



Applying Fuzzy Delphi Method and ANP to Analyze Instrumental Attributes in Purchasing Sustainable Apparel Products

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Keywords

Sustainable apparel product,
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Abstract.

Research on the relationship between sustainable product criteria and consumer decision-making has recently developed strongly. However, the type of product in these researches is unbalanced. Agricultural products are the most focused, while other sectors account much smaller portions. Therefore, the purpose of this research is to analyze instrumental attributes in purchasing sustainable apparel products.

Firstly, the authors examined main findings in previous studies to summarize the attributes. In the second stage, Fuzzy Delphi method was used to select the critical performance-related attributes. A total of 15 experts, who was working in sustainable development field over 7 years, participated in this stage. Finally, the importance degree of each attributes and sub-attributes was obtained by applying Analytic Hierarchy Process (ANP). The results showed that experts consider price and quality to be important criteria in consuming sustainable apparel products, whereas environmental concern information is the least important.

1. Introduction

Environmental thinking attracted considerable public interest since the 1970s. At that time, it was still just narrow in solving waste problem caused by industrial production [36]. By the start of the 2000s, academic research moved the focus on consumer research in green products and green consumer behaviour [17]. However, when review the preliminary studies in term of product sectors in sustainable agenda, we discover that the research focus is quite uneven. In the past decade (2008-2018), more than 60% of the papers focused on the food sector [2]. Fewer researchers interest in other categories such as furniture and cleaning products, household appliances and clothing. Thus, there is a need to fulfil this gap in knowledge regards to these sectors.

In industrial sectors, except agriculture, the textile and fashion industry used the most amount of water in its processes. It also produces enormous amounts of toxic into the environment [9]. Not only the producing process but also the using product process have serious environmental impacts. Fletcher stated that up to 82% of the energy consumption related to a garment's post purchase laundering [15]. According to a report in UK in 2012, £10 billion worth of UK consumers' clothes became waste and went to the landfill, while the amount of total unworn clothes was 3 times than that. Consumers themselves consider committing to sustainable clothing equals to limited clothes purchasing. Yet even consumers committed to sustainable clothing lack awareness of the sustainability issues in clothing care, with their interpretation of sustainable clothing limited to purchasing [5].

Nevertheless, there is an increasing number of sustainable apparel product consumer in recent years. They became more and more aware of their shortcomings in knowledge of sustainable clothing purchasing and the consequences of their own consumption decisions [19]. On the other hand, fashion companies started to engage in sustainability practices, such as the "Five-R" programs [12]. Even the fast-fashion giant, such as H&M, strongly emphasizes their commitment to sustainability. For example, H&M introduced a product lines called "Conscious", in which the garment must made of at least 50% sustainable material. [21]. In fact, fashion companies are under pressure shifting their traditional performances to a more sustainable way, while still maintain making profit. Therefore, concerns have risen in those businesses that which is customer's criteria when choosing a sustainable apparel product.

In general fashion field, there has been several studies about clothing selection criteria. Je [29] stated that Korean consumers prefer to have specific requirements for design, style and trend of an outdoor wear garment. Meanwhile in the US market, Kawabata and Rabolt [30] concluded that female university students tend to care for fit, quality, fashion and brand/designer. On the other hand, in the sustainable fashion area, some initial work was carried out just in recent years. Chan and Wong [8] found that the consumers' eco-fashion purchasing decision positively affected by store-related attributes such as customer service and store design and environment. However, in the best of our knowledge, there has not been any comprehensive study that focused on product-based attributes (instrumental attributes) of sustainable apparel product. Moreover, previous work has only focused on identifying the attributes in in general, rather than determine the importance weight of each attribute.

This research aims to investigating two research questions from the point of view of expert researchers, influencers and practitioners from the clothing industry.

RQ1: What is the key instrumental attributes and sub attributes of a sustainable apparel product for consumer's consumption decision?

RQ: What is the relative importance of the key instrumental attributes and sub attributes?

Contributions focus on providing a theoretical understanding of consumer behaviour on sustainable fashion and implicated by fashion companies.

2. Literature Review

There are several sustainable purchase behaviours which consumer can engage in. For example, that can be purchasing vintage clothes (see Hardy [23]) and apply “slow fashion” concept instead of fast-fashion (see Clark [13]). Another trend for customers who have individual style in fashion, is purchasing environmental clothing (see Cho et al. [11]). Goworek et al. [20] described sustainable clothing as “*clothing which incorporates one or more aspects of social and environmental sustainability, such as Fair Trade manufacturing or fabric containing organically-grown raw material*”. On the other hand, consumer perceived the definition of sustainable fashion including these important aspects: Ethical/sustainable design; Encourage fair trade, fair wages; Aware of harmful materials; Environmental standards; Human rights/working conditions (see Henninger et al. [24]).

When making a purchase decision, consumers will compare different choice alternatives based on criteria. Another name for criteria is attribute (see Blackwell et al. [4]). There are two types of attributes: ones related to utility (such as price, quality, brand, etc.) and the others related to hedonism (such as status, pleasure, social pressure, etc.) [31]. The ones related to utility are named instrumental attributes. Consumers evaluate this type of attributes based on logic [1]. They research each attributes and try to maximize the function of the product [34]. This research focus on instrumental attributes in consumer’s making decision in purchasing sustainable apparel product. These attributes, found in previous research, included price, quality, style/design, environmental concern information and label.

Iwanow et al. [28] suggested that in sustainable clothing consumption, price is considered the most important issue. Consumers would favour price over awareness of child labour when making purchase decision. From the point of view of consumer, a price of a product is considered as a type of cost. The basic logic of decision is to assess the cost and compare with the received benefits (see Zimmerman [43]). In additions, affordability will take into account in term of price criteria as well (see Hancock [22]).

Quality has been studied in several research in sustainable development field. Carey and Cervellon [6] stated that quality is one of the most crucial criteria in ethical fashion consumption. Forsythe et al. [16] found that consumers in China and South Korea rely on the physical quality to evaluate a garment. In the quality aspect, comfort plays a very important role in clothing evaluation, selection and consumption. For example, comfort was considered as the most important product cue for evaluating tennis wear (see Chae et al. [7]) and sleepwear in the USA (see Labhard and Morris [33]). On the other hand, material of an apparel product is perceived as a safety measurement criteria. During design and producing process, designers will excluded unsafe materials and use safer materials (see Chet et al. [10]). In sustainable fashion, sustainable material prefers as being made from nature or recycled process. The aim is to reduce bad impacts during production process and to environment. In addition, durability of a garment has a close relationship with sustainability. By increasing the product lifetime, consumer could spend less, save more resources and reduce waste into environment [41].

The basic function of clothes is protecting human body. However, according to the study in 2011, Gibson and Stanes [18] indicated clothing as a cultural symbol. It also is

Table 1: Instrumental attributes in sustainable apparel product consumption.

Attributes	Sub-attribute	Definition
Price	Benefits received	Benefits which customer can get in proportion to the cost
	Affordability	A price that customer can pay without hurting their financial ability
Quality	Material	Made from non-toxic material for health
	Durability	Being able to last for a long time without becoming damaged
	Comfort	Being physically relaxed and free from pain
Aesthetic	Style	Polular at this time
	Colour	Colour of the product
Environmental concern information	Production process	the way to manage how products or suppliers' products are produced
	Product afterlife	The way to manage product after usage lifecycle
Label	Standards and certifications	Standards and certifications given to a product that specific conditions have been met in the process of producing
	Country of production	The country where in the product was made
	Brand	A name, term, design, symbol, or any other feature that identifies the product

a way of expressing self-identity, creativity and socio-economic status. Wall and Heslop [42] found that aesthetics, including style and colour, were suggested more important than functional cues in selecting general women's clothing. Even though in term of sustainable fashion, the importance of aesthetic attributes has not been studied yet, it is still reasonable to assume that colour and style has strong impact on customer's purchasing decision.

More and more information about product's impact on environment is available, so that consumer can check before purchasing. Thus, environmental concern information of a product is one of the criteria for making decision. In 2020, Lenzing group, an international sustainably produced fibers company, conduct a survey about conscious consumers' perceptions and behaviours on sustainable apparel products. It was found that consumers would seek the information about production process before buying. They want to make sure that the garment they buy is made from a human and eco-responsible process. In addition, brands that transparent information about the product afterlife will increase the level of trust within consumers. For examples, products, which are described as "recyclable" or "biodegradable" afterlife, will make a good impression

on consumers [35].

Label includes brand name, country of origin and standards and certifications. Brand name can recover consumers' memory and gave the product an impression of, such as, "durable", "comfortable", "reliable" and "fashionable" (see Rowley [38]). However, Rahman et al. [37] found that consumers, especially China and Canada, ranked brand name as the second-least-important evaluative cue among other product cues.

On the other hand, there is controversial research results about whether country of origin is crucial in purchasing decision. Cordell [14] stated that country of origin is a critical attribute for judging durable goods. However, when the consumers are familiar with the products, they do not rely much on country of origin to evaluate the product quality (see Hock and Deighton [25]).

Finally, certifications appeared give consumer an instant information whether this garment is ethical. It is quite helpful when consumer do not have time to do in-depth research [3]. Certification is a verification from an accredited organization to a product which meet their required standards. In fashion industry, some popular sustainable certification could be Global Organic Textile Standard (GOTS), Fair Trade Certified or PETA Approved Vegan. Table 1 summarizes the instrumental attributes, sub-attributed and their definitions.

3. Methods

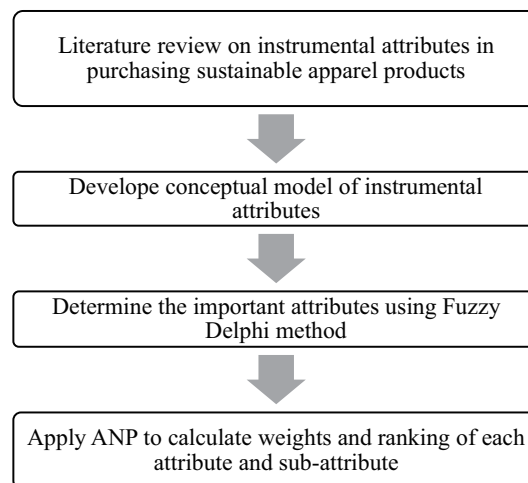


Figure 1: Research process.

3.1. Fuzzy Delphi method

Fuzzy Delphi method was proposed in 1993 by Ishigawa et al. [27]. It was built by combining the traditional Delphi Method and Fuzzy Set Theory. This results being able to determine the distance between the levels of consensus within the expert panel.

Table 2: 9-point Likert scale with triangular fuzzy number.

Scale	Linguistic variables	Triangular fuzzy number
1	Extremely unimportant	(1, 1, 1)
2	Very unimportant	(1, 2, 3)
3	Unimportant	(2, 3, 4)
4	Maybe Unimportant	(3, 4, 5)
5	Unsure unimportant or important	(4, 5, 6)
6	Maybe Important	(5, 6, 7)
7	Important	(6, 7, 8)
8	Very important	(7, 8, 9)
9	Extremely important	(8, 9, 9)

Before Fuzzy Delphi method, traditional Delphi method was widely used in forecasting by doing experts' opinion survey. The member of a panel of experts respond to questions and to each other until reaching agreement on an issue [26]. However, the weaknesses of this technique are costly and time-consuming because it requires several repetitive responses. Moreover, especially with complicated survey, responders lost their interests and declined the survey. The other disadvantage of survey is that responders are uncertain how to interpret their opinion in the accurate way. Linguistic terms, such as "good" or "very good", are usually assigned with number value, such as 4 or 5 in a 5-point Likert scale, respectively. This could lead to inaccurate results if responder want to express the opinion between "very good" and "good", or just a bit slightly more than "good". Therefore, Fuzzy Delphi method was introduced to resolve these issues [27].

The steps to perform Fuzzy Delphi method include:

Step 1: Collecting experts' opinions from the decision-making groups. This step helps to determine the evaluation score from experts, by using 9-point Likert scale.

Step 2: Setting up triangular fuzzy numbers.

Based on the survey result, we convert the linguistic variables of each answer into triangular fuzzy number. The definition of scale for triangular fuzzy numbers was described in Table 2. Because there's more than one expert in a group decision-making, we use this formula, proposed by Kir and Yuan [32], to obtain the mean value:

The evaluation value of the significance of No. j element given by No. i expert of n experts is $\tilde{w}_{ij} = (a_{ij}, b_{ij}, c_{ij})$, $i = 1, 2, \dots, n$; $j = 1, 2, \dots, m$. Then the fuzzy weighting \tilde{w}_j of No. j element is $\tilde{w}_j = (a_j, b_j, c_j)$, $j = 1, 2, \dots, m$. Among which $a_j = \text{Min}\{a_{ij}\}$, $b_j = \frac{1}{n} \sum_{i=1}^n b_{ij}$, $c_j = \text{Max}\{c_{ij}\}$.

Step 3: Defuzzy with this formula $S_j = \frac{a_j + b_j + c_j}{3}$, $j = 1, 2, \dots, m$.

Step 4: Retaining the attributes:

Table 3: Definition and description of the fundamental scale Source: Saaty [40].

Evaluation Scale	Definition	Description
1	Equal importance	Two elements contribute equally to the objective.
3	Moderate importance	Experience and judgement slightly favour one element over the other.
5	Strong importance	Experience and judgement strongly favour one element over the other.
7	Demonstrate importance	An element is favoured very strongly over the other.
9	Extreme importance	The evidence favouring one element over the other is one of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate values between adjacent scales	Compromised values lie between the aforementioned evaluation scales.

By setting the threshold α , proper attributes can be screened out and retained. If $S_j \geq \alpha$, then this attribute is retained. If $S_j < \alpha$, then this attribute is removed.

3.2. Analytic Network Process

In 1978, Saaty developed the Analytic Network Process (ANP) [39]. This method was applied to make decision in uncertain situations with multiple assessment criteria. The result can be achieved through paired comparisons from a 1 to 9 fundamental scale as in Table 2. Unlike Analytic Hierarchy Process (AHP), Analytic Network Process does not require a hierarchical model with specific level. Instead, an ANP model includes two major section: clusters of elements and links which made from a parent factor in a cluster to several elements. There are four steps of ANP, which are described as follows:

- Step 1.** Select the attributes and sub-attributes.
- Step 2.** Construct network and interdependence among attributes and sub-attributes.
- Step 3.** Construct the pairwise comparison matrix between attributes and sub-attributes.
- Step 4.** Solve the super matrix and obtain each attribute and sub-attribute’s weight.

In this step, we multiply the super matrix convergent by itself until the row values of the super matrix converge to the same value for each column of the matrix. After that, attribute and sub-attribute’s weight will be found out.

4. Results

We apply the Fuzzy Delphi method and ANP, respectively, to answer two research questions. The first question is which instrumental attributes and sub attributes of sustainable apparel product for making purchase decision. The second question is how much each attributes and sub attributes’ importance weigh.

4.1. Using Fuzzy Delphi method to screen important attributes and sub attributes

To begin, a survey was distributed to experts in the industry. Those experts have started the sustainable living style for more than 5 years. In addition, any of them are influencers in promoting using sustainable apparel product or working in sustainable fashion industry. They were asked to determine the importance of comparing 5 attributes and 12 sub attributes. A 9-point-scale was used. This survey was firstly tested by 4 experts to ensure every questions being clearly understood, with all the terms was explained. After that, the survey was sent to 15 experts. The responses were converted to triangular fuzzy numbers. Finally, these values were defuzzified and proper factors can be screened out with the threshold $\alpha = 6$. Table 4 shows important items before and after Fuzzy Delphi method screening.

Table 4: Items after Fuzzy Delphi method.

Attributes	Sub-attributes	Min	Average	Max	De-fuzzy	Threshold $\alpha = 6$
Price	Benefits received (C1)	6	7.8	9	7.6	Retained
	Affordability (C2)	6	7.86	9	7.62	
Quality	Material (C3)	7	8.26	9	8.09	
	Durability (C4)	6	7.47	9	7.49	
	Comfort (C5)	6	7.93	9	7.64	
Aesthetic	Style (C6)	3	6.8	9	6.27	
	Colour (C7)	3	6.27	9	6.09	
Environmental concern information (ECI)	Production process (C8)	4	6.47	9	6.48	
	Product afterlife (C9)	4	6.33	9	6.44	
Label	Country of production (C10)	4	6.33	9	6.44	
	Standards and certifications (C11)	4	5.93	9	6.31	
	Brand (C12)	2	4.73	8	4.91	

4.2. Using ANP to determine weight of importance of each items

In ANP, attributes are considered to have dependence relationship among each other. Figure 2 shows the interdependence relationship among attributes. This is the result of collecting opinions from 7 experts after brainstorming process. These questionnaires was integrated into one value by applying the geometric mean $\bar{x}_{geom} = \sqrt[n]{x_1 \cdot x_2 \cdot \dots \cdot x_n}$. The interdependence among attributes is achieved by using pairwise comparison. For example, in Table 5, we asked question "What is the relative importance of Aesthetic when compared to Quality with respect to Price?". The result was filled in the table and

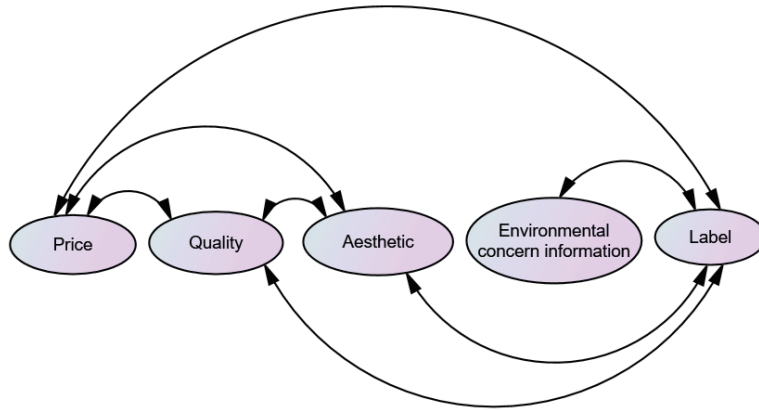


Figure 2: The interdependence among attributes.

we can calculate the relative importance weight (eigenvector) for each attributes. The same process was applied for the rest of 5 attributes.

Table 5: The interdependence matrix of attributes with respect to “Price”.

	Quality	Aesthetic	Label	Weight
Quality	1.000	2.621	6.952	0.617
Aesthetic	0.382	1.000	5.809	0.312
Label	0.144	0.172	1.000	0.071

The attribute weights were used to build the supermatrix as in Table 6. With two attributes have no interdependence, we fill in 0. The supermatrix was inputted to the Super Decisions software for final results. The software will multiply the supermatrix by itself multiple times, until the row values converge to the same value, as in Table 7. Quality is ranked the first, followed by price and aesthetic. Label and ECI are ranked the lowest.

We determine the weights and rank of sub-attributes by repeating the same method. The result is showed in Figure 3 and Table 8. The most important sub-attributes are Affordability (0.24) and Material (0.22). On the other hand, the least important sub-attributes are Colour (0.02) and Production process (0.01).

5. Conclusion and Implications

The main goals of this study are to find the key instrumental attributes and sub attributes of a sustainable apparel product for consumer’s consumption decision and determine their relative importance weights. For the first research question, Fuzzy Delphi

Table 6: The supermatrix of attributes prior to convergence.

	Price	Quality	Aesthetics	ECI	Label
Price	0.000	0.591	0.301	0.000	0.169
Quality	0.617	0.000	0.579	0.000	0.199
Aesthetic	0.312	0.312	0.000	0.000	0.619
ECI	0.000	0.000	0.000	0.000	0.218
Label	0.071	0.096	0.120	1.000	0.000

Table 7: The supermatrix of attributes after convergence.

	Price	Quality	Aesthetics	ECI	Label	Weights
Price	0.29980	0.29980	0.29980	0.29980	0.29980	2
Quality	0.34883	0.34883	0.34883	0.34883	0.34883	1
Aesthetic	0.24811	0.24811	0.24811	0.24811	0.24811	3
ECI	0.00979	0.00979	0.00979	0.00979	0.00979	5
Label	0.09347	0.09347	0.09347	0.09347	0.09347	4

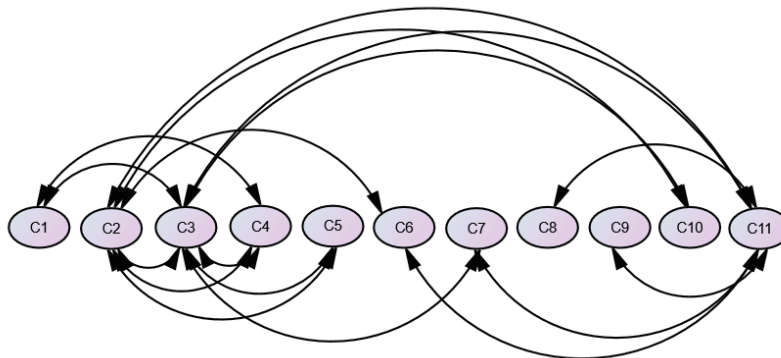


Figure 3: The interdependence relationship among sub-attributes.

method was used to identify the instrumental attributes and sub attributes, based on experts' opinions. The key attributes included price, quality, aesthetic, environmental concern information (ECI) and label. The sub-attributes included benefits received, affordability, material, durability, comfort, style, colour, production process, product afterlife, country of production and standards and certifications.

For the second question, we applied analytic network process to obtain the relative importance weights of each attributes and sub attributes. Our study discovered that experts emphasized more on quality and price of a sustainable apparel product, while label and ECI is the least important. The results also showed that the sub attributes

Table 8: The supermatrix of sub-attributes and their weights.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Weight	Rank
C1	0.00	0.00	0.11	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	8
C2	0.33	0.00	0.10	0.19	0.80	0.50	0.00	0.00	0.00	0.83	0.19	0.24	1
C3	0.67	0.28	0.00	0.68	0.20	0.00	0.75	0.00	0.00	0.17	0.19	0.22	2
C4	0.00	0.11	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	5
C5	0.00	0.22	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	3
C6	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.06	6
C7	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	10
C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.01	11
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.03	9
C10	0.00	0.07	0.14	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.06	7
C11	0.00	0.11	0.13	0.00	0.00	0.50	0.25	0.00	1.00	0.00	0.00	0.11	4

“Affordability” (belongs to the attribute Price) and Material (belongs to the attribute Quality) are the most important ones among 11 sub-attributes.

This study quantified the 5 instrumental attributes and 11 sub attributes in sustainable apparel product consumption. According to the results, sustainable apparel company can clearly understand how these factors should be prioritized when designing the final product, such as and price and quality. Managers should consider satisfying these factors first for customers’ requirement before the others. In addition, this research results could be applied in marketing strategy. For example, customers will pay more attention to apparel products which are promoted as made from good material with affordable price.

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