerning different criteria. Hence, to develop a holistic view of OTOP product development, the importance of OTOP groups must be first considered and included in the analysis. The AHP methodology proposed by Suttipong *et al.* (2019) can identify the priority of the sum of the product of the weights as the degree of importance of those five major OTOP groups concerning the developed BOSE criteria. Even though the identification of product group priority by Suttipong *et al.* (2019) can outline the right set of OTOP product groups to support, this method was improved and extended to account for more information generated from the stratums of the customers. When additional auxiliary information is available, this can be

used to improve the analysis. For example, the information on different consumer preferences concerning gender by Phanphet *et al*. (2019) showed that the preference of each OTOP group could be different among customer strata. This product preference shall be considered in defining the product group priority. Therefore, when the latent factor and information on customer preference can be identified and included, the analysis of AHP can be improved. The OTOP product group can be identified by accounting for the weight of elderly consumer preference. Suttipong *et al*. (2019) used information on the preferences of consumers on each product group represented by weights $\omega = [\omega_i]$ where ω_1, ω_2, ω_3, ω_4 and ω_5 are elderly consumer preferences on utensil, beverage, cloth, herbs and food, respectively.

Suttipong *et al*. (2022) suggested that customer preferences can be analysed across strata, such as male and female, improving the decision-making process accuracy. However, the extended AHP analysis incorporating the latent factor proposed by Suttipong *et al*. (2022) only accounts for gender factors with two strata and cannot present in the general form of arbitrary numbers of the latent factor with different strata for each factor. This paper presented an improved AHP-based OTOP product development method under the general structure of latent factors with possibly different strata. The proposed new method is presented in the next section.

Methodology

Step 1. Calculate the relative weights of the product preference. This research methodology identifies the consumer preference information at different levels of the latent factors. Without loss of generality, for example, consider the latent factor of gender (*A*) and age group (*B*). Suppose the latent factor *A* and *B* each having *a* and *b* stratum, respectively. The AHP process was used to define the information on the product preferences both overall and concerning each *a*b* cross stratum or levels of the latent factors.

Step 1.1. Define the set of overall preferences relative to weight $\omega = [\omega_1, \omega_2, \omega_3, \omega_4, \omega_5]^T$

Step 1.2. Define and calculate the set of preference relative weights stratum for each *a*b* cross stratum $\omega_m = [\omega_{m1}, \omega_{m2}, \omega_{m3}, \omega_{m4}, \omega_{m5}]^T$ for $m = 1,\ldots,a*b$ and ω_{m1}, ω_{m2}, ω_{m3}, ω_{m4} and ω_{m5} are elderly consumer preferences of the cross stratum *m* on the product group of utensil, beverage, cloth, herbs and food, respectively.

Recall that, in Suttipong *et al*. (2019) survey result, each of the $n = 1,275$ elderly consumers randomly sampled from the three provinces was asked to evaluate the preference of each OTOP group. The overall preference relative weights at the marginal or top-level were identified, denoted as weights $\omega_m = [\omega_{m1}]$ for the product group $i = 1,...,5$. Suttipong *et al*. (2022) denoted the preference relative weights of the male and female stratum $\omega_2 = [\omega_{2i}]^T$.

Step 2. Calculate the relative criteria weights $W = [W_B, W_O, W_S, W_E]^T$ and reveal each criterion's contribution or importance to each other. The pairwise comparison of each criterion was conducted and the AHP technique was applied to identify the potential relative weights W.

Step 3. Calculate the matrix of product group potential relative weights of importance $\psi = [\varphi_{ij}]$ for the product group $i = 1,...,5$ and the criterion $j = 1,...,4$. The technique of AHP was used to compare those five OTOP groups to each of the criteria i.e., BOSE and identify the relative weights of the OTOP product group importance $\psi = [\varphi_{ij}]$.

Step 4. Define the OTOP product group potential relative weights denoted as $\omega^P = [\omega_i^P]^T$. The product group potential relative weights are calculated using the AHP approach represented in this paper as matrix multiplication $\omega^P = \psi*W$. Suttipong *et al*. (2019) calculated this to identify the top three most potential groups of OTOP products for product development for the elderly consumer market.

Step 5. Calculate the extended OTOP product group potential relative weights at the overall level and for each stratum denoted as $\omega^E = [\omega_i^E]^T$ and $\omega_m^E = [\omega_{mi}^E]^T$, respectively. The product group potential relative weights at overall level ω^E can be represented in matrix form as $\omega^E =$

$diag(\omega)*\Psi*W$ where $diag(\omega)$ is the diagonal matrix of elements ω. Note that ω^E it needed to be standardised with $\sum_{i=1,..5}\omega_i^E=1$. This extended overall product potential is used as the marginal analysis that sheds light on the potential group better than the ω^P derived from conventional AHP since the consumer preference information is used to adjust the relative weights ω^P. Similarly, the product group potential relative weights for each stratum ω_m^P can be calculated as $\omega_m^E = diag(\omega_m)*\Psi*W$ with $\sum_{i=1,..5}\omega_{mi}^E=1$. Suttipong *et al*. (2022) presented the extended AHP product group potential relative weights for the stratum of male and female consumers and denoted as $\omega^{overall}$.

Step 6. Calculate the combined OTOP product group potential relative denoted as $\omega^C = [\omega_i^C]^T$. The product group's overall potential relative weights ω^C can be calculated as the weighted sum of the ω_m^E with weights ϕ_m representing, for example, the amount of information in each cross level. The ω^C can be represented as $\sum_{m=1,...ab}\phi_m\omega_m^E$. In general, the combined OTOP product group potential relative denoted as ω^C can provide the information of the OTOP product potential better than the ω^E since different stratum weight can be assigned.

The improved and new analysis has two contributions. First, the calculation presented in this matrix can incorporate any number of latent factors of the possibly different stratum. Second, the consumer's information on the OTOP product group preference is accounted for and was combined across all combinations of the latent factor levels. This result in a detailed analysis that can be used to position the OTOP product that meets the need of the elderly consumer segment and deploy the right policy for product evolution. The application of the new method is shown in Figure 1.
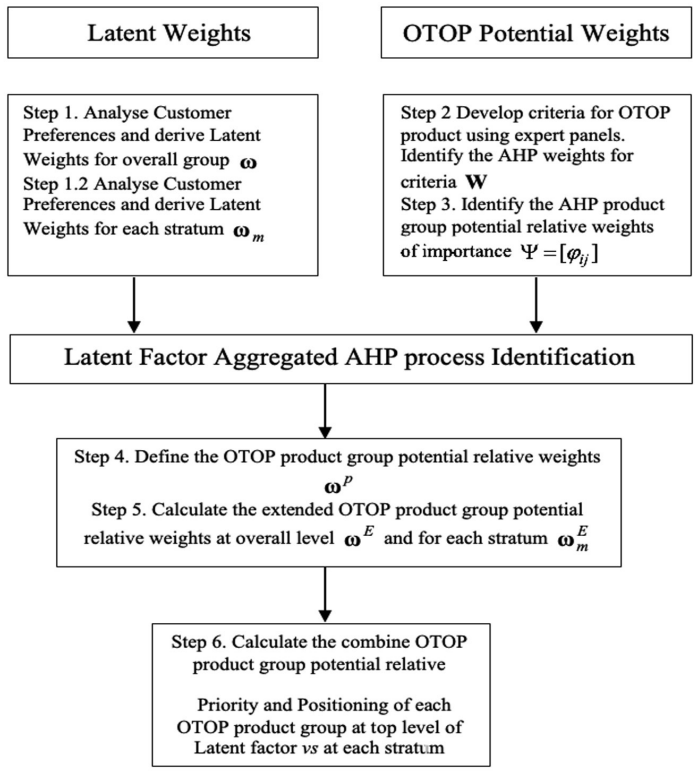

Figure 1: Steps of the matrixed-based new approach

This extended approach incorporating the preferences leads to several advantages. First, different groups of OTOPs have different potentials for the elderly consumer market. The identification of the preferences of the product groups gives more accurate derivations of the consumer selection and product target. Adopting the extended AHP helps devise a rational framework for making the right decisions where multiple criteria and objectives can be correctly quantified. Using this new method will systematically rank and relate all the key elements necessary for accomplishing the goal of selection among multiple alternatives.

Results and Discussion

First, we replicated the results and used the same AHP approach of Suttipong *et al.* (2019; 2022).

The product preference relative weights from the elderly consumer preference to each OTOP product category or group of overall preference relative weight $\omega = [\omega_1, \omega_2, \omega_3, \omega_4, \omega_5]^T$ and the set of preference relative weights stratum for each cross stratum $\omega_m = [\omega_{m1}, \omega_{m2}, \omega_{m3}, \omega_{m4}, \omega_{m5}]^T$ were summarised in Table 1. Based on the Consistency Index (CI) and the Consistency Ratio (CR) of less than 0.1, the information is coherent and the preferences can be considered justified for the decision-making process. The derived set of weights shown in Figure 2 shows the decreasing weights from utensil, beverage, cloth, herbs and food. This research also tested whether the weights differ among male and female elderly. There is no strong evidence suggesting the differences. Hence, the weights will be used for prioritising each OTOP product group in the next step.

Table 1: Comparison matrix of elderly preferences

	Overall ω	Male Age < 65 ω_1	Female Age < 65 ω_2	Male Age > 65 ω_3	Female Age > 65 ω_4
Utensil	37%	31%	39%	35%	43%
Beverage	24%	27%	25%	20%	25%
Cloth	17%	19%	12%	15%	16%
Herbs	13%	13%	15%	11%	9%
Food	10%	10%	8%	19%	6%

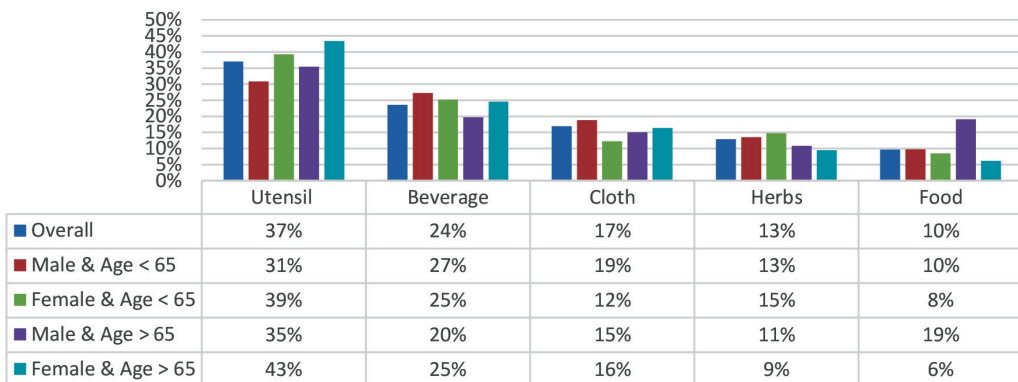|	Utensil	Beverage	Cloth	Herbs	Food
Overall	37%	24%	17%	13%	10%
Male & Age < 65	31%	27%	19%	13%	10%
Female & Age < 65	39%	25%	12%	15%	8%
Male & Age > 65	35%	20%	15%	11%	19%
Female & Age > 65	43%	25%	16%	9%	6%

Figure 2: Latent weights of each cluster of consumer for OTOP product preference

The results show that the different consumer groups can have different preferences among different groups of the OTOP product. The utensil group generally received the highest preference for buying among the elderly, followed by beverages, clothes, herbs and food. This is also true for each cluster of consumers. These results aligned with a formal report conducted by the OTOP office that the utensil has the highest buying volume compared with others. However, the gender stratum used to demonstrate the technique shows little preference difference. Next, the AHP approach of Suttipong *et al.* (2019; 2022) as shown in Figure 3 was adopted with the four main criteria of BOSE.

The relative criteria weights $\mathbf{W} = [W_B, W_O, W_S, W_E]^T$ were calculated. These weights represent the contribution or importance of each criterion to each other. Together with the criteria relative weights $\mathbf{W}$, the matrix of product group potential relative weights of importance $\psi = [\varphi_{ij}]$ for the product group $i = 1,...,5$ and the criterion $j = 1,...,4$ were derived and the product potential relative weights $\boldsymbol{\omega}^p$ were also adopted from Suttipong *et al.* (2019; 2022) as shown in Table 2.
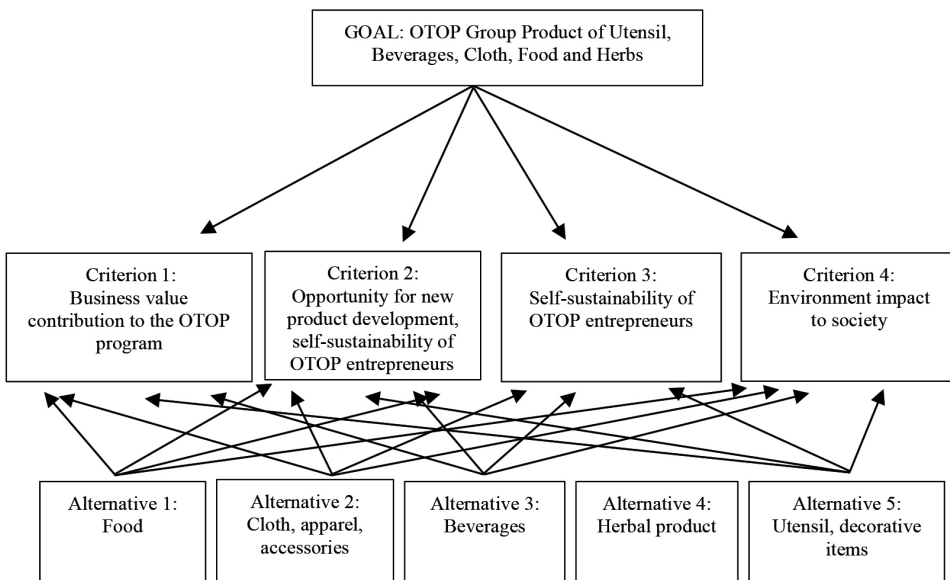

Figure 3: AHP approach and structure adopted from Suttipong *et al.* (2019; 2022)

Table 2: Criteria relative weights $\mathbf{W} = [W_B, W_O, W_S, W_E]^T$, product group relative weights of importance $\psi = [\varphi_{ij}]$, product potential relative weights $\boldsymbol{\omega}^p$ adopted from Suttipong *et al.* (2019)

	Business	Opportunity	Sustainability	Environment	Product Potential Relative Weights ω^p
	47%	*27%*	*17%*	*9%*	*100%*
Utensil	37%	38%	38%	41%	38%
Beverage	22%	24%	23%	21%	23%
Cloth	19%	19%	21%	18%	19%
Herbs	12%	10%	11%	12%	11%
Food	10%	9%	7%	8%	9%
	100%	100%	100%	100%	100%

The extended OTOP product group potential relative weights at the overall level ω^E and for each stratum ω^E_m were computed. Table 3 compares the proposed extended AHP product group potential relative weights across all four levels of the two latent factors of gender and age group. The combined OTOP product group potential relative ω^C computed from $\sum_{m=1,...ab}\phi_m\omega^E_m$ is also provided. Figure 4 also indicates that the graphical comparisons between the various computed weights of each stratum. With the preference weights accounted for different stratum, the combined weights can be aggregated. As mentioned, in general, the combined OTOP product group potential relative denoted as ω^C provides more information of the OTOP product potential than the ω^E. In this case, the use of different stratums indicated that the product potential relative weights ω^p_1 of the Utensile product group accounted for almost 55%-56% importance whereas the ω^p_1 computed from traditional AHP of Suttipong *et al.* (2019) is only 37%. This indicated that incorporating the elderly consumer preference for each OTOP product category or group can enhance the understanding and the important or potential product more precisely.

Table 3: The extended OTOP product group potential relative weights at the overall level ω^E and for each stratum ω^E_m and the combined OTOP product group potential relative denoted as ω^C

Product Potential Relative Weights ω^p	Overall Level ω^E	Male & Age < 65 $\omega^E_{m=1}$	Female & Age < 65 $\omega^E_{m=2}$	Male & Age > 65 $\omega^E_{m=3}$	Female & Age > 65 $\omega^E_{m=4}$	Combined Extended AHP
100%		$\phi_{m=1}$ 24%	$\phi_{m=2}$ 31%	$\phi_{m=3}$ 19%	$\phi_{m=4}$ 26%	$\sum_{m=1,...,4}\phi_m\omega^E_m$
Utensil 38%	56%	49%	59%	61%	59%	57%
Beverage 23%	21%	26%	23%	21%	19%	22%
Cloth 19%	13%	15%	9%	12%	14%	12%
Herbs 11%	6%	6%	7%	4%	5%	5%
Food 9%	4%	4%	3%	2%	3%	4%

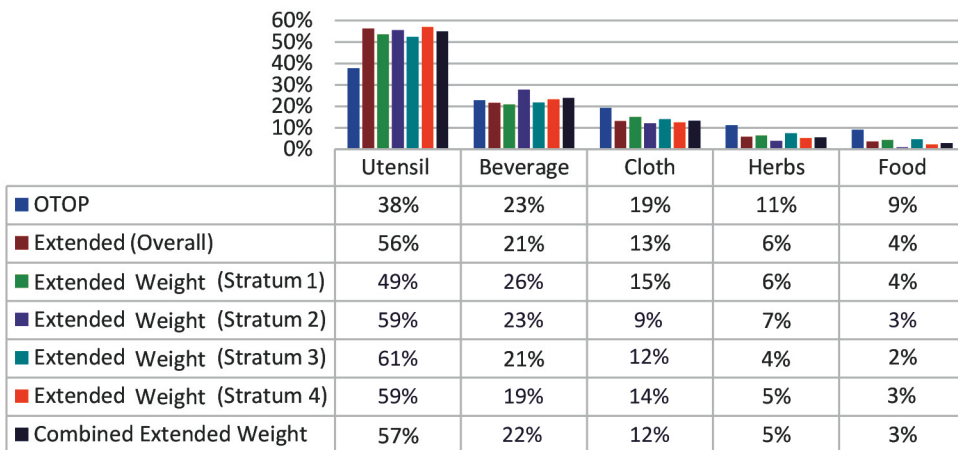|	Utensil	Beverage	Cloth	Herbs	Food
■ OTOP	38%	23%	19%	11%	9%
■ Extended (Overall)	56%	21%	13%	6%	4%
■ Extended Weight (Stratum 1)	49%	26%	15%	6%	4%
■ Extended Weight (Stratum 2)	59%	23%	9%	7%	3%
■ Extended Weight (Stratum 3)	61%	21%	12%	4%	2%
■ Extended Weight (Stratum 4)	59%	19%	14%	5%	3%
■ Combined Extended Weight	57%	22%	12%	5%	3%

Figure 4: Adjusted product potential relative weights of OTOP product group with latent factors

The results from Table 3 indicated that incorporating consumer preferences of the new extended approach put stronger importance on the utensil group of product that need to be focused on for support and development. Similarly, the importance of the last two OTOP groups of herbs and food was adjusted with less emphasis. The analysis reveals that the stratification of the aggregated weights using gender and age as stratum helps the policy maker to understand in depth the product group potential and the feasibility of the market needs.

Conclusion and Discussion

Similar to the results of Suttipong *et al*. (2019; 2022), the differences in the market opportunity of the five OTOP product categories in the different elderly consumer sectors or strata provide information on how to choose the right OTOP group. This newly proposed method for the general structure of latent factor can accommodate the practitioner and provide discrimination of the priority compared with the previous approach presented by Suttipong *et al*. (2019; 2022). This example of using gender and age group as stratum factors leads to the more general AHP approach that can reflect the real implication of product targeting since elderly consumers prefer differently on different OTOP products. Considering and adjusting the weights with different cross-stratum combinations, the combined relative weights were developed and can be compared with the overall relative weights for the extended case. Even though the analysis results lead to the same product group choice, the weights are different. This can be attributed to the different weights or amounts of information on each stratum. After adjusting with the latent weights, this research concludes that the utensils, decorative items and souvenirs group received the highest priorities to be focused and supported. The new finding shows that the product development must be emphasised on those high potential OTOP groups. This new product development is verified and agreed with the OTOP statistic reports. Thus, the high-priority group of the utensil has been reported

and planned to be further promoted. More new product development will ensure the triple economic, social and environmental bottom line will be achieved.

The newly proposed technique leads to stronger discrimination of product targeting and suggests the new positioning of the OTOP product for the elderly market. Thus, the results of this new technique affirm the right selection of the right OTOP product group. This can justify the strategic action plan for OTOP product and process development.

Lastly, the value of this new proposed methodology is justified by the contextual concepts that the priority needs to be viewed from the customer's perspective. Hence, the auxiliary information on consumer preferences is needed to be included. The traditional AHP approach to product selection cannot consider auxiliary or latent factors. The traditional use of the AHP of Suttipong *et al*. (2019) depends heavily on step 2 of OPOP potentials. This research extended the AHP by introducing the latent factor and stratum analysis technique. This new technique can generally be applied to more latent factors and different stratum layers.

Even though the extended AHP proposed in this paper has more advantages than the application of the traditional AHP methodology, the proposed limitation exists. First, the latent factors and their meanings were construct and context related. The use of consumer preferences in our model represents the intermediary relationship between endogenous and exogenous variables. The latent construct is very important and subject-related and must be carefully designed before applying this proposed technique. With the justification of the latent factor identification, the practitioner must also verify this construct at the beginning stage. The identification of the latent factor must come from the expert knowledge in knowing how those endogenous and exogenous variables can be depicted from which lens.

This paper also proposed new future research on: (1) How the latent factor construct can be statistically tested or justified with what

tools or methods, (2) How the latent factors and their degrees can influence the typical AHP, leading to how to select the right number of latent factor for the analysis and (3) How the dimension of the alternatives interact with the latent factor dimensions. These questions lead to future research on investigations and clarification of the extended AHP concerning their efficiency.

Applying our proposed method from a managerial perspective can lead to country-level contribution since selecting the right group of OTOP products can lead to optimising government resources. The right selection of product group reduces the government's burdens and budgets and maximise resource efficiency. Moreover, the economic impact of the right product promotion and development is substantial. Hence, managerial implications of the proposed technique are justified not only from resource perspectives but also through the lens of economic impact on the country.

Acknowledgements

References

Battistoni, E., Colladon, A., Scarabotti, L., & Schiraldi, M. (2013). Analytic Hierarchy Process for New Product Development, *International Journal of Engineering Business Management*, *5*(42), 1-8.

Belton, V. (1986). A comparison of the analytic hierarchy process and a simple multi-attribute value function, *European Journal of Operation Research*, *26*(1),7-21.

Choomrit, N., Chantana, P., & Janverod,W. (2011). The study in economic feasibility for OTOP's distributed location of Chonburi Province in Thailand. In *The 18th International Conference on Industrial Engineering and Engineering Management, Bangkok, Thailand*, (pp. 1593-1596).

Denpaiboon, C., & Amatasawatdee, K. (2012). Similarity and difference of One Village One Product (OVOP) for rural development strategy in Japan and Thailand. *Japanese Studies Journal Special Issue: Regional Cooperation for Sustainable Future in Asia*, *29*, 52-63.

Joompha, W., & Pianthong, N. (2018). Development of durian chips product by apply of quality function deployment, *Journal of Science & Technology, Ubon Ratchathani University*, *20*(3), 204-218.

Kurokawa, K. (2009). Effectiveness and limitations of the 'One Village One Product (OVOP) approach as a government-led development policy: Evidence from Thai 'One Tambon One Product' (OTOP), *Studies in Regional Science*, *39*(4), 977-989.

Lungtae, S., & Noknoi, C. (2014). The Marketing Stra tegies of Five-star rated herbal businesses of One Tambon One Product (OTOP) entrepreneurs in Songkhla Province, Thailand, *International Science Index*, *8*(8), 155-158.

Natsuda, K., Igusa, K., Wiboo npongse, A., & Thoburn, J. (2012). One Village One Product - rural development strategy in Asia: The case of OTOP in Thailand. *Canadian Journal of Development Studies/Revue Canadienne D'études Du Développement, 33*(3), 369-385.

Noble, V. (2019). Mobilities of the one-product policy from Japan to Thailand: A critical policy study of OVOP and OTOP. *Journal Territory, Politics, Governance*, *7*(4), 455-473.

Phanphet, S., Sukprasert, N., Suttipong, R., Wangmai, A., & Chattinnawat, W. (2019). Factor affecting elderly consumer buying attitude on Thailand OTOP product. *The International Journal of Engineering and Advanced Technology*, *9*(1), 942-946.

Phriwanrat, T. (2014). Properties of rhizophora charcoal for product design. *World Academy of Science, Engineering and Technology International Journal of Chemical, Molecular, Nuclear, Materials and Metallurgical Engineering*, *8*(4), 333-335.

Saaty, T. L. (1980). *The Analytic Hierarchy Process*, New York: McGraw Hill. International, Translated to Russian, Portuguese and Chinese, Revised editions, Paperback, Pittsburgh: RWS Publications.

Suttipong, R., Wangmai, A., Phanphet, S., Reungsri, S., & Chattinnawat, W. (2019). Prioritizing and positioning of Thailand's program of OTOP product for elderly using AHP. *International Journal of Engineering and Advanced Technology*, *9*(1), 2110-2116.

Suttipong, R., Phanphet, S., Wangmai, A., Reungsri, S., Chattinnawat, W. (2022). Extended AHP approach with latent factor and stratum in prioritizing and positioning of OTOP Thailand's program for elderly market, *International Journal of Global Optimization and Its Application*, *1*(1), 22-31.

Tarapitakwong, J., Chartrungruang, B., Somhom, S., & Tantranont, N. (2016). The development of criteria and indicators of OTOP quality in wood handicraft production meticulousness using analytic hierarchy process. In *The 3rd Kamphaeng Phet Rajabhat University National*, 403-415.

Thammasang, S., & Poonikom, K. (2016) The Development of indicators and form of knowledge management in production management case study: Agricultural machine industry in the Northeast of Thailand. *International Journal of Applied Engineering Research*, *11*(22), 10912-10922.

Theppitak, T. (2013). Managing effective Logistics and supply chain management for Thailand's One Tambon One Product (OTOP)- a way to creating sustainable business, In *The 5th International Conference on Logistics and Transport, Doshisha University Kyoto, Japan*, 25.

Tuamsuk, K., Phabu, T., & Vongprasert, C. (2013). Knowledge management model of community business: Thai OTOP Champions. *Journal of Knowledge Management*, *17*, 363-378.