

**EXPLORE EU RETAILERS' SOURCING STRATEGIES FOR CLOTHING  
MADE FROM RECYCLED TEXTILE MATERIALS**

by

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## **ABSTRACT**

This study examined retailers' sourcing strategies for clothing made from recycled textile materials in the five largest European countries (i.e., the UK, Italy, France, Germany, and Spain) based on an extensive analysis of the country of origin information and product details of thousands of such clothing items for sale in these five EU countries from January 2021 to May 2023. The results show that EU retailers sourced clothing using recycled textile materials from diverse sources, including over 40 developing and developed countries from Asia, America, Europe, and Africa. However, other than assortment diversity, no statistical evidence shows that developing countries had advantages over developed ones regarding product sophistication, replenishment frequency, and pricing in the five EU markets. Additionally, a supplying country's geographic location statistically affects the detailed assortment of recycled clothing EU retailers import. The study's findings offered new insights into the business aspects of recycled clothing and revealed promising global sourcing opportunities for such products. The results also imply a potentially significant shift in global apparel trade patterns as retailers embrace fashion circularity and expand sourcing clothing made from recycled textile materials.

**Keywords:** clothing made from recycled textile materials, textile recycling, EU retailers

## Chapter 1

### INTRODUCTION

#### 1.1 Background

As environmental awareness among consumers grows, retailers in Europe (EU) have expressed a heightened interest in selling clothing using recycled textile materials (i.e., “recycled clothing” in the study). For example, fast fashion giants like H&M and Zara and luxury brands such as Hugo Boss have started carrying recycled clothing, aiming to integrate circularity into their product designs and business models (Obiko-Pearson, et al., 2022; Hugo Boss, 2023). Moreover, the European Union outlined a vision to have apparel placed on the EU market containing substantial recycled textile materials by 2030, implying further growth of the recycled clothing market in the years ahead (European Commission, 2022).

Textile recycling and recycled clothing have also been popular interdisciplinary research topics. For example, existing studies have investigated various textile recycling techniques or the unique design process of using recycled textile materials (e.g., Xie et al., 2021; Eppinger, 2022; Juanga-Labayen et al., 2022). Other studies examined consumers’ shopping behaviors for recycled clothing (e.g., Chaturvedi et al., 2020; Kim et al., 2021; Polyportis, 2022). Additionally, some studies have investigated retailers’ merchandising strategies for clothing made from recycled textile materials (e.g., Botwinick & Lu, 2023). However, where clothing made with recycled

textiles comes from and what its supply chain looks like remains mostly a “black box.” Even fewer studies specifically looked at EU retailers’ sourcing and supply chain strategies for recycled clothing despite the increasing availability and sales of such products in the retail market (European Commission, 2022).

## **1.2 Research question**

This study explores retailers’ sourcing strategies for clothing made from recycled textile materials in five European countries, including the UK, Italy, France, Germany, and Spain. These five countries represent the EU’s largest clothing retail markets, consistently accounting for over 60% of the region’s total apparel sales (Euromonitor, 2023). Specifically, by leveraging unique product-level data collected from EDITED, a big data tool for the fashion industry, the study will examine where recycled clothing sold in these five EU countries came from and factors affecting the sourcing patterns (EDITED, 2023).

The study’s findings fill critical research gaps regarding EU retailers’ sourcing strategies for clothing made from recycled textile materials and offer essential new knowledge about recycled clothing’s supply chains. The study’s findings also provide valuable input for fashion companies interested in expanding recycled clothing sales in the competitive EU retail markets. Additionally, the study’s findings could help policymakers develop appropriate policies supporting EU companies’ efforts to source

more clothing made from recycled textile materials and promote the development of a circular fashion business model.

## Chapter 2

### LITERATURE REVIEW

#### 2.1 Supply chains for making clothing using recycled textile materials

Compared to making clothing from virgin fiber, the supply chains for making clothing using recycled textile materials could be more versatile due to the various methods of creating recycled fibers. For example, Table 2.1 shows that recycled textiles can be produced through mechanical recycling, i.e., shredding and carding used clothing to create new textile fibers (Maris et al., 2018; Costa et al., 2022). Chemical recycling is another commonly adopted method that generally breaks down textile waste into its chemical components and reconstitutes them into new materials (Majumdar et al., 2020). Additionally, certain recycled textiles, like recycled polyester, are often made from plastic bottles through a mechanical process (Thiounn & Smith, 2020).

The distinctive process and characteristics of making clothing using recycled textile materials could impact its production location. Specifically, according to the factor proportion trade theory, countries should specialize in producing goods that intensively use their abundant production factors, such as labor and capital (Sorin, 2019). In general, developing countries abundant with cheap labor are typically

Table 2.1 Methods of Making Recycled Textile Materials

Method	Processes
Mechanical recycling from textile waste	<ol style="list-style-type: none"> <li>1. Collecting textile waste;</li> <li>2. Sorting textile waste based on their fiber type, fabric composition, or color;</li> <li>3. Shredding sorted textile waste into small pieces or fibers</li> <li>4. Cleaning shredded fibers to remove any impurities or containments;</li> <li>5. Carding the cleaned fibers are then carded to separate and align the fibers;</li> <li>6. Spinning the carded fibers into yarns and then weaving them into new fabrics;</li> <li>7. The new fabrics may undergo finishing processes such as dyeing, printing, or coating;</li> </ol>
Chemical recycling from textile waste	<ol style="list-style-type: none"> <li>1. Collecting textile waste;</li> <li>2. Depolymerizing textile wastes into their component polymers through methods such as using acid hydrolysis;</li> <li>3. Purifying the depolymerized polymers to remove any contaminants or impurities;</li> <li>4. Repolymerizing the purified polymers into new long-chain molecules;</li> <li>5. Spinning and weaving the new polymer chains into new textile fibers, yarns and fabrics;</li> <li>6. The new fabrics may undergo finishing processes such as dyeing, printing, or coating;</li> </ol>
Creating recycled textiles from plastic	<ol style="list-style-type: none"> <li>1. Collecting plastic waste, such as PET bottles</li> <li>2. Sorting and cleaning collected plastic waste to remove any labels, caps, or other non-plastic materials;</li> <li>3. Shredding the cleaned plastic waste into small flakes or granules;</li> <li>4. Melting down the shredded plastic and extruding it into long strands or filaments;</li> <li>5. Spinning and weaving the new strands or filaments into new textile fibers, yarns and fabrics;</li> <li>6. The new fabrics may undergo finishing processes such as dyeing, printing, or coating;</li> </ol>

Reference: Maris, J., et al. (2018); Thiounn & Smith (2020); Majumdar et al. (2020); Damayanti et al. (2021); Costa et al. (2022)

involved in making labor-intensive products, whereas developed countries, rich in capital and technology, generally focus on making capital and technology-intensive goods (Siddiqui, 2015; Lu, 2023).

Unlike making virgin textile fiber mainly using automated machines, producing recycled textile waste requires both significant labor and capital input. For example, studies found that collecting and sorting textile waste remains highly labor-intensive due to limited technology and the complexity of separating different fiber content (Ho & Cao, 2019; Juanga-Labayen et al., 2022). However, companies usually rely on expensive and specialized machinery to mechanically or chemically transform sorted textile waste into recycled fibers and further process them into new yarns and fabrics (Bhatia et al., 2014). Further, studies found that cutting and sewing recycled fabrics into clothing has no significant difference from making clothing using virgin fibers, and it remained a labor-intensive process (Bukhari et al., 2018; Lu, 2023).

Therefore, in theory, countries at different economic development stages could get involved in the supply chain of making clothing using recycled textile materials (EDITED, 2023). Studies such as Bukhari et al. (2018), Koszewska (2018), Luu et al. (2021), and Lu (2023) also indicate that countries around the world, from Asia, EU, America to Africa covering both developed and developing economies, have engaged in making and exporting clothing using recycled textiles.

## **2.2 EU retailers' apparel sourcing strategies**

As EU retailers typically treat clothing made from recycled textile materials as part of their product assortment, companies' sourcing criteria and strategies for regular clothing could also apply to clothing made from recycled textile materials (Eppinger, 2022; Lu, 2023). In general, EU retailers' apparel sourcing strategies have several unique features.

First, EU retailers considered various factors when deciding where to source apparel products. As apparel retailing is a buyer-driven industry, EU retailers must strike a delicate balance to meet consumers' diversified demand regarding product assortment, quality standards, pricing, and delivery speed (Perry & Wood, 2018; Gereffi, 2019). For example, European apparel retailers, especially those targeting the mass and value market segments, regard cost and product quality as essential vendor selection criteria. These factors directly impact apparel retailers' ability to survive in the highly competitive market with relatively low-profit margins (Lorentz et al., 2015; Perry et al., 2015). Meanwhile, studies such as Akesson et al. (2007) and Taplin (2014) found that in response to market uncertainties, some European apparel retailers increasingly prefer suppliers that could offer sourcing flexibility and agility, i.e., allowing the adjustment of order quantities and product details within a short timeframe. Working with such vendors would provide apparel retailers several potential benefits, from optimizing inventory levels and accurately responding to market demand to increasing profit margins (Madhani, 2017).

Further, with consumers' growing awareness of the fashion industry's environmental impact and garment workers' well-being, EU retailers commonly consider environmental and social compliance risks in their sourcing decisions (Park & Lennon, 2006; Turker & Altuntas, 2014). Most studies agree that effectively controlling compliance risks in sourcing helps fashion companies protect their brand images and avoid potential supply chain disruptions (Perry, 2017; Lu, 2022). Likewise, in recent years, EU fashion companies have pulled out of specific sourcing destinations, such as Cambodia and Myanmar, primarily because of rising social responsibility concerns (Tanaka, 2022).

Second, EU retailers adopt a diverse sourcing base for their apparel products. For example, trade statistics show that apparel sold in the EU came from over 100 countries, covering both developed and developing economies globally (UNComtrade, 2023; Eurostat, 2023). Firm-level data also indicates that leading EU apparel retailers typically source from more than ten countries, and many continue to develop a more diverse sourcing base for whatever reasons (Gereffi, 2019; Harper & Pal, 2022).

Two factors contribute to EU apparel retailers' sourcing diversification strategy. On the one hand, studies show that no single sourcing destination can perfectly meet all of the primary sourcing criteria an apparel retailer sets (Handfield et al., 2020; Lu, 2022). Instead, like their peers in the United States, EU apparel retailers commonly source from various countries that can collectively serve companies' sourcing needs, such as competitive sourcing costs and fast speed to market (Arrigo, 2021; Sumarliah et al., 2021). On the other hand, compared to "putting all eggs in one

basket,” sourcing diversification, primarily geographically, allows EU apparel retailers to control various supply chain risks better, such as potential shipping delays and unexpected imposition of new trade barriers (Whitney et al., 2014).

Table 2.2 Sources of EU Apparel Imports (by value)

Exporters	2010	2015	2019	2021	2022
Intra-EU	43.5%	43.6%	47.3%	50.9%	48.2%
China	24.8%	20.2%	15.6%	15.3%	15.8%
Bangladesh	5.0%	8.6%	9.3%	8.6%	10.7%
Turkey	6.6%	5.9%	5.5%	5.6%	5.7%
India	3.6%	3.3%	2.7%	2.2%	2.5%
Vietnam	1.1%	1.8%	2.0%	1.9%	2.3%
Others	15.5%	16.6%	17.6%	15.3%	14.8%

Data source: Eurostat (2023). “Apparel” refers to the Standard International Trade

Classification (SITC) code 84. “EU” covers the 27 European Union members (excluding the UK).

Third, near-sourcing is a notable strategy among EU apparel retailers. Table 2.2 shows that, in value, around half of EU countries’ apparel imports consistently came from within the EU over the past decade, known as the EU intra-region trade (Lu, 2018; Eurostat, 2023). The firm-level analysis of EU apparel retailers’ detailed supplier base also indicates that near-sourcing from within the EU region was common, whether for fast fashion retailers like Zara and H&M or luxury brands such as Hugo Boss (Aftab et al., 2018; Arrigo, 2021; Hugo Boss, 2023).

Several factors supported EU apparel retailers’ near-sourcing pattern. One was the EU region’s relatively complete textile and apparel supply chains. For example,

several Western EU countries, such as Italy, Germany, and France, are known for their long history and skilled craftsmanship in making textiles and apparel products, especially those targeting the high-end market (Eurostat, 2023; Pasquinelli, 2023). Meanwhile, Eastern EU countries like Romania and Poland have long been significant clothing exporters serving the EU market, and they typically use textile supplies from Western EU countries (Plank & Staritz, 2015; Sadowski et al., 2021). Second, near-sourcing enables EU apparel retailers to enjoy several advantages over sourcing from distant locations outside the region, such as shorter lead times, greater sourcing flexibility, and a more sustainable business model achieved through a reduced carbon footprint (Cagliano 2013; Leal Filho, et al., 2019; López, et al., 2022). Additionally, near-sourcing allows EU apparel retailers to enjoy relatively lower tariffs and non-tariff barriers for their apparel imports, thanks to the customs union and other regional trade arrangements among EU countries (Lu, 2018; WTO, 2023).

Furthermore, numerous studies indicate that EU apparel retailers often use near-sourcing from within the EU region for specific product and sourcing goals. For example, Hammer and Plugor (2016) and López et al. (2022) found that EU fashion retailers typically sourced clothing items that require a smaller volume but faster turnaround locally from the EU. Meanwhile, studies by Gereffi (2019) and Arrigo (2021) argue that due to EU countries' higher wage levels, clothing "Made in the EU" is more likely to target the premium and luxury markets as a means to offset the higher production costs. In contrast, it remains common for EU retailers to rely on Asia as

their primary sourcing destination for cheaper clothing targeting the mass and value markets (Malik et al., 2021).

### **2.3 EU retailers' sourcing strategies for clothing made from recycled textile materials**

In summary, trade theories and past studies suggest that EU retailers' sourcing strategies for clothing made from recycled textile materials could be affected by the supplying countries' geographic location and economic development level and demonstrate several unique patterns:

*Hypothesis 1: EU retailers would source clothing made from recycled textile materials from diverse sources.*

On the one hand, there seems to be no “perfect” sourcing destination for clothing made from recycled textiles due to its complex supply chain requiring both intensive labor and capital input (Ho & Cao, 2019; Juanga-Labayen et al., 2022). Thus, it is likely that EU retailers may rely on a diverse sourcing base that collectively meets their sourcing demand for such products. On the other hand, retailers mainly treat clothing made from recycled textile materials as part of their total product assortment and apply the same vendor selection criteria as regular clothing using virgin fibers (Lu, 2023). Therefore, similar to the case of regular clothing, sourcing diversification would more easily allow EU retailers to achieve essential sourcing objectives, ranging from costs, speed to market, and flexibility to compliance risks

when importing clothing made from recycled textiles (Pandit et al., 2019; Nguyen et al., 2022).

*Hypothesis 2: Near-sourcing would be a critical component of EU retailers' sourcing strategies for clothing made from recycled textile materials, especially those targeting the luxury or premium market.*

For several reasons, EU retailers would source clothing made from recycled textile materials locally from within the EU. One factor is the readily available local supply chain, supported by a relatively abundant supply of textile waste in the EU, one of the world's largest apparel consumer markets, and the capability of EU countries to produce recycled textile raw materials and finished garments (Juanga-Labayen et al., 2022; Harper & Pal, 2022). Meanwhile, EU policy directives mandating increased offerings of apparel products made from recycled textile materials could incentivize investments to strengthen the region's local manufacturing capacity for such products (European Commission, 2022; Amicarelli & Bux, 2022). Additionally, given the EU's reputation for producing luxury apparel items, it is reasonable to speculate that retailers may employ a similar strategy for clothing made from recycled textile materials to mitigate the relatively higher production costs in the EU (Blancheton, 2021; Pasquinelli, 2023).

*Hypothesis 3: A supplying country's economic advancement level could affect the product assortment of recycled clothing imported by EU retailers.*

The cutting and sewing process of making clothing from recycled textiles has no significant difference from using virgin fibers (Bukhari et al., 2018; Lu, 2023).

Thus, based on the factor proportion trade theory, a country's economic advancement level theoretically could affect the characteristics of the recycled clothing it produces (Romalis, 2004). For example, as garment manufacturing has mostly shifted to developing countries with abundant skilled labor forces, developing nations could enjoy an advantage in producing a wider range of recycled clothing categories than developed economies (Saha et al., 2022; Guo et al., 2020). Meanwhile, EU retailers may source recycled clothing with a deeper assortment (e.g., more color or sizing choices) from developing countries, given developing countries' overall superior garment manufacturing capabilities and flexibility over developed economies (Nayak et al., 2015; Lu, 2022).

However, it remains uncertain whether EU retailers would view developing countries as cost-effective sourcing destinations for clothing made from recycled materials. For example, EU retailers' limited sourcing volume for recycled clothing could potentially undermine the economies of scale advantages developed countries enjoy over developed ones in garment manufacturing (Botwinick & Lu, 2023). Easier access to a more abundant supply of textile waste could also assist developed countries in reducing transportation costs in making clothing using recycled textile materials despite their significantly higher labor costs (Rathinamoorthy, 2018; Repp et al., 2021).

## Chapter 3

### METHODS

#### 3.1 Data source

The study collected data from EDITED, an industry database that captures detailed product assortment information of clothing items sold in the EU retail market at the Stock-Keeping Unit (SKU) level (EDITED, 2023). Different from macro-level government statistics and aggregated industry-level data, EDITED's datasets provides unique insights into the country of origin information and detailed product-level features of a clothing item available in the EU market, including those made from recycled textile materials. The unique features of the dataset allow us to analyze companies' specific sourcing strategies for such products.

Specifically, based on the latest data available, 5,000 SKUs of clothing items made from recycled textile materials for sale in the UK, Germany, Italy, France, and Spain retail markets between January 2021 and May 2023 were randomly selected by EDITED. These samples explicitly mentioned on the product labels that they were "100% made from recycled textile materials." Random sampling helps ensure that the selected samples closely resemble the population and enables statistical inference for the results (Todorov & Filzmoser, 2010). Also, the 2.5-year period covered by the samples was long enough to reveal EU retailers' relatively stable sourcing patterns (Botwinick & Lu, 2023).

In conducting the study, data regarding the product assortment, pricing, and country of origin for each clothing item were extracted from the raw data provided by EDITED. Specifically:

- *Assortment diversity*: the number of Stock Keeping Units (SKUs) available for the clothing item. A higher *assortment diversity* value (i.e., having more sizing or color options) indicated that a clothing item's assortment was deeper and more diverse (Wang & Vakratsas, 2021).
- *Product sophistication*: the sophistication of sewing and making the garment. Based on EDITED's categorization, the value of *Product sophistication* was assigned as simple products (i.e., T-shirts and socks)=1; medium sophisticated products (i.e., bottoms and tops excluding T-shirts)=2; sophisticated products (i.e., outerwear and dresses)=3.
- *Replenishment*: the number of replenishment of a clothing item during the examined period.
- *Market segment*: the clothing item's target market. According to EDITED's classification, the value of *Market segment* was assigned as follows: value market in the EU =1; mass market in the EU =2; premium market in the EU=3; luxury market in the EU=4.
- *Retail price*: this refers to a clothing item's original retail price based on EDITED's information.

- *Development*: based on a clothing item's country of origin information, if the garment was made by a developed country=1 and if the garment was made by a developing country=0. The country classification was based on the United Nations (2022) standards.
- *Region*: the geographic location of where the clothing item was made, such as Europe and Asia (United Nations, 2022).

### **3.2 Data analysis**

The study adopted the multivariate analysis of variance (MANOVA) method to analyze the data and test the hypotheses. MANOVA is a commonly used statistical method for comparing the mean values of observation vectors and assessing the degree of difference between groups.

Compared to other methods, such as Analysis of Variance (ANOVA), MANOVA offers the advantage of handling multiple dependent variables within the model without inflating Type I errors (Todorov & Filzmoser, 2010).

Corresponding to the study's hypotheses, MANOVA could evaluate whether retailers in the five EU countries set differentiated product assortments for clothing made from recycled textile materials based on a supplying country's geographic location and economic development level. Specifically, the dependent variables included the following four that measure a clothing item's detailed product features, i.e., *Assortment diversity*, *Product sophistication*, *Replenishment*, *Market segment*, and

*Retail price*. Meanwhile, independent variables included *Development* and *Region*, which represent country groupings.

## Chapter 4

### RESULTS AND DISCUSSIONS

#### 4.1 Descriptive analysis

A total of 4,159 clothing items made from recycled textile materials and indicated their country of origin were included in the analysis. As summarized in Tables 4-1, 4-2, and 4-3:

Table 4.1 Sources of Apparel Made from Recycled Textile Materials

Country	Region	Development	Observations	Percent
China	Asia	Developing	1,330	31.0%
Italy	Europe	Developed	591	13.8%
Portugal	Europe	Developed	327	7.6%
India	Asia	Developing	216	5.0%
Vietnam	Asia	Developing	206	4.8%
Bulgaria	Europe	Developing	198	4.6%
Japan	Asia	Developed	162	3.8%
Canada	America	Developed	142	3.3%
Romania	Europe	Developed	131	3.1%
UK	Europe	Developed	127	3.0%
Mexico	America	Developing	113	2.6%
Colombia	America	Developing	63	1.5%
Spain	Europe	Developed	58	1.4%
USA	America	Developed	54	1.3%
Europe	Europe	Developed	54	1.3%
France	Europe	Developed	45	1.0%
Turkey	Europe	Developing	43	1.0%
Hungary	Europe	Developed	38	0.9%
Indonesia	Asia	Developing	32	0.7%
Morocco	Africa	Developing	31	0.7%
Thailand	Asia	Developing	28	0.7%
Nicaragua	America	Developing	28	0.7%
Sri Lanka	Asia	Developing	24	0.6%
Tunisia	Africa	Developing	17	0.4%
Greece	Europe	Developed	16	0.4%
El Salvador	America	Developing	15	0.3%
Cambodia	Asia	Developing	13	0.3%

Poland	Europe	Developing	9	0.2%
Lithuania	Europe	Developed	7	0.2%
Indonesia	Asia	Developing	7	0.2%
Germany	Europe	Developed	6	0.1%
Bangladesh	Asia	Developing	5	0.1%
Albania	Europe	Developing	4	0.1%
Czech Republic	Europe	Developed	4	0.1%
Denmark	Europe	Developed	4	0.1%
Myanmar	Asia	Developing	3	0.1%
Nepal	Asia	Developing	2	<0.1%
Kenya	Africa	Developing	2	<0.1%
Madagascar	Africa	Developing	2	<0.1%
Taiwan	Asia	Developed	2	<0.1%

Table 4.2 Descriptive Analysis by Region

Variables	Asia (N=2,030)	America (N=415)	Europe (N=1,662)	Africa (N=52)
<i>Assortment diversity</i>	5.46	5.63	4.95	5.77
<i>Product sophistication</i>	2.78	2.22	2.49	1.91
<i>Replenishment</i>	0.16	0.30	0.12	0.16
<i>Market segment</i>	2.85	3.16	3.28	3.40
<i>Retail price</i>	\$379.59	\$401.41	\$657.91	\$195.51

Table 4.3 Descriptive Analysis by Economic Development

Variables	Developing countries (N=2,519)	Developed countries (N=1,640)
<i>Assortment diversity</i>	5.81	4.45
<i>Product sophistication</i>	2.70	2.47
<i>Replenishment</i>	0.18	0.10
<i>Market segment</i>	2.98	3.28
<i>Retail price</i>	\$387.28	\$642.90

First, consistent with Hypothesis 1, retailers from the five EU countries imported clothing using recycled textile materials from a wide range of sources. Specifically, Table 4-1 illustrates that the sampled clothing items originated from a total of 40 nations, encompassing both developed and developing economies across

the EU, Asia, America, and Africa. The results echo the findings of previous studies, suggesting that making clothing using recycled textile materials has already become a global phenomenon, offering many sourcing options for EU retailers worldwide (Lu, 2023).

However, unlike the trade pattern for regular clothing made from virgin fibers, for which labor-abundant developing countries dominate the exports, a much higher percentage (i.e., 40%) of clothing made from recycled textile materials came from developed economies in the samples (UNComtrade, 2023; EDITED, 2023). The result could be attributed to the unique supply chain composition and labor and capital requirements of producing clothing using recycled textile materials, making it more likely for advanced economies to make such products (Bukhari et al., 2018).

Second, consistent with Hypothesis 2, the results indicated that near-sourcing from within the EU played a critical role in EU retailers' sourcing strategy for clothing made from recycled textile materials. For example, Table 4-1 shows that more than fifteen EU countries produced and exported clothing using recycled textile materials in the samples, including many prominent traditional apparel exporters in the region like Italy, Hungary, Portugal, and Romania (UNComtrade, 2023).

Moreover, Table 4-2 indicates that clothing made from recycled textile materials produced by EU countries differed from those from other regions. For example, on average, EU-made products had the highest value in the variable *Market segment*, suggesting they were more likely to target luxury and premium consumers. Likewise, EU-made products also reported a much higher average retail price

(variable *Retail price*) than those sourced from other regions like Asia. EU apparel manufacturers' relatively higher production costs and long-time strengths in making luxury items could be important factors behind the phenomenon (Pasquinelli, 2023).

However, Table 4-2 suggests that clothing made from recycled textile materials locally sourced from the EU, on average, offered fewer color or sizing choices than those from other regions (variable *Assortment diversity*). Likewise, there is no clear evidence that EU-made recycled clothing received more frequent replenishment than those products imported from Asia, America, and Africa (variable *Replenishment*). Thus, EU retailers' selection of sourcing destinations for clothing made from recycled materials and each region's strengths and weaknesses in making such products appear more sophisticated than what was suggested theoretically (Gereffi, 2019; Harper & Pal, 2022).

Third, consistent with Hypothesis 3, Table 4-3 revealed nuanced differences in product characteristics of clothing made from recycled textile materials sourced from developing and developed economies. For example, on average, products made by developing countries offered broader assortment choices (variable *Assortment diversity*) and focused on relatively more sophisticated categories (variable *Product sophistication*). In comparison, on average, products sourced from developed economies included more luxury and premium items (variable *Market segment*) and were priced higher than those from developing countries (variable *Retail price*), possibly due to the different costing structures (Chakraborty & Biswas, 2020; Lu, 2023). However, statistical analysis needs to be conducted further to confirm the

apparent differences in product characteristics between developed and developing countries for clothing made from recycled textile materials.

#### 4.2 Statistical analysis

The Box's test for equality of covariance revealed that at the 99% confidence level ( $p$ -value  $<.01$ ), the collected samples in the study did not fully satisfy the assumption of equal covariance, a typical challenge when dealing with a large dataset (Katsikea & Skarmeas, 2003). Therefore, Pillai's trace test was conducted for the MANOVA analysis to ensure robust statistical results (Sarma & Vardhan, 2018, pp. 74-81).

Table 4.4 Results of the MANOVA Main Effect Test

Statistics/Variables	<i>Development</i>	<i>Region</i>
Pillai's trace	3.78 (0.00)**	19.39 (0.00)**
Wilks' lambda	3.78 (0.00)**	19.61 (0.00)**
Hotelling-Lawly trace	3.78 (0.00)**	19.78 (0.00)**
Roy's greatest root	3.78 (0.00)**	19.39 (0.00)**

Note: Number in the bracket is p-value; \* $p < .05$ , \*\* $p < .01$

First, as Table 4-4 shows, MANOVA's main effect was statistically significant at the 99% confidence level for the variables of *Development* and *Region* ( $p$ -value  $< .01$ ), as determined by Pillai's trace test. These findings corroborate the proposed hypotheses, demonstrating that an exporting country's economic development level

and geographic location influenced the clothing products made from recycled textile materials sourced by EU retailers from that specific country.

Table 4.5 Results of Between-subjects Test F-value

<i>Variables</i>	<i>Development</i>	<i>Region</i>
<i>Assortment diversity</i>	12.55 (0.00)**	62.95 (0.00)**
<i>Product sophistication</i>	0.04 (0.08)	7.24 (0.00)**
<i>Replenishment</i>	2.99 (0.99)	10.24 (0.00)**
<i>Market segment</i>	0.00 (0.99)	5.45 (0.00)**
<i>Retail price</i>	3.25 (0.07)	20.68 (0.00)**

Note: Number in the bracket is p-value; \* $p < .05$ , \*\* $p < .01$

Next, the between-subjects test was performed to examine which of the five dependent variables assessing EU retailers' product assortment contributed to the statistically significant main effect observed in the MANOVA test. Regarding a country's economic advancement level (variable *Development*), only the variable *Assortment diversity* was suggested to be statistically significant between developing and developed countries. In other words, no statistical evidence shows that developing countries have advantages over developed countries for clothing made from recycled textile materials in the EU market regarding product sophistication, replenishment frequency, and pricing. Meanwhile, the results indicate that from a statistical standpoint, EU retailers acquired clothing made from recycled textile materials with

unique regional characteristics, including variations in product sophistication, assortment diversity, market segmentation, and pricing.

Table 4.6 Results of Post Hoc Comparisons (Tukey's HSD test)

Comparison	<i>Assortment diversity</i>	<i>Product sophistication</i>	<i>Replenishment</i>	<i>Market segment</i>	<i>Retail price</i>
Asia vs. America	-0.16 (0.45)	0.56 (0.00)**	-0.13 (0.00)**	-0.30 (0.00)**	-21.83 (0.91)
Asia vs. Europe	0.52 (0.00)**	0.29 (0.00)**	0.04 (0.07)	-0.42 (0.00)**	-278.32 (0.00)**
Asia vs. Africa	-0.30 (0.75)	0.88 (0.00)**	-0.28 (0.00)**	-0.54 (0.00)**	184.07 (0.21)
America vs. Europe	0.68 (0.00)**	-0.27 (0.00)**	0.17 (0.00)**	-0.12 (0.05)*	-256.49 (0.00)**
America vs. Africa	-0.14 (0.97)	0.31 (0.19)	-0.15 (0.24)	-0.24 (0.28)	205.32 (0.16)
Europe vs. Africa	-0.82 (0.038)*	0.58 (0.00)**	-0.32 (0.00)**	-0.12 (0.79)	462.39 (0.00)**

Note: Number in the bracket is p-value; \* $p < .05$ , \*\* $p < .01$

Third, the Post Hoc test was then conducted to delve deeper into whether EU retailers establish distinct product assortments for items imported from individual world regions. (Stevens, 2012, p.184-187). Table 4-6 shows several notable patterns.

1. Regarding *Assortment diversity*, the results suggested no statistically significant difference between clothing items made in Asia, America, and Africa at the 99% confidence level ( $p\text{-value} > .05$ ). However, EU-made clothing items had the least assortment diversity (i.e., sizing and color options) statistically ( $p\text{-value} < .01$ ). These results could be affected by the specific types of products EU retailers imported from each region.

2. In terms of *Product sophistication*, the results indicate that EU retailers' imports from Asia encompassed more sophisticated product categories, such as outerwear, compared to other world regions, with statistical significance at the 99% confidence level ( $p\text{-value} < .01$ ). Conversely, EU retailers' imports from the Americas and Africa comprised simpler product categories, such as T-shirts or socks, statistically more than other world regions ( $p\text{-value} < .01$ ). Moreover, clothing made from recycled textile materials locally sourced from EU, on average, featured less sophisticated categories than those from Asia but were more sophisticated than imports from the Americas and Africa, with statistical significance at the 99% confidence level ( $p\text{-value} < .01$ ).
3. Concerning variables *Market segment* and *Retail price*, the findings indicated that EU retailers' imports from Asia and America primarily included lower-priced products for the mass and value markets, with statistical significance at the 99% confidence level ( $p\text{-value} < .01$ ). Conversely, garments imported from EU and Africa featured a more significant proportion of higher-priced items targeting the luxury and premium markets, also with statistical significance at the 99% confidence level ( $p\text{-value} < .01$ ).

## Chapter 5

### Conclusions and Futures Research Agenda

#### 5.1 Conclusions

Based on an analysis of thousands of clothing made from recycled textile materials for sale in five European countries from January 2021 to May 2023, the study allows for a better understanding of where recycled clothing comes from and the factors affecting retailers' sourcing patterns. The results show that 1) EU retailers source clothing made from recycled textile materials from diverse sources and 2) a country's economic advancement level affects the type of products that EU retailers import from them, especially in terms of the assortment variety of products.

With this, EU retailers source clothing made from recycled textile materials from different countries with different priorities. For example, from Asia, EU retailers typically source more sophisticated products that target the mass market. From the Americas (North, South, and Central), retailers typically source more simple products that target the mass and value market. From Europe, EU retailers source sophisticated products for the luxury or premium market. Meanwhile, from Africa, EU retailers source simple products sold in the luxury/premium market.

Ultimately, it can be concluded that clothing made from recycled textile materials being sold in the five European countries is coming from a wide range of diverse sourcing destinations. Moreover, differing geographic locations of these

sourcing destinations is the main factor that affects the various sourcing patterns for European retailers.

## **5.2 Implications**

The study's findings filled critical research gaps and enhanced our understanding of EU retailers' sourcing strategies for clothing made from recycled textile materials. The findings also offered new insights into the business aspects of recycled clothing, particularly regarding its intricate supply chains and leading suppliers. The study's results have several additional important implications.

First, while existing studies often suggest "local for local" textile recycling, the study's findings revealed promising *global sourcing* opportunities for clothing using recycled textile materials (Cao et al., 2014; Buchel et al., 2022). Particularly, leveraging a diverse sourcing base would allow EU retailers to take advantage of each supplying country's unique production strength regarding product categories and assortment features and more efficiently balance various sourcing factors ranging from costs and flexibility to speed to market. Meanwhile, the study's findings indicate that many countries worldwide have begun producing and exporting clothing using recycled textile materials. As textile recycling technologies advance and manufacturing capabilities expand globally, EU retailers could have more sourcing options for such products (Eppinger, 2022; Lu, 2023).

Second, the study's findings suggest that, unlike the patterns of making regular garments using virgin fiber, low-wage developing countries demonstrated no

noticeable competitive edges over developed economies regarding producing and exporting clothing using recycled textile materials. Instead, according to the study's results, developed economies, including many high-wage Western EU countries, emerged as top suppliers and leading sourcing destinations for recycled clothing (EDITED, 2023). Developed countries' abundant capital and technological resources provided essential support for producing clothing using recycled textile materials (Ho & Cao, 2019; Juanga-Labayen et al., 2022). Thus, expanding clothing production using recycled textile materials presents an exciting economic opportunity with a promising future in developed countries, where many have plans to revitalize the domestic manufacturing sector and establish a sustainable circular economy (European Commission, 2022).

Third, building on the previous point, the sustained commitment of fashion brands and retailers to carry more clothing made from recycled textile materials in their product assortment could hold significant implications for the future landscape of global apparel trade and sourcing patterns. For example, whereas apparel products are predominantly exported from developing to developed countries today, more trade flows could occur between developed economies in the future, attributed to their increasing production capacity and growing demand for clothing using recycled textile materials (UNComtrade, 2023). Similarly, major apparel exporters in Asia, such as China and Bangladesh, might assume a less dominant role as a sourcing base for recycled clothing due to their lack of sufficient infrastructure for efficiently sorting

used clothing and generating high-quality recycled textile materials (Juanga-Labayen et al., 2022; Suarez-Visbal et al., 2023).

### **5.3 Future research agendas**

Future studies can be conducted in the following aspects to continue to explore the supply chain and the business aspects of recycled clothing.

First, while this study examined the origin of finished garments made from recycled textile materials, with new data availability, future research can delve deeper into the supply chain of such products, exploring the locations of tier 2 (i.e., fabric mills) or even tier 3 suppliers (i.e., fiber mills). The results would enhance our understanding of the critical stages of making clothing using recycled textile materials, the key players involved in each production stage, and the implications for trading and sourcing.

Second, due to data limitations, this study was not able to investigate the financial implications of carrying clothing made from recycled textile materials for EU retailers. Future research could collect data through surveys or in-depth interviews with retailers to better understand the financial opportunities and challenges of sourcing clothing made from recycled textile materials, such as the production and shipping costs and the impacts on retailers' profit margins. The results could offer new insights into the business aspects of making and selling recycled clothing and provide a helpful guide for companies interested in entering this growing market.

Additionally, future studies can explore policymakers' roles in promoting EU retailers' sourcing of clothing made from recycled textiles or other sustainable materials. Several EU regulations and policies have been adopted to develop a circular textile industry, such as the EU Strategy for Sustainable and Circular Textiles and the Extended Producer Responsibility (EPR) schemes (European Commission, 2022; European Commission, 2023). Considering EU retailers' intriguing sourcing patterns for clothing made from recycled textile materials, future research could further evaluate the effectiveness of these policies in incentivizing companies' production and sourcing of recycled clothing while building a circular fashion business model.

Note:

1. In this paper, "regular clothing" refers to apparel items that use virgin fiber only and do not contain recycled textile materials.

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