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**l'Université technique d'Iasi (Roumanie) et l'Université de Soochow (Chine)**

**Étude des attentes et de la perception du consommateur sur les  
marques de mode éthique, et de leur lien avec les paramètres textiles  
selon les méthodes Kansai et de l'ACV**

**Study of consumer expectation and perception on ethical  
fashion brands and their relationship with textile parameters  
by using Kansai and LCA approaches**

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# **Study of consumer expectation and perception on ethical fashion brands and their relationship with textile parameters by using Kansai and LCA approaches**

## **Abstract**

Ethical fashion, also called eco, sustainable or slow fashion, has increasingly evolved but remains a niche market. According to marketing studies, the eco-design appearance in terms of environmentally-friendly image or attractiveness fails to support consumer expectations. A successful product design should meet consumer expectations and emotions. Consumer perception and expert knowledge needs to be involved within the evaluation process of ethical fashion. The current research work is mostly based on the exploration of ethical fashion values from a traditional business, marketing or design perspective. Different from this approach, the proposed study originally integrates quantitative consumer emotional and perceptual values towards environmentally-friendly, and detailed analysis into the eco-fashion design approach. This approach has not been studied before and can minimize the gap between expectations and design values of ethical fashion. In this context, new eco-fashion design products will receive broader acceptance in various consumer markets.

In this thesis, the research project presented aims at qualitatively and quantitatively characterizing consumer expectation and consumer perception on ethical fashion in a series of representative textile products and their relations with concerned product design parameters. For this purpose, we proposed four evaluation approaches for acquiring and analyzing relevant human data. These approaches include the following: Firstly, we proposed a consumer focus group determination and a survey questionnaire development in order to characterize the relationship between consumer expectations and design parameters qualitatively. This method is popular for reflecting society and able to gain new insights. Secondly, we designed two sensory experiments to quantitatively characterize human perception and emotions by using sensory engineering and Kansei engineering including the acquisition of expert perceptual data on design parameters and using fuzzy logic in order to characterize more objectively the relationship. Sensory analysis is socio and cultural context independent, whereby Kansei engineering is different from sensory engineering as it is related to human emotions. In order to make ethical fashion products more adapted to consumer

expectations, sensory evaluation has been used to acquire perceptual measurements and Kansei engineering for emotional measurements to improve the design for the concerned products.

These proposed approaches will permit to not only characterize consumer perception on ethical branded fashion products but also identify the credibility of ethical needs. The study can find new insights to improve the understanding of the ethical fashion concept and its impact on consumers and will permit to improve the design by providing designers relevant advice. We proposed a focus group study and survey to explore the ethical fashion concept through modeling and analyzing consumer awareness and knowledge. And, we applied a real case: i.e., consumers from a country with a lower level of sustainable development (Romania). This method includes the selection of the most relevant factors in terms of environmentally-friendly criteria such as eco-materials, aesthetic design, and quality. We generated linguistic eco descriptors from these results.

We used the obtained results in the following quantitative study for quantitative data acquisition. This method enables fashion designers to analyze or further improve the eco-fashion style according to the identified linguistic descriptors on the eco-fashion appearance. We developed the qualitative research model of consumers' awareness by using dimensions of consumer awareness to identify consumer behavior. This approach used open-ended questions to avoid biased responses occurring in multiple-choice questions due to limited knowledge. We could generate the first understanding of consumers' perception. The sensory and Kansei studies mentioned previously will be used to characterize and optimize the design of eco-fashion style based on the eco-product design profile in terms of material and style provided by experts using the identified eco-descriptors. The proposed studies have been tested and analyzed in two real cases: i.e., consumers and experts from countries with a higher level of sustainable development (France and Germany).

Furthermore, we anticipated a gap between real LCA and human perception. In practice, human perceived ethical values are not necessarily consistent with real environmental impacts. We compared the real impacts of a fashion product obtained with life cycle assessment (LCA) methodology with human perception of ethical through the visual appearance of fashion products. However, we found that, by using a simplified life cycle impact assessment (LCIA) for consumer perception and a case study of a T-shirt, the perceived ethical values can roughly cover the environmental impacts obtained from a systematic evaluation.

**Keywords:** Ethical fashion, human evaluation, consumer perception, sensory evaluation, Kansei engineering.

# **Étude des attentes et de la perception du consommateur sur les marques de mode éthique, et de leur lien avec les paramètres textiles selon les méthodes Kansai et de l'ACV**

## **Résumé**

La mode éthique, aussi appelée mode écologique, durable, ou lente, a considérablement évoluée, mais demeure un marché de niche. Selon les études marketing, la notion d'éco-conception ne répond pas aux attentes des consommateurs, que ce soit en termes d'attractivité ou d'image respectueuse de l'environnement. Une conception de produit réussie doit répondre aux attentes et à la perception des consommateurs. Ainsi, le processus d'évaluation de la mode éthique doit inclure l'expertise technique et la perception du consommateur. Les travaux de recherche actuels sont principalement basés sur l'exploration des valeurs de la mode éthique, se distinguant des approches traditionnelles (marché, marketing et design). Les travaux proposés intègrent des données quantitatives sur les émotions et la perception du consommateur, ainsi qu'une analyse détaillée de l'approche d'éco-conception. Cette démarche est mise en œuvre pour la première fois et peut permettre de rapprocher les attentes du consommateur et la conception de la mode éthique. Dans ce contexte, les futurs produits éco-conçus seront mieux acceptés par les divers marchés de consommation.

Dans cette thèse, le sujet de recherche présenté a pour objectif de caractériser qualitativement et quantitativement les attentes et la perception du consommateur sur la mode éthique en les mettant en relation avec une série de produits textiles représentatifs et les paramètres de conception associés. Dans ce but, quatre techniques d'évaluation ont été mises en œuvre pour recueillir et analyser des données humaines fiables. Ces techniques sont les suivantes: Tout d'abord, afin de caractériser de manière qualitative le lien entre les attentes du consommateur et les paramètres de conception, nous avons déterminé un groupe de discussion constitué de consommateurs et avons développé un questionnaire d'enquête. Cette méthode est reconnue comme fiable pour refléter la société et recueillir de nouvelles tendances. Deuxièmement, nous avons conçu deux expériences sensorielles en utilisant l'ingénierie sensorielle et l'ingénierie Kansei pour caractériser quantitativement la perception et les émotions. Cela inclut l'acquisition de données de perception des experts sur les paramètres de conception et l'utilisation de la logique floue pour caractériser plus objectivement leurs liens. L'analyse sensorielle, indépendante du milieu socio-culturel, a permis de mesurer des données

de perceptions et de rendre les produits de mode éthiques plus adaptés aux attentes des consommateurs. Tandis que l'ingénierie Kansei, liée aux émotions humaines, a permis de mesurer les émotions et d'améliorer la conception des produits concernés.

Les approches proposées permettront non seulement de caractériser la perception du consommateur sur les produits de mode revendiqués comme éthiques, mais aussi d'identifier la crédibilité des besoins éthiques. L'étude mettra en lumière de nouveaux éléments pour mieux appréhender le concept de mode éthique et son impact sur les consommateurs, et permettra d'en améliorer sa conception en fournissant au designer des recommandations pertinentes. Nous avons proposé à un groupe de discussion une étude et un sondage afin d'explorer le concept de mode éthique en modélisant et en analysant la conscience et la connaissance du consommateur. Ensuite, nous avons mis en œuvre un vrai cas: une étude sur des consommateurs issus d'un pays avec un niveau de développement durable inférieur (La Roumanie). Cette méthode propose d'identifier les facteurs les plus pertinents selon des critères de respect de l'environnement comme les matériaux écologiques, l'esthétique du design et la qualité. Nous avons créé un ensemble de termes permettant de décrire la mode éthique à partir de ces résultats.

Nous avons utilisé les résultats obtenus dans l'étude quantitative suivante pour l'acquisition de données quantitatives. Cette méthode permet aux créateurs d'analyser et d'améliorer le style de la mode éthique grâce à l'ensemble de termes descriptifs de la mode éthique. Nous avons développé le modèle de recherche qualitative de la conscience des consommateurs en utilisant ses dimensions pour identifier les comportements de consommation. Afin d'éviter les biais de réponses des QCM dus au manque de connaissances, nous avons formulé les questions de manière ouverte. Ainsi, nous avons été capable de générer une première compréhension de la perception du consommateur. L'étude sensorielle et l'étude Kansei mentionnés précédemment permettront de caractériser et d'optimiser la conception du style de la mode éthique. Elle se base sur le type de conception d'un produit écologique en termes de matériaux et de style fournis par des experts utilisant l'ensemble de termes descriptifs. Les études proposées ont été testées et analysées selon deux cas: études sur les consommateurs et experts de pays avec un haut niveau de connaissance en développement durable (France et Allemagne).

De plus, nous avons anticipé le décalage entre l'ACV réelle et la perception humaine. En pratique, les valeurs éthiques perçues par l'homme ne sont pas nécessairement alignées avec les réels impacts environnementaux. Nous avons comparé les impacts réels d'un produit de mode (obtenus grâce à une l'analyse du cycle de vie-ACV) et la perception humaine de

l'éthique (à travers l'apparence visuelle des produits de mode). Malgré cela, nous avons constaté qu'en simplifiant l'impact du cycle de vie pour la perception du consommateur et en utilisant un cas d'étude avec un T-shirt, les valeurs éthiques perçues sont compatibles avec les impacts environnementaux obtenus grâce à une évaluation systématique.

**Mots clés:** Mode éthiques, évaluation humaine, perception des consommateurs, évaluation sensorielle, Kansai.

# **Studii privind așteptările și percepțiile consumatorilor pentru branduri etice de modă și relația acestora cu parametrii textili prin utilizarea abordărilor Kansei și LCA (evaluarea ciclului de viață)**

## **Rezumat**

Moda etică, denumită și ecologică, sustenabilă sau lentă, a rămas o piață de nișă chiar dacă a cunoscut o evoluție constantă. Conform studiilor de marketing, aspectul estetic al produsului ecologic care presupune o configurație prietenoasă mediului înconjurător sau atractivitate nu reușește să satisfacă așteptările consumatorului. Conceperea unui produs de succes ar trebui să țină cont de așteptările și emoțiile consumatorului. Este necesar ca procesul de evaluare al modei sustenabile să îmbine percepția clientului și cunoștințele experților. Lucrările de cercetare contemporane se bazează mai ales pe explorarea valorilor promovate de moda etică din perspectiva afacerilor, comercializării sau proiectării tradiționale, clasice. Spre deosebire de această abordare tradiționalistă, studiul pe care îl propunem integrează, într-o manieră originală, valori cantitative ale emoțiilor și percepțiilor clientului cu privire la produse ecologice și o analiză detaliată pentru proiectarea produselor de îmbrăcăminte aparținând modei ecologice. Această abordare nu a mai fost studiată până în prezent și considerăm că este utilă în diminuarea discrepanței dintre așteptările clientului și valorile de proiectare ale modei etice. În acest context, noile produse ce aparțin modei sustenabile și care beneficiază de un design ecologic vor fi acceptate pe scară mai largă, într-o varietate de piețe de desfacere.

În disertația de față, proiectul de cercetare prezentat are ca scop caracterizarea calitativă și cantitativă a percepției și așteptărilor consumatorului privind moda etică, prin abordarea unei serii de produse textile reprezentative în relație cu parametrii vizați ai proiectării produselor. Pentru a ne atinge scopul, au fost propuse patru metode de evaluare pentru a obține și a analiza date relevante. Aceste abordări conțin următoarele etape: mai întâi, am propus identificarea unui grup de consumatori pe care să ne axăm și conceperea unui chestionar de sondaj pentru a caracteriza relația calitativă dintre așteptările consumatorului și parametrii de proiectare a produsului. Această metodă este adesea întrebuințată pentru a lua pulsul comunității și pentru a dobândi o perspectivă nouă asupra consumatorilor.



În a doua fază am conceput două experimente senzoriale cu scopul de a caracteriza cantitativ percepțiile și emoțiile umane prin utilizarea ingineriei senzoriale și a sistemului Kansei; în plus, am adunat de la experți informații de percepție despre parametrii de design și am folosit logica fuzzy pentru a descrie, într-un mod obiectiv, această relație. Analiza senzorială este independentă de contextul social și cultural, la fel cum sistemul Kansei este diferit de ingineria senzorială deoarece este corelat cu emoțiile umane. Pentru a fabrica produse etice mai adaptate exigențelor consumatorului, s-a folosit o evaluare senzorială cu scopul de a obține valori de percepție, și metoda Kansei pentru a deduce parametri emoționali cu scopul final de a îmbunătăți designul produselor vizate.

Aceste abordări pe care le propunem vor permite nu doar caracterizarea percepției consumatorului asupra modei etichetate sustenabilă, dar și identificarea credibilității necesităților etice. Studiul deschide noi perspective pentru a îmbunătăți înțelegerea conceptului de modă etică, iar impactul său asupra consumatorului va permite perfecționarea procesului de proiectare a produselor prin furnizarea de sfaturi și informații pertinente către experți. Am propus studierea și aplicarea de sondaje pe un grup țintă cu scopul de a cerceta conceptul de modă etică prin analizarea și realizarea unui model de cunoaștere a consumatorului. Am aplicat un caz real: consumatorii dintr-o țară cu un nivel mai scăzut de dezvoltare a modei sustenabile (România). Această metodă presupune selectarea celor mai relevanți factori ce țin de criteriile ecologice, cum ar fi: materiale ecologice, proiectare estetică, calitate. Au fost generați descriptorii ecologici lingvistici pentru aceste rezultate.

Rezultatele obținute au fost folosite în studiul cantitativ care a urmat pentru a genera date cantitative. Această metodă permite designerilor să analizeze sau să îmbunătățească stilul modei etice în conformitate cu descriptorii lingvistici identificați ce caracterizează dimensiunea estetică.

A fost dezvoltat un model de cercetare calitativă a cunoștințelor consumatorilor pentru a identifica comportamentul lor. Această abordare a folosit întrebări deschise pentru a evita influențarea răspunsurilor persoanelor chestionate care s-ar putea produce în cazul întrebărilor cu variante multiple de răspuns, din cauza cunoașterii limitate. S-a obținut o evaluare inițială a percepției consumatorilor. Studiile senzoriale și Kansei, menționate anterior, vor fi folosite pentru a caracteriza și optimiza designul modei etice, în baza unui model-profil de proiectare a produsului ecologic, în ceea ce privește materialul și stilul propuse de experți, folosind descriptorii ecologici identificați. Studiile propuse au fost testate și analizate pe două cazuri reale: consumatorii și experții din țări cu un grad mai ridicat de dezvoltare sustenabilă (Franța și Germania).

Mai mult decât atât, am anticipat o discrepanță între evaluarea ciclului de viață (LCA) real și percepția umană. În practică, valorile etice percepute de oameni nu sunt neapărat în concordanță cu impactul real asupra mediului. Am comparat impactul real al unui produs obținut prin metodologia evaluării ciclului de viață cu percepția umană asupra eticii prin aspectul vizual al produselor textile. Totuși, am descoperit că, folosind o evaluare a impactului ciclului de viață (LCIA) pentru concepția consumatorului și un studiu de caz referitor la un tricou, valorile etice percepute pot coincide aproximativ cu impactul ecologic obținut printr-o evaluare sistematică.

**Cuvinte cheie:** Moda etică, evaluare umană, percepția consumatorului, evaluare senzorială, ingineria Kansei.

# 基于感性工学和 LCA 方法的消费者对伦理时尚的期望 和认知及其与纺织品参数的关系研究

## 摘要

伦理时尚也被称为生态时尚、可持续时尚或慢时尚，已经逐步形成和发展形成了一定的市场基础。但是根据市场研究结果发现，服装外观生态设计在环境友好方面的形象或吸引力无法达到消费者的期望水平。一个成功的服装产品设计应该满足消费者的期望和情感需求。消费者认知和专家知识需要贯穿伦理时尚的评估过程。目前的相关的研究工作主要是基于从传统商业、营销或设计的角度探索伦理时尚价值观。与此不同的是，本研究将消费者情感和感性价值观进行量化，与环境友好理念相结合，对生态时尚设计方法进行详细分析。这种方法以前没有被研究过，可以将伦理时尚的期望和设计价值之间的差距达到最小化。并且，在此背景下，新的生态时尚设计产品将在各个消费市场得到更广泛的认可。

本文开展的研究项目旨在用定性和定量的方法描述一系列具有代表性的纺织产品的消费者期望和消费者对伦理时尚的认知，以及建立它们与相关产品设计参数的关系。为此，我们提出了四种评估方法来获取和分析相关的人类数据。这些方法包括以下几个方面：首先，我们提出了一种以消费者为中心的群体确定方法和一个调查问卷开发方法，用定性的方法描述消费者期望与设计参数之间的关系。这种方法在反映社会反响和获得新见解方面很受欢迎。其次，我们设计了两个感官实验，分别用感性工学的方法对人的感知和情感进行定量表征，包括获取有关设计参数的专家感知数据和使用模糊逻辑数学方法，以便更客观地表述人类的感知和情感关系。感官分析是独立于社会和文化背景的，因此感性工学与人类情感有关。为了使伦理时尚产品更符合消费者的期望，采用感官评价方法来获取情感和感觉测量指标和方法，以改进相关产品的的设计。

这些建议的方法不仅可以描述消费者对品牌时尚产品的认知，还可以确定有关伦理需求的可信度。通过本项研究可以找到新的见解，以提高对伦理时尚概念及其对消费者影响的理解，并可以根据研究结果向设计师提供相关建议来改进设计。本研究还进行了一个小组的焦点研究和调查，通过对消费者的意识和知识进行建模和分析，探

索了伦理时尚概念。而且，我们应用了一个实际案例：即来自可持续发展水平较低国家（罗马尼亚）的消费者的研究。这种方法包括从环保标准（如生态材料、美学设计和质量）方面选择最相关的因素。我们从这些结果中生成了生态的语言描述符号。

我们将所得结果用于相关的定量研究，以获取定量数据。该方法使服装设计师能够根据语言描述对生态时尚的外观进行识别，对生态时尚风格进行分析或进一步改进。本研究利用消费者认知维度对消费者行为进行识别，建立了消费者认知的定性研究模型。这种方法使用了开放式问题，以避免由于知识有限而在多项选择题中出现有偏见的回答。通过这种方法来了解消费者的感知。前面提到的感官和感性研究将用于根据生态产品设计需求，根据专家使用确定的生态描述符号来确定材料和风格，对生态时尚风格的设计进行特征化和优化处理。本研究提出的方法在两个实际案例中进行了测试和分析：即来自可持续发展水平较高国家（法国和德国）的消费者和专家。

此外，我们预估了产品生命周期评价结果与人类感知之间存在差距。在实践中，人类感知的伦理价值并不一定与实际的环境影响相一致。我们将通过生命周期评估（LCA）方法获得的产品的实际环境影响与通过时尚产品的视觉外观获得的人类伦理认知进行了比较。研究发现，通过使用消费者感知的简化生命周期影响评估（LCIA）和 T 恤的案例研究，感知的伦理价值可以大致涵盖从系统评估中获得的环境影响。

**关键词：**伦理时尚、主观评价、消费者感知、感官评价、感性工程。

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# Table of Contents

General Introduction.....	1
Chapter 1. Ethical Fashion, Brands, Design Style and Consumer Perception.....	6
1.1 Fashion Industry .....	6
1.1.1 Apparel Market and Brands .....	7
1.1.2 Environmental Impacts and Assessment.....	9
1.2 Ethical Fashion .....	10
1.2.1 Concepts and Definitions .....	12
1.2.2 Product Attributes and Solutions.....	13
1.2.3 Design Style .....	20
1.3 Ethical Fashion Consumer .....	22
1.3.1 Consumer Expectation: Awareness and Knowledge.....	22
1.3.2 Consumer Perception: Purchase Interest .....	25
1.3.3 Understanding Consumer Perception .....	27
Chapter 2. Classical Survey-Based and Sensory-Based Consumer Methods: Data Acquisition, Analysis and Visualization Tools .....	30
2.1 Classical Survey-Based Consumer Methods .....	30
2.1.1 Survey.....	32
2.1.2 Group Administered Survey.....	32
2.1.3 Focus Group .....	33
2.1.4 Expert Interview .....	36
2.1.5 Methodological Criticism.....	38
2.2 Sensory-Based Consumer Methods.....	39
2.2.1 Sensory Evaluation.....	39
2.2.2 Kansei Engineering .....	44
2.3 Visualization Tools .....	47
2.3.1 Word Cloud: Counts and Codes.....	47
2.3.2 Mood Board.....	48
2.4 Mathematical Modeling Using Fuzzy Theory .....	48
Chapter 3. Materials and Methods .....	53
3.1 Study 1: Consumer Expectations and Awareness of Ethical Fashion through Survey Questionnaire .....	53

3.1.1	Participants .....	54
3.1.2	Materials .....	54
3.1.3	Methods .....	57
3.2	Study 2: Consumer Perceptions of Eco-Fashion Style through Sensory Evaluation	59
3.2.1	Participants .....	59
3.2.2	Materials .....	60
3.2.3	Methods .....	62
3.3	Study 3: Consumer Perceptions of Environmentally-Friendly Appearance through Kansei Engineering.....	67
3.3.1	Participants .....	67
3.3.2	Materials .....	67
3.3.3	Methods .....	70
3.4	Study 4: Consumer Perceptions of Environmental Impact through Survey Questionnaire .....	72
3.4.1	Participants .....	72
3.4.2	Materials .....	72
3.4.3	Methods .....	77
Chapter 4.	Results and Discussion .....	79
4.1	Study 1: Consumer Expectations and Awareness of Ethical Fashion through Survey Questionnaire .....	79
4.1.1	Introduction .....	79
4.1.2	Case Study: Consumer Awareness in Romania .....	80
4.1.3	Results and Discussion .....	81
4.1.4	Conclusion.....	87
4.2	Study 2: Consumer Perceptions of Eco-Fashion Style through Sensory Evaluation	89
4.2.1	Introduction .....	89
4.2.2	Results and Discussion .....	89
4.2.3	Analysis and Validation of Results .....	96
4.2.4	Conclusion.....	97
4.3	Study 3: Consumer Perceptions of Environmentally-Friendly Appearance through Kansei Engineering.....	99
4.3.1	Introduction .....	99
4.3.2	Case Study: French sustainable children's fashion brand.....	99
4.3.3	Results and Discussion .....	100

4.3.4	Analysis and Validation of Results .....	106
4.3.5	Conclusion.....	108
4.4	Study 4: Consumer Perceptions of Environmental Impact through Survey	
	Questionnaire .....	110
4.4.1	Introduction .....	110
4.4.2	Results and Discussion.....	110
4.4.3	Conclusion.....	113
	General Conclusion and Future Work.....	115
	References .....	118
	Appendices .....	138
Appendix 1.	Web of Science Search .....	139
Appendix 2.	Eco Fashion Themes Questionnaire .....	141
Appendix 3.	Ethical Fashion Themes Results .....	143
Appendix 4.	Mood Boards .....	149
Appendix 5.	Consumer Questionnaire Results.....	152
Appendix 6.	Consumer Questionnaire Results.....	153
Appendix 7.	List of Publications .....	155



# List of Figures

Figure 0-1: Organization of the chapters.....	5
Figure 1-1: The garment lifecycle stages. ....	10
Figure 1-2: Examples of existing terms for the ethical fashion concept.1.....	12
Figure 1-3: Schematic representation of the role of expectations on part a) product selection and part b) product evaluation, [104]. ....	23
Figure 1-4: The perception process, adapted from [38, 121]. ....	27
Figure 1-5: The conceptual framework of ethical fashion. ....	29
Figure 2-1: The general process of a Kansei engineering system (KES), adapted from Nagamachi [171]. ....	45
Figure 2-2: A schema of a Kansei tree structure, Nagamachi [171]. ....	46
Figure 2-3: A schematic example of the coding procedure, adapted from Johnstone [179]. ...	48
Figure 2-4: Schematic sketch of the Triangular Fuzzy Number. ....	50
Figure 3-1: Research design, adapted from Deliza and MacFie [104]. ....	54
Figure 3-2: Research model of consumer awareness. ....	55
Figure 3-3: Consumer awareness dimensions and its elements. ....	55
Figure 3-4: The experimental design analysis process.....	59
Figure 3-5: Model presenting the process of data using fuzzy logic.....	66
Figure 3-6: The ten samples. ....	68
Figure 3-7: Example of mood board B. Organic. ....	69
Figure 3-8: Example of the mood board “green”. ....	73
Figure 3-9: LCA of a T-shirt, adapted from Zhang et al. [20]. ....	74
Figure 3-10: Simplified LCIA of T-shirt Life Cycle.....	77
Figure 4-1: Summary of research outcome - Consumer definitions for the ethical fashion term and issues.....	83
Figure 4-2: Word clouds by experts, presenting expectations of eco-design style in three main concepts: a) style; b) versatile; c) fashion. ....	91
Figure 4-3: The image boards used in the experiments: (a) style; (b) versatile; (c) fashion.5	92
Figure 4-4: Three representative garment style samples.....	93
Figure 4-5: Distance to excellent condition. ....	96
Figure 4-6: Boxplots of samples for green and organic. ....	103
Figure 4-7: Boxplots of samples for recycled perception. ....	105
Figure 4-8: Boxplots of samples for attractive perception. ....	106
Figure 4-9: Consumer perception of T-Shirt life cycle. ....	112
Figure 4-10: Comparing simplified and perceived LCA.....	113
Figure A 1: Total Publications TOPIC: “ethical fashion consumer perception”, adapted from Web of Science [114].139	
Figure A 2: Times Cited TOPIC “ethical fashion consumer perception”, adapted from Web of Science [114]. ....	139
Figure A 3. Ethical Fashion Themes Questionnaire (in French).....	141
Figure A 4. Ethical Fashion Themes Questionnaire - Image selection. ....	142

Figure A 5: Mood board A. Green .....	149
Figure A 6: Mood board B. Organic. ....	150
Figure A 7: Mood board C. Recycled. ....	150
Figure A 8: Mood board D. Reduced. ....	151
Figure A 9: Mood board C. Recycled/Reduced. ....	151

# List of Tables

Table 1-1: Top 20 Global Fashion Companies, adapted from The Business of Fashion and McKinsey & Company [8]. ..... 7

Table 1-2: Fashion and ethical market segments according to the price index, adapted from The Business of Fashion and McKinsey & Company [9]. ..... 8

Table 1-3: Main impact categories, adapted from Zhang et al. [20]. ..... 9

Table 1-4: The EPI 2018 for France, Germany, Romania, and China [29]. ..... 11

Table 1-5: Ethical fashion product cues. .... 13

Table 1-6: Main sustainable fashion solutions, adapted from Caniato et al. [47]. ..... 14

Table 2-1: Comparative differences in qualitative and quantitative methods, adapted from [129, 130]. ..... 31

Table 2-2: Example of a survey question. .... 32

Table 2-3: Preparation of focus group [134, 135]. ..... 34

Table 2-4: Design and conducting of a focus group, adapted from [133, 134]. ..... 34

Table 2-5: Example of Kansei Words. .... 45

Table 2-6: Example of a Semantic Differential scale for slow-fast. .... 45

Table 2-7: Evaluation scores, linguistic terms, and fuzzy numbers (TFNs). ..... 51

Table 3-1: The demographics of the sample group. .... 55

Table 3-2: Survey questionnaire of the ethical fashion concept ..... 56

Table 3-3: Evaluator Groups. .... 60

Table 3-4: Eco-fashion designer experience. .... 60

Table 3-5: Level of work experience. .... 61

Table 3-6: Eco-fashion consumer demographics. .... 61

Table 3-7: Eco-fashion consumer experience. .... 61

Table 3-8: Evaluation scale. .... 62

Table 3-9: Eco values and word pairs. .... 70

Table 3-10: Semantic rating scale for natural. .... 70

Table 3-11: Main phases of LCA case study, adapted from Zhang et al. [20]. ..... 74

Table 3-12: Basis for the simplified LCIA (“Potential hotspots throughout the life cycle of T-shirts”), adapted from Zhang et al. [20]. ..... 75

Table 3-13: Ten impact categories, adapted from Zhang et al. [20]. ..... 76

Table 3-14: Environmentally-friendly (EFR) rating scale ..... 76

Table 4-1: Summary of research outcome - Well-known ethical product attributes. .... 84

Table 4-2: Summary of research outcome - ethical fashion challenges identified. .... 87

Table 4-3: Eco-design descriptors. .... 92

Table 4-4: Aggregated evaluation results for products A-C. .... 93

Table 4-5: Material content and design features of the ten samples. .... 100

Table 4-6: Median values for each sample for material, sample S1-10. .... 102

Table 4-7: Median values for each sample for design, sample S1-10. .... 102

Table 4-8: Obtained results of garment technical parameters (material), themes, and related advices. .... 106

Table 4-9: Obtained results of garment technical parameters (design), themes, and related advices. ....	107
Table 4-10: Consumers' evaluation results for the T-Shirt Life Cycle. ....	111
Table A 1: Publication Search: "ethical fashion consumer perception" (06.02.2019, 17:00), adapted from Web of Science [114].	139
Table A 2: Web of Science List of Publications, adapted from Web of Science [114]. ....	140
Table A 3: Image questionnaire results A. Green. ....	143
Table A 4: Image questionnaire results B. Organic. ....	144
Table A 5: Image questionnaire results C. Recycled. ....	145
Table A 6: Image questionnaire results D. Reduced. ....	147
Table A 7: Consumers' evaluation results for three products P1-3. ....	152
Table A 8: Consumers' evaluation results (R=63) for Material, Green 1 for ten samples S1-10. ....	153

# List of Abbreviations

AHP	Analytical Hierarchy Process
AI	Artificial Intelligence
COO	Country-of-Origin
CSR	Corporate Social Responsibility
FEA	Functional, Expressive, and Aesthetic
Fuzzy AHP	Fuzzy Analytical Hierarchy Process
FWF	Fair Wear Foundation
GDP	Gross Domestic Product
GEN X	Generation X (born 1961-79) [1]
GEN Y	Generation Y (Millennials, born 1980-99) [1]
GEN Z	Generation Z (born 2000-2005)
GOTS	Global Organic Textile Standard
HCD	Human Centered Design
HMM	Human Measuring Method
ISO	International Organization for Standardization
KE	Kansei (Sensitivity) Engineering
KES	Kansei Engineering System
KW	Kansei Word
LCA	Life Cycle Assessment
LCIA	Life Cycle Impact Assessment
MDA	Model and Genetic Algorithm
NN	Neural Network
NGO	Non-Governmental Organization
PD&D	Product Design and Development
SD	Semantic Differential
SE	Sensory Evaluation/Engineering
TFN	Triangular Fuzzy Number
UNEP	United Nations Environment Programme
WOS	Web of Science

# General Introduction

Contemporary fashion has significantly evolved into a complex and fast industry, producing cheap, trendy, disposable clothes, which causes environmental and social issues. Consumers are increasingly concerned and more and more demanding for ethical fashion that meets their expectations. Following up on this trend, both ethical fashion brands, as well as fast fashion brand extensions, are growing such as the “Conscious Collection” by the retailer H&M. However, ethical fashion consumers expect eco styles to satisfy their environmentally-friendly and aesthetic product needs. To minimize the gap between consumer eco style expectations and design parameters, designers need to analyze consumer perception of the eco-design appearance.

Consumer evaluation has long been carried out in traditional business, marketing or design studies. The two main issues in the analysis process of ethical fashion are first that consumer perception is somewhat subjective due to a lack of systematic and objective methods, and secondly, that the decision-making of ethical fashion is complex and involves emotions. This last problem refers to the phenomenon of the attitude-behavior gap. Thus, we proposed to include sensory and perceptual values towards an environmentally-friendly image to successfully design ethical fashion products. Therefore, it is critical to study human perception using recognized systematic approaches for sensory evaluation and intelligent data mining techniques. There is a limited amount of studies on consumer perception and the evaluation of ethical fashion design style. The critical challenges of this study include the acquisition and analysis of human perception data on ethical fashion products.

In this context, we propose four evaluation approaches to deal with this issue. The first approach aims to qualitatively characterize the relationship between consumer expectations and design parameters, using a consumer focus group determination and a survey questionnaire development. Next, two sensory experiments are designed to quantitatively characterize human perception and emotions by using sensory engineering and Kansei engineering including the acquisition of expert perceptual data on designed products and using fuzzy logic in order to characterize more objectively the relationship between perception and design parameters. These two approaches include firstly, to qualitatively defining eco-design descriptors of the eco-fashion appearance such as minimal design, for example, defined as reduced design with, e.g., timeless silhouettes. Accordingly, garment styles can be selected, and finally, these garments can be quantitatively analyzed using

sensory evaluation. Data from the traditional sensory analysis are more related to product features and are independent of a socio and cultural context, and from human emotions.

Next, we used Kansei engineering in order to explore all product features related to human perception, including human emotions in ethical fashion. Kansei involves consumer perception more related to design issues such as an environmentally-friendly image. The approach can qualitatively describe ethical garments according to their material composition (e.g., organic cotton), design elements as well as fashion images such as a basic design image, and to measure the appearance of their environmentally-friendly related perception quantitatively. Furthermore, a survey is used to identify the gap of real life cycle assessment (LCA) and human perception, comparing the real environmental impacts of a product obtained through LCA methodology with human perception of ethical through the visual appearance of fashion products.

The thesis organization is as follows:

**Chapter 1** introduces the general background and context of this thesis. This chapter provides an overview of the current ethical fashion concept including insights into design such as fashion solutions and styles. We explored the ethical fashion consumer on the subject of consumer expectations and consumer perceptions. Notably, we explain the necessity of developing a human evaluation method for the acquisition and analysis of perception data to support the successful development of ethical fashion.

**Chapter 2** acknowledges human perceptual data acquisition methodologies and their challenges; and, describes statistical techniques and the fuzzy set theory as a mathematical modeling tool for formalizing and modeling human perception data with uncertainty and imprecision, and including the measurement of emotional response. Several questionnaires were carried out for the acquisition of consumer data. The choice of qualitative and classical methods was made, based on the need for gaining new insights by describing the concept of ethical fashion through the collection of descriptive words and adjectives. Quantitative and sensory methods such as Kansei and sensory engineering were considered to gain numerical data that is measurable. The review on methodologies constitutes the foundation of the studies performed in the following chapters.

**Chapter 3** introduces the research methodology. We defined four studies to acquire human perception data on ethical fashion design parameters from design experts and consumers respectively:

**Section 3.1, Study 1** provides a study on a consumer model including the discussion of different awareness dimensions based on classical qualitative survey methodology.

**Section 3.2, Study 2** describes the sensory analysis of eco-designed fashion products based on an eco-design perception model considering a target group dedicated to an ethical commitment.

**Section 3.3, Study 3** focuses on consumer perception towards ethical fashion products based on Kansei engineering focusing on textile design attributes.

**Section 3.4, Study 4** studies the environmental performance and overall sustainability impact of the textile product T-Shirt assessed by LCA methodology and its consumer perception using a simplified visualization approach of the life cycle impact assessment (LCIA) results.

**Chapter 4** presents the experimentations and results of the four studies, as described next.

**Section 4.1, Study 1** discusses the influence of subjective and objective factors on the consumer decision-making process of ethical fashion. This qualitative study characterizes the ethical fashion concept, determining a consumer focus group and developing a survey questionnaire. The first approach can qualitatively characterize the relationship between consumer expectations (expressed as consumer awareness including consumer knowledge and purchase interest) and design parameters. In a case study, focusing on countries with a lower level of sustainable development such as Romania, consumers showed good environmental awareness, focusing mainly on the ethical fashion topics of material and design. These findings regarding important eco-themes support the further development and analysis of the eco-fashion style, appearance, and impact perception as shown in the following description of **Section 4.2 - 4.4**.

**Section 4.2, Study 2** provides a detailed study on the use of sensory evaluation, to analyze the relations between the garment design style and the evaluation criteria of eco-fashion. Sensory analysis was used as a first experiment as it represents an independent social and cultural environment, whereby Kansei engineering includes emotions. This methodology can identify the extent to which eco-fashion style exists in garment style. Concluding, this study proves that with the help of eco-design descriptors the style of an ethical garment can be quantitatively described. The study follows up on the qualitative findings of **Section 4.1** and supports the development of **Study 3** in **Section 4.3** as described in the following.

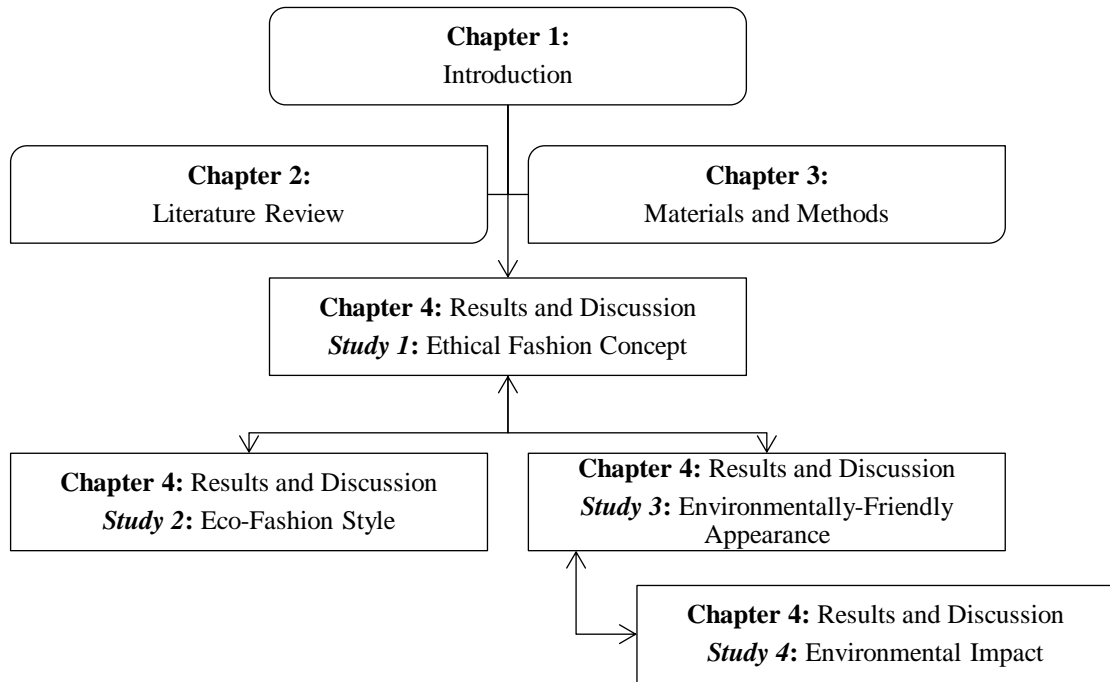
**Section 4.3, Study 3** presents Kansei engineering as a method to evaluate the appearance of environmentally-friendly fashion products. We found that emotions are essential within the context of ethical fashion consumer behavior. The Kansei methodology can translate



consumer feelings into product design. In this study, we showed the relationship between the environmentally-friendly product image and product design attributes. Concretely, we proposed a set of predefined evaluation descriptors. The Kansei words (KWs) can identify the relation between garment design and material with descriptive eco values. Finally, garments could be compared according to their environmentally-friendly appearance, using consumer eco-themes as presented in **Chapter 1** and discussed in **Section 4.1**.

**Section 4.4, Study 4** identifies the relation of perceptual and real data regarding the parameter ethical to visualize the gap of real LCA and human perception. This quantitative study applies a rating scale for measuring a simplified life cycle impact assessment (LCIA) and consumer perception using a consumer survey. We highlighted the gaps in a case study of a T-shirt. We based this study on the insights of the previous chapters. For example, the collection of numerous sustainable fashion solutions in **Chapter 1** supported the idea to include LCA to measure the different concepts in terms of real and perceived impacts. **Section 4.1** indicated gaps between consumer awareness and various concepts. To conclude, the methodology of LCA is used to develop a simplified life cycle impact assessment (LCIA) for consumers. This assessment can be applied to measure human perception data. The procedure uses a simple rating scale and can compare the rating results of human perception to real LCA data. Based on gaps detected, misperceptions can be targeted with awareness campaigns and be evaluated using the approach in **Section 4.1**.

**General Conclusion and Future Work** note the overall outcome of these studies. As described in **Section 4.1, Study 1** identified material and design as essential consumer concerns. **Section 4.2** and **4.3** reflect these findings in the development of **Study 2** and **Study 3** where we focused on the garment style and its eco-design descriptors, as well as the garment material and design and its eco-values. In **Study 2**, we applied fuzzy logic in the context of a more objective characterization of perceptual data on design parameters. In **Section 4.3**, we complemented the outcome of the previous studies with **Study 4**. Whereby **Study 1** proofed that consumers have a general awareness of ethical fashion, i.e., consumers can assess their impact, **Study 4** allowed to quantify this knowledge, refer to Figure 0-1, presenting the framework of the studies.



**Figure 0-1:** Organization of the chapters.

# Chapter 1. Ethical Fashion, Brands, Design Style and Consumer Perception

The ethical fashion phenomenon has transformed the global fashion industry. Sustainability is a multidimensional trend that is shaping brands and designers. The perception of ethical is subjective and depends on cultural and social factors. Consumer perception is a set of processes based on sensory data. With the complexity of the concepts, this chapter will introduce the basic concept of ethical fashion and consumer perception in the context of the global fashion industry. We describe the details about existing markets, brands, and impacts along with the design solutions and design style and conclude with the consumer perception theory in the following sections.

## 1.1 Fashion Industry

The fashion industry has seen a massive transformation due to globalization and industrialization. It currently holds a broad range of markets and companies, as described in this first section. Conventional brands offer mostly fast fashion, i.e., quick and cost-effective mass-produced clothing. Besides the garment quality, this procedure can affect the whole supply chain. Several impacts on the environment and workers have been found and will be presented in this second section. New challenges and opportunities have arisen through the leading trends digitalization, and sustainability. The development of sustainability is one of the European Union's (EU) fundamental objectives [2].

According to studies such as the Nielsen Global Survey of Corporate Social Responsibility [3], consumers worldwide have become more aware of the fashion industry's social and environmental impacts. Also, increasing consumer concern grows the demand for sustainability [4, 5]. Consumers expect more sustainability when purchasing apparel products from fashion companies [3]. With this growing consumer awareness, the industry is under pressure to make changes for the good [3].

Fashion is socio and cultural context-dependent. In history, clothing styles often correlated to changes in the society or economy. The industry has set impactful fashion trends that still remain, such as unisex dressing. The current issues in the fashion industry caused a rise of ethical fashion. Conscious consumers influence eco-trends and eco-clothing styles. Fashion shows presented minimalism or feminine trends with minimalistic patterns, see-through

garments, flower prints, or neutral colors. For example, the trade fair Neonyt in Berlin, Germany (previously called the Ethical Fashion Show and the Greenshowroom) presents ethical fashion and represents sustainable lifestyles. Set up in parallel with the Berlin Fashion Week, it has become a growing platform for ethical fashion designers that combine an “urban Zeitgeist, eco-fair lifestyle and fashion” [6]. The ethical fashion textile parameters, including eco-design style are further studied in this thesis.

To conclude, ethical fashion is causing changes in the fashion supply chain. The increasing popularity of the circular economy is an example of economic influence. Accordingly, markets and fashion brands have developed sustainable brands and design concepts (for example, Mud Jeans offering a leasing concept and applying design for recycling, or Patagonia using sustainable materials and a branding strategy to buy less). Markets and fashion brands are described next.

### 1.1.1 Apparel Market and Brands

The total size of the global apparel market is worth three trillion dollars and represents two percent of the world’s gross domestic product (GDP) [7]. In the fashion sector, the top 20 companies account for 97 percent of the economic profit [8], see Table 1-1.

**Table 1-1:** Top 20 Global Fashion Companies, adapted from The Business of Fashion and McKinsey & Company [8].

Top 20 Global Fashion Companies					
1. Inditex	6. H&M	11. LBrands	16. Luxottica		
2. Nike	7. Richemont	12. Pandora	17. Michael Kors		
3. LVMH	8. Ross	13. Fast Retailing	18. Gap		
4. TJX Companies	9. Adidas	14. Next	19. Hanes Brands Inc.		
5. Hermès	10. Kering	15. VF Corporation	20. Burberry		

The top fashion companies derive from different market segments. The segmentation can be done through price rankings of branded garments with low to high prices, see Table 1-2 [9]. For example, the segment of Zara represents Mid-Market. Zara Join Life is its sustainable brand extension. The brand belongs to the Inditex group, which ranks first among the top companies see Table 1-1. Whereby, Nike or Patagonia targets the Premium/Bridge segment (see Table 1-2).

**Table 1-2:** Fashion and ethical market segments according to the price index, adapted from The Business of Fashion and McKinsey & Company [9].

<b>Segments</b>	<b>Brand Examples</b>	<b>Price Examples: Jeans</b>
1. Luxury	Chanel/Mara Hoffman, Stella McCartney	> \$315
2. Affordable luxury	Michael Kors/Edun	\$156 - \$315
3. Premium/Bridge	Nike/People Tree, Patagonia	\$96 - \$155
4. Mid-Market	Zara/Zara Join Life	\$41 - \$95
5. Value	TJ Maxx/H&M Conscious	\$21 - \$40
6. Discount	Primark/ Primark Cares	< \$20

Estimations for the ethical fashion market present a niche market with around 1 percent of the global fashion industry [10]. Measuring sustainable fashion is challenging due to its various definitions and relatively new sectors [11]. However, brands are increasingly incorporating social and environmental themes into their products and service [8]. Sustainable fashion can offer advantages for both mass-market or luxury fashion brands [9]. For example, B Lab awards the B Corporation certification for a business that balances purpose and profit [12], and as of April 2018, there are nearly 200 Certified B Fashion Corporation such as Patagonia, compared with just seven in 2010 [8]. Crane [10] highlighted the high amount of ethical fashion producers in the United Kingdom and the United States (66 per cent), including fashion brands, shops, buyers, press, and NGO (Non-Governmental Organization) certifiers, referring to the Ethical Fashion Forum (EFF) ([www.ethicalfashionforum.com](http://www.ethicalfashionforum.com), the world's most comprehensive database of ethical fashion businesses and resources) to which 6,000 ethical fashion organizations belong, and representing 90 countries.

In his study of ethical fashion, Shen et al. [13] found the following ethical fashion brands named by respondents in order of importance: 1. Muji, 2. H&M, 3. Marks & Spencer, 4. Stella McCartney, 5. Timberland, and 6. Uniqlo. Global fast fashion chains such as H&M (H&M Conscious) and Muji have launched organic collections and fair trade products [13]. Others promoting sustainability are Kering [14]; with sustainable fashion being mainly seen in the luxury fashion market [15].

In summary, the ethical fashion niche market is a growing, global phenomenon. More sustainability in the fashion industry has become a key concern. This year's World Economic Forum Annual Meeting in Davos-Klosters, Switzerland, included fashion and a discussion of the fast fashion model and possible changes [16]. In the following, we describe the negative impacts on the environment and society, which are well-known in the fast fashion industry.

## 1.1.2 Environmental Impacts and Assessment

According to the Measuring Fashion report by Quantis [17] (p.18), the apparel industry impacts are equivalent to 6.7 percent of the total global climate impacts (3,290 million metric tons CO<sub>2</sub>eq) in 2016. The impact of the fashion industry could estimate one-quarter of the total carbon budget if there is no change in the fashion industry by 2050 [18]. For the fashion industry, there are five fundamental problems which are high water consumption, discharge of hazardous chemicals, violation of human rights and labor standards, greenhouse-gas emissions, and waste production [9]. For example, Fletcher [19] researched the critical stages of the lifecycle in terms of material cultivation and extraction, production, use, and disposal. The author looked at the lifecycle sustainability impacts of fashion and textiles, focusing on the design, proposing definitions for the design concepts. Zhang et al. [20] categorized the main impacts into three categories, referring to a cotton T-shirt, see Table 1-3.

**Table 1-3:** Main impact categories, adapted from Zhang et al. [20].

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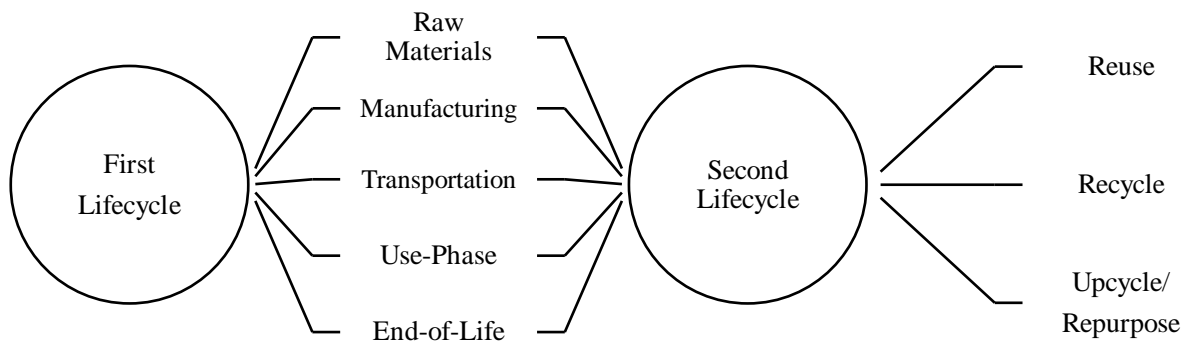
### Impact Categories

---

1. Total raw material or resource consumption
  2. Atmosphere and water impacts
  3. Toxicity
- 

The first category, the total raw material or resource consumption, refers to the cultivation and production processes of raw materials such as cotton and their consumption of resources in terms of water or coal and for example, in the dyeing stage, dyes, and auxiliaries [20]. The second category covers the atmosphere impacts such as from burning coal within the stage of dyeing as well as the water impacts in terms of water use and wastewater [20]. Finally, the last category, the toxicity, discusses, for example, the impacts of the dyeing process, e.g., the discharge of heavy metals to the freshwater. Thus, environmental and social issues occur along the garments' lifecycle stages. Similarly, other researchers such as Chouinard and Brown [21] defined comparable impact categories in terms of the exploitation of finite resources, cause of high CO<sub>2</sub> emissions, and impact due to synthetic chemical products.

To lower impacts, the first lifecycle can be extended through re-use and re- or up-cycling into a second lifecycle (see Figure 1-1). This model refers to the Cherry Model of the Bachelor work entitled “‘The Future of Denim, Lease a Fleece’”, extending the first lifecycle with a second lifecycle by recycling jeans into a fleece [22].



**Figure 1-1:** The garment lifecycle stages.

Life cycle assessment (LCA) tools can measure impacts. Potential impacts can be systematically measured through the primary methodology LCA, mostly focusing on environmental aspects [23]. According to the European Commission’s Integrated Product Policy - Building on Environmental Life-Cycle Thinking (COM(2003)302), “LCAs provide the best framework for assessing the potential environmental impacts of products currently available” [2]. The life cycle assessment (LCA) can quantify impacts and give valuable insights into products’ environmental impacts throughout all life cycle stages. LCA, a cradle-to-grave assessment, is defined by the International Organization for Standardization (ISO) [24] 14.040:2006 “compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle” (ISO 14.040:2006). One of the early LCAs was conducted by Patagonia [21], detailing the impacts of four major fibers used in their products (polyester, nylon, cotton, and wool). The study concluded that every fiber had a drawback, and finally selected organic cotton as their desired fiber. Impacts can vary significantly throughout the different lifecycle stages.

Life cycle impact assessment (LCIA) is defined as “phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product” [24]. Researchers such as Resta et al. [23] proposed to also include economic aspects in order to analyze the influence of LCA on decision making. Concluding, the ethical fashion concept aims at improving negative impacts as described next.

## 1.2 Ethical Fashion

In this context, the concept of ethical fashion has become a change-maker, i.e., fashionable clothes that are less harmful to the environment [25]. Also, improving the working conditions for people, focusing on both the culture and the environment [26]. The

ethical trend is not entirely new; the first “ethical consumerism” appeared in the late 1980s, when “retailers adopted codes of conduct to end relationships with suppliers who exploit workers, and set out to improve labour standards” [27]. With consumers and the fashion industry gaining more awareness, ecological (ECO) fashion has been evolved since 1991 [26].

The movement of the ethical fashion concept spread globally with geographical variations. Differences in cultures result in a variety of consumer behavior [28]. This unsteadiness and variation make it more challenging to define the concept globally. The Environmental Performance Index (EPI) 2018 is a global metric to measure and rank countries based on their environmental performance [29]. The index ranks the regions “Europe & North America” with higher sustainable development scores, and “East Europe & Eurasia” lower; whereby Asia shows diverse geographical results with China scoring lower, see Table 1-4 [29].

**Table 1-4:** The EPI 2018 for France, Germany, Romania, and China [29].

<b>Country</b>	<b>EPI Ranking</b>	<b>EPI</b>	<b>Environmental Health</b>	<b>Ecosystem Vitality</b>
France	2	83.95	95.71	76.11
Germany	13	78.37	88.68	71.50
Romania	45	64.78	58.67	68.85
China	120	50.74	31.72	63.42

Most research has been conducted targeting one or several nationalities [30]. In this thesis, case studies were applied to acquire perception data from ethical fashion consumers in France, Germany, and Romania. As described before, fashion theory assumes that differences in culture and economy can influence consumer expectations and perceptions. Tjandra et al. [30] highlighted different perceptions of consumers from various nationalities and economy levels. The authors targeted Generation Y consumers from advanced (e.g., Germany and France) and emerging (e.g., China) economies. A qualitative research method in terms of virtual interviews in a chat room and e-mail interviews were used to analyze perceptions towards Country-of-Origin (COO) of fashion products: All respondents agreed that fashion products made in advanced economies are of better quality compared to those made in emerging economies; Whereby consumers from advanced economies agreed that besides quality, ethical issues are important, but most of the consumers from emerging economies preferred functional issues [30]. In the following, ethical issues are further defined, explaining different concepts and definitions of the ethical fashion concept.



## 1.2.1 Concepts and Definitions

A first Google search of the term “Ethical Fashion” on 7<sup>th</sup> February 2019 showed about 150,000,000 results (0.52 seconds). The first result by Victoria and Albert Museum (V&A) [31] defined ethical fashion as the following:

Ethical fashion is an umbrella term to describe ethical fashion design, production, retail, and purchasing. It covers a range of issues such as working conditions, exploitation, fair trade, sustainable production, the environment, and animal welfare.

Also, the V&A Museum is an example of the importance of design. Their collaboration with the ethical fashion brand People Tree offers a capsule collection using the great pattern of the Museum (<https://www.peopletree.co.uk/edits/va-collaboration>). The ethical fashion concept has various expressions. Besides ethical, the concept is also called eco, organic, green, sustainable, or slow fashion. These are only a few of the many wordings used, see Figure 1-2. The terms defined in different contexts can be similar or have common understandings. Various concepts and terms create confusion and misunderstandings among experts and consumers [26].



**Figure 1-2:** Examples of existing terms for the ethical fashion concept.<sup>1</sup>

<sup>1</sup> The word cloud presenting most popular definitions of ethical fashion found in literature was created using the online tool “worditout” (<https://worditout.com>).

Along with the terms, different concepts have emerged. The slow fashion concept evolved from the slow food movement with its focus on local and small producers [32]. Slow fashion refers to high quality realized through design, and fair labor conditions, as defined by the Slow Fashion Award [33]. This concept is about small lines and local productions, or high quality of products obtained through eco-design, as well as fair labor conditions. Other important aspects of this approach are innovation and transparency; examples are the use of alternative fibers and production technology to reduce the environmental impact by creating less waste and pollution [34]. By integrating ethics and sustainability into the design process, ethical fashion can provide more conscious products. Other terms to describe the alternative fashion concept are circular or the circular economy [35], sweat-free [32], and social responsibility [36]. As diverse as the concepts and definitions are the solutions of ethical fashion, listed in the following.

## 1.2.2 Product Attributes and Solutions

In the following, we describe an ethical fashion product and list relevant solutions. Firstly, we define a fashion product with general product characteristics. Product attributes have intrinsic (physical) and extrinsic (non-physical) cues, see Table 1-5 for an overview.

**Table 1-5:** Ethical fashion product cues.

<b>Intrinsic cues</b>	<b>Extrinsic cues</b>
a) color [37]	a) price [37, 40–42]
b) performance/utility	b) brand name/designer label [37, 43]
c) fiber/fabric/material content: organic, recycled, or traceable	c) country-of-origin [37]
d) product quality [38]	d) packaging [44]
e) fashionability [39]	e) advertising [43]
f) innovativeness [39]	f) certification seals/warranty/sustainable certificate label
g) style	g) fair trade
h) weight	h) corporate name
i) construction	i) ease of use [39]
j) workmanship [37]	j) care instructions
k) comfort	k) store image [37]
l) general appearance	l) ease of care
m) fit	

Most obvious cues are the extrinsic such as price or brand name, influencing consumer perceptions towards the product [42]. Also, intrinsic cues can relate to more abstract attributes, such as aesthetics. Cues can be perceived, either, in the decision-making process (before buying the product and thus impacting the purchase intentions) or, after the purchase

evaluation. However, consumers can not always fully and objectively assess cues due to misunderstanding or not being able to gain or understand the information [42]. For example, low-familiar consumers are not able to interpret intrinsic information, but would rather use extrinsic ones [45]. In textiles, intrinsic and extrinsic cues are mainly used to study product quality. Hatch and Roberts [46] studied the quality of textile items in terms of socks and sweaters, using a questionnaire and found that the subjects relied more on intrinsic cues.

However, an ethical fashion product has no unified formal definition and has diverse product characteristics. In here, we agreed to define the ethical fashion product considering solutions from existing literature. We reviewed sustainable practices, current trends, and consumer needs. The findings were structured according to the definition of Caniato et al. [47], and further adapted to eight solution categories, see Table 1-6. In the following, the essential sustainable fashion solutions are listed accordingly.

**Table 1-6:** Main sustainable fashion solutions, adapted from Caniato et al. [47].

<b>Sustainable Fashion Solutions</b>	
a)	use of organic or low impact fibers
b)	reuse and recycling of materials and upcycling
c)	alternative consumption practices (vintage practices and second hand)
d)	clean technologies
e)	green certifications and communication
f)	use of green product and process design
g)	ethical or local production
h)	use of green appearance

**a) organic or low impact fibers**

Natural fibers such as cotton but also man-made fibers such as polyester are dominating the textile market. Thus, one of the most common sustainable product solution found in fashion is natural organic fibers with organic cotton being the most popular. Similarly, the first category defined by Caniato et al. [47], is the “use of organic fibers”. Organic fibers have a lower impact on the soil and environment by excluding toxic insecticides, herbicides, or fungicides. Other natural, plant-based materials are hemp or kapok. Animal-based materials are wool and silk. These materials are available as organic [48].

Also, fibers can be ethical besides environmentally-friendly. For example, peace silk refers to an alternative and more ethical procedure of gaining silk fibers. This process avoids the boiling of the silk cocoon and the killing of the silkworms [49]. Another example is mulesing-free wool. The standard procedure of wool shearing is to partially cut the sheepskin to decrease skin infections by parasites. Mulesing-free wool avoids this practice [50].

Consumers are shaping the trend of new fibers and processes. For instance, consumers following a vegan lifestyle will avoid all animal products such as wool and silk. Organic fibers have a lower environmental impact, but not in all impact categories, although, most consumers are not aware of this fact. Organic cotton has been criticized for offering lower yields and being water-intensive [51]. For example, synthetic fibers such as polyester have a negative environmental impact as they are derived from petrochemicals and oil, but they need less water in their production. Therefore, we extended this category to *low impact fibers*.

There is extensive literature available concerning the topic of sustainable and biodegradable fibers, textiles, and apparel, including the use of LCIA tools to measure environmental impacts: Notable works are by Blackburn [52–54]. Alternative fibers are, for example Lyocell fibers, also called Tencel, and made from cellulose. Food sources such as fibers made from soy [55], milk [56] or coffee [57] are used, as well as food waste which is recycled, including orange waste peels and seed [58]. Another example from nature is algae fabric [59].

This category is also highly attractive to companies and brands. One of the first companies' implementing this product solution is Patagonia. This US brand based its management on sustainable development and aimed to offer innovative and efficient products [60]. As their design strategy, they solely use organic cotton and focus on both the product quality and sustainability [21]. The quality of a product is linked with a longer lifetime. If textile materials are durable, this can prolong the product life and decrease its impact. Also, consumers tend to prefer natural to synthetic fibers [61]. However, the fibers' COO is another concern, according to The Ethnicity report [62]. French consumers have a higher interest of knowing the origin of raw materials and production location than focusing on the production process and its environmental or social impacts [63]; for instance, local suppliers can shorten the transport and thus lower the environmental impact. Another solution for more sustainable materials is the use of recycled fibers, as described in the following.

#### **b) reuse and re/up-cycling**

The “reuse and recycling of materials” is another important method to achieve environmental sustainability, using besides pre-consumer waste, i.e., manufacturing scraps, also post-consumer waste in terms of old clothing, and other materials such as bottles and tire [47]. With the need for fewer resources, the environmental impact can be decreased; similarly, decreasing waste and landfill. Well-known concepts are the three R's (3R) reduce, reuse, and recycle, as well as the circular economy, where the traditional linear process transforms into a

circular by using circular design. When designing for recycling, there are the following main concerns: The material content and product accessories. A mixed material content which is most common nowadays needs to be separated into diverse materials. Clothing accessories in terms of buttons or labels need to be replaced before the separation. This process can be done by hand or by using specific recycling machinery and processes. The design can include the design for recycling (D4R) to ease the process of recycling. For example, using alternative closings or replacing leather with printed labels. Also, these non-animal solutions can be attractive for vegan consumers.

We further defined the recycling concept into down- and upcycling, either decreasing or increasing the quality. Therefore, we extended this category with the *upcycling* of materials. Most products contain a certain percentage of recycled content, being mixed with virgin fibers, as a problem of recycling is the lower quality. Achabou and Dekhili [64] found that recycled luxury products are perceived negatively as lower-quality products. The concept of upcycling means to increase the products' value. A notable example of this concept is the Swiss brand Freitag. The company is well-known for its initiative to recycle truck canvas and sells them as backpacks, bags, and other accessories made from this recycled material. Other recycling material sources are safety belts or bicycle tubes. The unique pieces sell at high prices; for example, backpacks range from €175.00 – €360.00 [65]. The design and the lower environmental impact add more value and suit customers' conscious lifestyles.

This concept has spread globally as other companies have been seen selling similar upcycled products. In Romania, the brand Upsidedown sells products Made in Romania, recycling old outdoor advertising banners and billboards. Also, this concept offers opportunities for communities. For example, REDU provides a lab to give workshops on how to creatively upcycle, raising awareness, and running a shop with collections made from textile waste [66]. In Turkey, the brand %100 ISTANBUL offers upcycled bags in their concept store, using seed or food sacks, and exhibition banners beside others. In Germany, the world famous sports brand Adidas got well-known for its launch of Parley for the Oceans. This initiative uses ocean plastic such as fishing nets and debris and recycles it to create new products such as sneakers. These success stories proof that recycling and upcycling are important methods, also aligning with consumer expectations. Next, we discussed other practices related to consumer consumption.

### **c) alternative consumption practices**

To consume more environmental-friendly, consumers try to buy fewer products at all or change their consumption practices. Besides “vintage practices and second-hand” [47], there are many more *alternative consumption practices*, with the most popular ones being renting (e.g., the clothing rental service Rent the Runway [67]), sharing (e.g., the peer-to-peer closet rental app Tulerie [68]), swapping (e.g., the trading website Rehash [69]) or leasing (e.g., the brand Mud Jeans [70]). Instead of products that have a short life as being worn only several times and then thrown away, the renting concept offers a shared wardrobe with other consumers. The leasing concept is based on minimalism, to own less and only what is needed. The service can become more important than a product itself. However, all concepts have in common to offer unique products along with the emotional value. Regarding vintage practices and second-hand, clothes are different from the mainstream market and can trigger nostalgic emotions. Also, modern developments change the way of consumption. For example, Lockett [71] explored the second-hand market in China, calling “Old is the New New”. This market has mainly shifted from an offline flea market to an e-market. Other reasons for second-hand purchases can be the lower price desired by consumers with low-income or the desire to save on garment purchasing. Also, second-hand offers advantages for certain types of clothing such as children wear. Children need bigger sized garments very fast due to their growth.

### **d) clean technologies**

Old and new “clean technologies” including information technologies [72] are another method to reduce negative environmental impacts [47]. Cleantech can include products, processes, and services. It is related to the sustainable use of resources, and the improvement of energy technologies, trying to reduce non-renewable resources. Technologies can relate to power and water, as well as transport, buildings, and infrastructure. Clean technologies can include renewables such as wind and solar (power), and electric vehicles (transport), but also, water efficiency or wastewater treatment (water, blue tech), or automation (buildings and infrastructure). For example, textile companies focus on the improvement of production, e.g., using less water during dyeing or using natural dyes, i.e., vegetable and plant dyes. Also, clean technologies can include social causes by using dyeing with traditional methods. In this context, companies are working with a non-profit organization to develop sustainable community-based projects. These clean technologies should be shared widely by using open source to develop sustainable practices further.

#### **e) green certifications and communication**

More and more consumers have been attracted to labeling for textile and clothing goods [73]. “Green certifications” such as the Ecolabel (<http://ec.europa.eu/environment/ecolabel>) are another important method [47]. This supranational EU label is a voluntary scheme, and also available for food and other consumer products. Often, labels include both environmental and social criteria. For example, the international Global Organic Textile Standard (GOTS) (<https://www.global-standard.org>) is a leading textile processing standard for organic fibers. The Fairtrade (<https://www.fairtrade.net>) label offers a higher price to exporters and producers, mainly from developing countries, to support better trading conditions. Also, the Fair Wear Foundation (FWF) (<https://www.fairwear.org>) is an independent, non-profit organization to improve workplace conditions. The registered trademark Oeko-Tex (<https://www.oeko-tex.com>) is known worldwide, offering test methods and product labels according to their standards. Also, there are country-specific, national certificates, such as the German Bündnis für nachhaltige Textilien (Textilbündnis) (<https://www.textilbuendnis.com>). Certifications need independent assessments by a third party of the entire supply chain.

Certification and labeling make ethical products recognizable and generally available, meeting consumer expectations, but can fail to influence consumers [73]. *Communication* strategies were included as they are essential in order to show added value to consumers, and help companies to promote their products and services by increasing consumer awareness. For example, using CSR communication tools such as social media in terms of Facebook and Twitter [74]. Notable research works include the following: Koszewska [73], discussed social and eco-labeling as a tool to communicate and differentiate products, conducting a study with Polish consumers about the recognition of eco- and social labels. Henninger [75] focused on the traceability, including consumer perceptions and micro-organizations responses. Clancy et al. [76] researched the sustainability performance of clothing design by applying eco-labeling criteria and found that the positive impact is still low. Besides the traditional design requirements, the design for green products follows specific eco standards, as discussed in the following.

#### **f) green product and process design**

Caniato et al.’s [47] last method “green product and process design” includes production technologies and services, as well as product characteristics and materials. Thus, this method refers to previously discussed practices, i.e., a green product can include one or all of the five solutions. For example, referring to the first method of organic fibers, a green product could

be a product using organic cotton. Still, this product could be toxic through other process impacts such as dyeing. Instead of using a single approach, multiple approaches could include, for example, more sustainable dyeing, i.e., using natural dyestuff to avoid chemical substances.

Other practices are digital printing, laser cutting, and zero or minimum waste pattern. Besides the product itself, a sustainable design also applies to the packaging and services, using improved packaging design or recycling materials (refer to the second practice of recycling), or giving consumers care advice to decrease washing temperatures and cycles. As mentioned before, consumers and their use phase influence the products' sustainability. Also, services such as offered by H&M with their Garment Collecting system can support a more sustainable product.

#### **g) ethical or local production**

Additional to green production technologies, we considered social considerations such as *ethical or local production*. They can be certified using the Fairtrade label as mentioned before, or by indicating the County-of-Origin (COO) and using Made-in labels. Ethical and local production can minimize environmental impacts as using local resources to reduce transportation. For example, Cappelli et al. [77] found a significant “premium price” recognized by consumers for Made-in Italy products.

#### **h) green appearance**

In addition to “green design”, the *green appearance* was added, i.e., the visibility of the design. More sustainability should be incorporated into the design to trigger trendsetting [78]. Researchers such as Joergens [25] suggested to include aesthetics - if ethical fashion is attractive, it can also attract young consumers. Also, classic or aesthetically appealing design can count as a green appearance. Simple clothing is more sustainable, such as a sleek black dress [78]. Style orientations lead to more sustainable patterns than do fashion orientations [79]. However, designers lack knowledge of sustainable design. Design is one of the major barriers as revealed by fashion professionals [80]: more attention needs to be on the product styles and aesthetics instead of the single focus on the use of environmentally friendly materials, such as cotton and hemp or other natural fibers. We discuss the eco-design appearance in the following section further.



### 1.2.3 Design Style

Despite all product influences, visual appearance is a critical factor [81]. The physical attributes of products influence consumers and their behavior, such as the likelihood to purchase. The design of product attributes is an essential part in the product development process as product and consumer characteristics can have an impact on sales; in fashion forecasting, color and design (pattern and other design elements) are critical but less researched [82].

Fashion has its own design language. Fashion is the style and design of clothes. Design is the basic product layout; whereby style refers to the product's outer look. The design description can be based on abstract, original, and concrete features of the product [83]. The visuals of a product can have aesthetical values and transmit impressions. Thus, style is the choice of a company regarding aesthetic and symbolic product features and their combination; and design semantics can describe a fashion product, and create or select a style [84]. The main elements of fashion design are the principles of silhouette, line, and texture, and their applications and combinations [85]. Whereby, the first impact of a garment is given through the silhouette or body (overall outline and shape); next, details such as variations on silhouette including volume are perceived [85]. In fashion, new collections in terms of products and styles, are created according to inputs such as trends and fashion themes [84]. These inputs can be based on existent concepts and ideas, and refer to materials, decoration or graphics, as well as colors and patterns [84]. Fashion companies and their brands can have a distinct style and symbolic value through which they compete [84].

There is an increasing importance of sustainability in fashion retail [86]. In this regard, fashion brands pay more attention to incorporate eco design into their fashion products, taking into account environmental impacts in the product development phase [87]. For example, Patagonia using organic cotton [78], Stella McCartney using faux-fur and -leather [88], and H&M Conscious, Zara Join Life, or Mango Committed using sustainable materials for their fast fashion products. On the other hand, consumers doubt the design style. Design is one of the major barriers of sustainable fashion [80]. Sustainable design and appearance are unfashionable or unattractive [78]. Consumers need more aesthetically pleasing designs [25, 89] but they also have a demand for dynamic and flexible products [90] (p. 297), or radical sustainable design innovations [91]. Eco-designed fashion products can have a distinctive style regarding an environment-friendly appearance. Niinimäki [89] (p.160) discussed the

usage of eco-materials such as hemp or linen well-known for their natural coarse texture, causing trends such as “creased linen” [92]. Also, there is an image of old-fashioned clothes:

Eco-clothing, very often, has a stereotypical image of conservation, thriftiness, and anti-fashion. Such styles are often associated with those of the 1960s’ hippie costume, like rope sandals, ethnic embroidery or tie-dye dresses, and crocheted or hand-knitted shawls. [80]

This perception is slowly reducing as eco-fashion style is changing, focusing more and more on the design. The design of eco-fashion can be mainly style or fashion orientated [79], focusing on simple and basic garments [78]. Contemporary eco clothing needs to balance ethics, aesthetics, and functionality. One of the pioneers in ethical fashion research is Joergens [25]: This author proposed that ethical fashion if fashionable can also attract young mainstream consumers. The perception of sustainable fashion products is observed to be unstylish, unfashionable or unsuited to consumers’ needs [78, 80]. However, this depends on the consumer, and on the country and its development as awareness can differ according to attitudes and values, which can be analyzed by using a cultural framework such as Hofstede’s Cultural Dimensions [93]. Some researchers studied how consumers will evaluate the eco-design [89], product appearance, and its visual information (garment style), and how it can influence consumers’ purchase decision-making [94]. They have two common concerns regarding the appearance of eco-fashion design. The first concern is the visibility of eco-values in the eco-designed garment. The second concern is the preference regarding eco-values in appearance and aesthetics of these eco-values. For example, Wang and Shen (2017) tested consumers’ acceptance through the analysis of online consumers’ comments on websites and their product scores.

However, consumer perception and the evaluation of the ethical fashion design style are rarely researched. There is a limited number of studies on eco-appearance and the visibility of eco-style. Several authors have researched consumer perceptions towards the general concept of ethical fashion such as the perception towards a fast-fashion sustainable brand extension [96], the slow fashion concept [34], or sustainable fashion and key criteria [97], or elements of fashionability in second-hand garments [98].

Concluding, there is not enough emphasis on the eco-design process, and there are some challenges when applying consumer analysis related to ethical fashion. First, there is no industry standard to define ethical fashion [25, 86]. Before analyzing the design, we need to identify all of the critical aspects of eco-design influencing the garment appearance. Second, human decision-making is somewhat subjective; Zhou et al. [99] highlighted this in their research for product design evaluation. And in particular, this is the case for the measurement

of human perception towards ethics. Studies on ethics are not always reliable, referring to the social bias or attitude-behavior gap [100]. When analyzing consumer perception, we need to consider that the data is qualitative and perception of consumers towards ethical fashion is rather uncertain and imprecise. Besides, sustainable product development and apparel design approaches are limited in consideration of human factors. To ensure the success of the eco-fashion product, the product design and development of eco-fashion needs more attention to better understand consumer expectation and perception of sustainable design [25, 78, 80, 89, 101]. And, the analysis of a garment allows for correcting and developing the design [85].

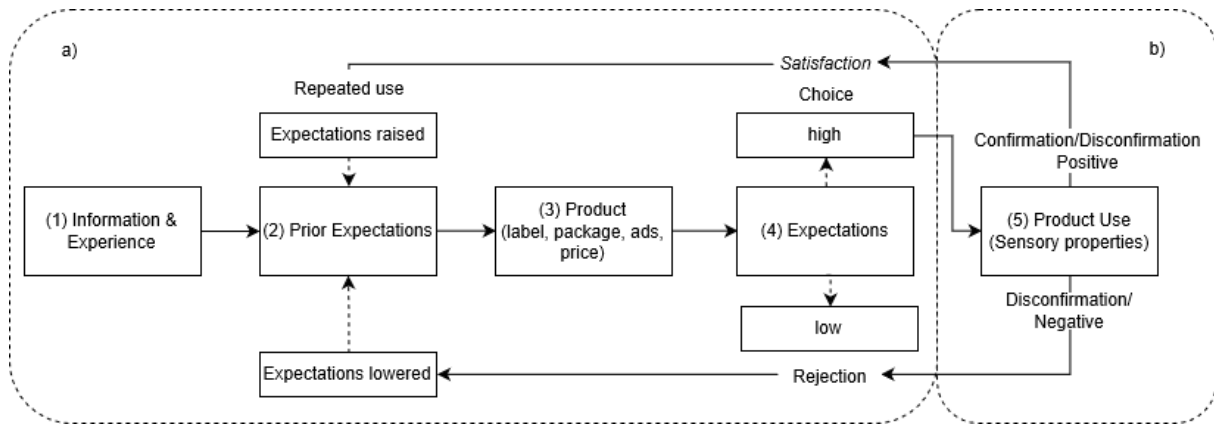
The knowledge of product appearance can help companies to design products for environmentally conscious consumers. Especially for sustainable products, the eco-design can be emphasized [102]. Environmentally friendly products could appear sustainable but also attractive. In this context, to acquire the corresponding consumer perception data on ethical fashion, the data acquisition methods are described in the following chapter.

## **1.3 Ethical Fashion Consumer**

Competitions have become more and more fierce in the fashion industry and consumers more demanding. Similarly, human emotions involved in the environmental and social impacts of fashion products have become more critical. The analysis of consumer perception is an essential part of consumer behavior theories and models.

### **1.3.1 Consumer Expectation: Awareness and Knowledge**

Expectations play an important role in consumer perception and the processing of product information [103]; and, consumer expectations can influence the purchase decision making [42]. Consumers can form certain expectations of ethical fashion products. Consumer perceptions can be multidimensional as both, informational cues and expectations are used when considering, for example, the garment quality [37, 40]. Figure 1-3 is illustrating the effects of expectations on part a) product selection (left side) and part b) product evaluation (right side) [104].



**Figure 1-3:** Schematic representation of the role of expectations on part a) product selection and part b) product evaluation [104].

This model shows that expectations on part a) product selection can involve (1) information & experience. These are forming the (2) prior expectations. Moreover, together with the (3) product, these can form the (4) expectations which can be low or high. All aspects of a product can create expectations such as intrinsic or extrinsic information cues including brand names, labels, and advertising (refer to Table 1-5) [104]. For example, Swinker and Hines [37] studied consumer expectations of high-quality garments and found that aesthetic expectations are related to “more style details.” Thus, consumer expectations related to the garment appearance in terms of image and style (intrinsic cues), could be influenced by style details, or the degree of fashionable [37]. Each product stage can have different expectations and related emotions [105].

Second, in part b) product evaluation, expectations can influence the sensory perception of the product while stage (5) product use [104]. For example, during product usage, expectations about product performance can be developed [105]. Expectations can lead to emotional response such as liking or disliking, influencing the (2) prior expectations again.

- **Awareness and Knowledge**

Furthermore, before consumers can perceive, they need to become aware [106]. Consumer awareness refers to the personal understanding of, for example, a brand, a company’s performance, service or product, or, consumer rights. Similarly, awareness can have an impact on consumer behavior: consumers’ awareness [107, 108], concern [107], as well as knowledge [109] influence behaviors and decisions. Awareness based on sustainability-focused values positively influences a responsible consumer behavior pattern [110]. Galbreth and Gosh [108] found that an increased level of awareness for sustainable products can be beneficial for firms; higher awareness can be achieved through marketing strategies such as

sustainability labeling initiatives. Thus, the impact of sustainability depends on the concern and the general level of awareness.

Regarding the purchase behavior, there are still too many consumers with limited or no awareness of the potential issues regarding the sustainability of fashion products [111]. Hence, there is a need for consumer education to create more awareness. However, regarding the ethical fashion concept, there is some continuous confusion. As seen in Figure 1-2 there is an overload of terms and shifting of meanings. Shen et al. [112] reported the American consumers' awareness using a quantitative survey; They defined eight sustainable fashion dimensions: (1) Recycle (2) Organic (3) Vintage (4) Vegan (5) Artisan (6) Locally made (7) Custom and (8) Fair trade certified. Respondents were most aware of recycle-vintage, followed by fair trade-locally made, and less conscious of organic-vegan, and artisan-custom [112].

For the ethical fashion movement, it is important that consumers understand the ethical values in the ethical fashion product. Therefore, this awareness dimension refers to the knowledge of the ethical fashion concept, and the following three elements.

**(a) definition and issues**

As various terms and definitions exist for the ethical fashion concept, it is important to analyze how currently, consumers understand this concept. This definition aims at the description of main environmental and social problems, along with issues within the fashion industry. Consumers can be asked to define critical processes within the fashion manufacturing to stimulate responses. Prior knowledge about the apparel industry can affect consumer attitude and intention [113].

**(b) product attributes knowledge**

The product attributes of ethical fashion are diverse (refer to 1.2). Ethical fashion attributes can reflect the conventional fashion concept in terms of similar or opposite descriptions such as slow and fast fashion. Alternatively, new terminology can be used, such as circular product design. Thus, the description of product characteristics depends on the level of consumer product knowledge.

**(c) un-ethical and ethical retailer knowledge**

As discussed before, the attitude-behavior gap in ethical fashion research can result in biased consumer responses. To avoid this gap, the actual identification of fashion retailers and brands regarding their corporate social responsibility (CSR) and the sustainability of their

products can determine the level of consumer awareness more accurately. The prior knowledge could have been obtained through companies' marketing efforts, social media, and news channels, as well as family and acquaintances and the workplace [38]. If a firm promotes sustainability, this could positively affect customers [108]. In conclusion, to determine the level of knowledge regarding the ethical fashion concept, consumers can be asked to identify ethical retailers and brands.

### **1.3.2 Consumer Perception: Purchase Interest**

“Ethical fashion consumer perception” has never been a more relevant research topic according to a Web of Science (WOS) [114] search, showing an increased research interest, especially in 2018. The search results can be found in Appendix 1 (Table A 1, Figure A 1, and Figure A 2). Existing literature concerning the topic of ethical fashion consumer perception is uncomprehensive but increasingly available; refer to Appendix 1, Table A 2. Notable works include Lundblad and Davies [115], Reimers et al. [116], and Dabija et al. [117, 118] (See Table A 2). Lundblad and Davies [115] explored frequent sustainable clothing consumers of sustainable stores, conducting in-depth interviews. Reimers et al. [116] found four influential dimensions: environmental responsibility, employee welfare, slow fashion attributes, and the most substantial influence was found in animal welfare. Dabija et al. [118] found that consumers prefer retailers who implement sustainable strategies; whereby Baby Boomers were most concerned [117].

Consumer samples can be derived from the general population or by focusing specifically on ethical fashion consumers. An overall understanding of sustainable fashion consumption will lead to insights into purchasing criteria and behavioral choices of sustainable fashion consumers [115]. Many studies are using student samples. Reimers et al. [116] looked at the academic definition and measurement of ethical clothing using a consumer household sample. They noted that convenience sampling could account for the attitude-behavior gap in research.

Lombart et al. [119] used the cue utilization theory as a framework to explain consumers' perceptions and purchase intentions toward misshapen fruits and vegetables. Zeithaml (1988) analyzed consumer perceptions of price, quality, and value, proving that price is the primary cue for product quality. The process of the cue utilization theory [42] allows product cues to be encoded by a perceiver: A general product cue such as the price information could be encoded by a rapid, unconscious initial sensory processing such as “cheap” or “expensive”; whereby, more specific cues in terms of dimensions and attributes, lead to more conscious

awareness. In the goal-oriented cue utilization process, a task goal could be “high quality”. Concluding, this process has two primary stages, which are the acquisition of cues and its information integration [42]. Swinker and Hines [37] found that the impact of particular attributes on consumer perceptions of quality is inconsistent.

Consumer perceptions of responsibility are based on sensory overload, hindering sustainable consumption [106]. Although, ethical fashion being trendy and a contemporary term, it still needs to be promoted. There are two concerns, with the first regarding the credibility of ethical within fashion. It looks like a paradox, as fashion and sustainability can be two contradictory concepts. However, there are already solutions to proof the concepts, mainly in terms of evaluating potential environmental impacts, referring to LCA.

For the ethical fashion consumption, it is important that consumers are interested in the ethical values in the ethical fashion product. Therefore, this dimension refers to the purchase interest, and the following three elements.

- **Purchase Interest**

Besides the characterization of consumers’ knowledge about ethical fashion, this dimension refers to the purchase interest. In general, it addresses the following elements of consumers’ recent purchase purpose, product attribute importance, and future consciousness of the ethical fashion concept, reflecting their intention to purchase ethical fashion products.

- (d) purchase purpose**

The fashion purchase history and personal relation with fashion can give valuable insights towards purchase intention. Insights can include details about previously purchased products and purchase reasoning. Thus, it can refer to the last fashion shopping experiences and which products and attributes were considered mostly during the search process. Consumers have to recall their last recent purchase to define essential shopping characteristics. References should be given to recent purchases. For example, East and Uncles [120] suggested referring only to the purchases which are done in the last half year, to achieve greater reliability.

- (e) product attribute importance**

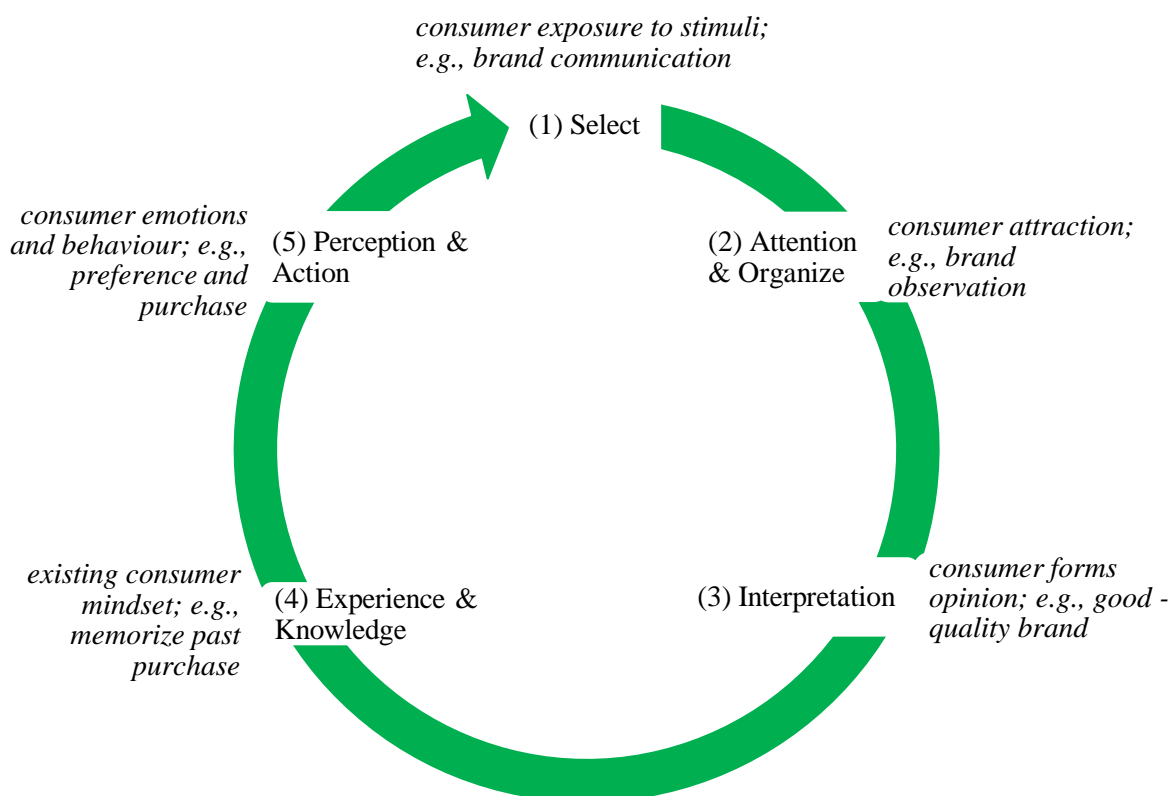
After defining the product attributes according to consumers knowledge, these attributes can be analyzed towards consumers’ importance scale, reflecting their purchase interest.

### (f) future consciousness

This last dimension focuses on how optimistic consumers are towards the ethical fashion concept in the future. For example, the high price of ethical fashion is often a barrier to purchase. The question arises if consumers would be more interested in more affordable ethical fashion.

## 1.3.3 Understanding Consumer Perception

Consumer perception involves several steps, see Figure 1-4. It is a process by which people select, organize, and interpret information [38]. The perception process starts with the selection phase by receiving information. And, the process ends with our perception and reaction [121]. Perception is based on experience and refers to existing knowledge. The experience of a person can be sensory, i.e., “relating to the use of the senses” [122]. Thus, in the perception process, sensory data is received, organized, and finally, an opinion is formed.



**Figure 1-4:** The perception process, adapted from [38, 121].

In this thesis, various steps of the perception process are studied. In a first study, we focused on consumer awareness and expectations which are formed by brands, as well as experience and knowledge. Finally, expectations can influence purchase decision making [42].



Thus, we also studied consumer preference and interest in terms of purchase action. In a second study, we focused on the interpretation of environmental impacts. Finally, we carried out two studies based on sensory evaluation. Two sets of descriptors can evaluate the perception of a garment product: First, basic and concrete sensory descriptors, independent of a socio-cultural context; Second, abstract and complex concepts, dependent of socio-cultural background [123].

In the proposed studies, both levels of consumer perception for ethical fashion products were considered. First, we evaluated the basic perception of ethical fashion products to generate normalized sensory descriptors of eco-fashion design style. The sensory evaluation method was used to extract socio-cultural independent perception. Furthermore, we applied the mathematical modeling tool fuzzy logic to process the perception data for a more objective characterization of the relationship between consumer perception and the design style parameters. Second, we analyzed the abstract and complex concept of environmentally-friendly in fashion product appearance. We defined eco-values to create more concrete eco-themes. Examples are organic, green and recycled or reduced. The Kansei engineering method was used to relate to socio-cultural dependent emotions. Finally, the visualization tools word cloud and mood board were used to support the definition of the eco-design concepts.

To conclude, the concept of ethical fashion is broad as there are multiple eco-fashion design solutions. Research on consumer behavior aims at the identification of consumer attitudes and consumption patterns, as to understand customers, and their expectations is increasingly crucial for the fashion business. However, brands and consumers are diverse regarding their environmental impact and awareness, leading to the need for definitions and consumer segmentation. Generally, consumers with high environmental awareness will expect high ethical values in fashion products. Fashion products can be ethical in several ways; and finally, to measure consumer perception of the ethical fashion product is essential to give clues for the success of the branded product. The characterization of consumer expectations and consumer perception on ethical fashion and design parameters is significant as to better understand the dynamic reality of the broad and subjective concept ethical fashion and to improve product development and design, as shown in the following chapters.

In this thesis, four studies were carried out, including different data acquisition tools to discover gaps between expectations and perceptions of the ethical fashion product. Concluding, we targeted three gaps with the studies:

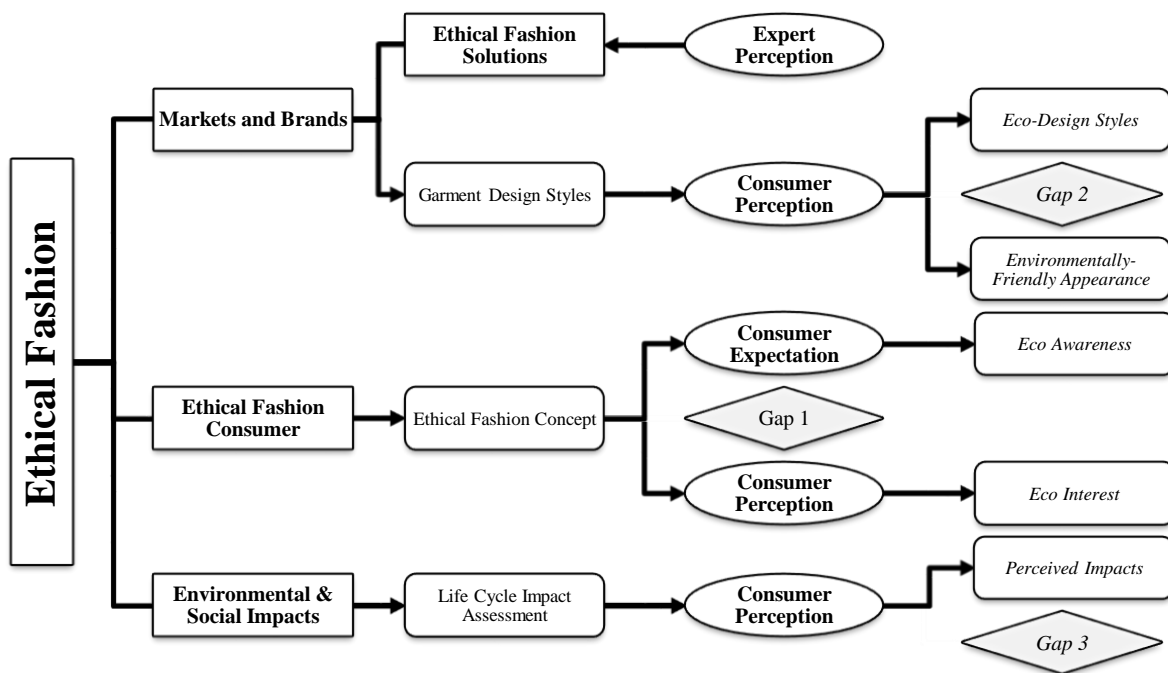
- 1) Attitude-behavior gap
- 2) Consumer eco style expectations and design parameters gap
- 3) Real LCIA and human perception gap

The first gap, the attitude or intention-behavior gap is one of the most common gaps in ethical fashion research, and still present. By defining what ethical fashion means for consumers and how they characterize the related issues such as purchase preferences, can help to predict their attitudes, and eventually their consumption practices.

The second gap, the consumer eco style expectations and design parameters gap is essential to address as the design style is crucial for successful ethical fashion products. Also, this topic has not been addressed in research. In this study, we designed and conducted sensory and Kansei engineering investigations to find out solutions for filling this gap.

The third gap, the real LCIA and human perception gap is important as to understand consumer knowledge, which influences behaviors and decisions [109]. Regarding the purchase behavior, there are still too many consumers with limited or no awareness of the potential issues regarding the sustainability of fashion products [111]. The identification of this gap also fills the first gap.

Ultimately, the final purpose of the studies is to evaluate consumer perceptions overcoming these gaps. For the conceptual framework, including the gaps, see Figure 1-5. The methodology used will be presented in the next chapter.



**Figure 1-5:** The conceptual framework of ethical fashion.

## Chapter 2. Classical Survey-Based and Sensory-Based Consumer Methods: Data Acquisition, Analysis and Visualization Tools

According to the discussions in **Chapter 1**, the characterization of human perception on ethical fashion constitutes an important issue. The analysis of ethical fashion includes consumer expectation, consumer perception, and designer expertise. In this chapter, we acknowledge various data acquisition methodologies. We present their main advantages and disadvantages. We conclude how the methods deal with different aspects of human perception, including the measurement of emotional response.

First, we describe the classical survey-based methods. In consumer research, these methods are subject to social bias despite their extensive use [124]. Next, we present the sensory evaluation and Kansei engineering methods. They are commonly used for extracting quantitative socio-cultural independent perception and socio-cultural dependent emotions on products, respectively. Based on these frequently-used human data acquisition methods, four studies were proposed to acquire the corresponding perception data.

Two first studies are based on the classical survey-based methodologies, see **Section 2.1**. *Study 1* aims to qualitatively characterize the relationship between consumer expectations and product design parameters. And, two other studies make use of sensory evaluation and Kansei engineering, see **Section 2.2**. *Study 2* identifies consumers' perception on product design parameters. And, word cloud and moodboard were applied as visualizations tools, see **Section 2.3**. Also, we used the fuzzy set theory as a primary mathematical modelling tool for formalization and analysis of extracted sensory data, see **Section 2.4**. *Study 3* identifies consumers' perception and emotions on product design parameters. *Study 4* quantifies human perception on real environmental impacts of a product. The detailed materials and methods of the studies respectively will be described in **Chapter 3**. The basic concepts are given in the following.

### 2.1 Classical Survey-Based Consumer Methods

Consumer behavior research, such as consumer perception of ethical fashion is based on consumer data. Researchers need to collect and analyze data in order to study and understand any phenomenon in the field of consumer perception. Consumer data can be either

quantitative (numerical) or qualitative (verbal responses or text). Quantitative research methods are used for the quantification of data, using various types of statistical analysis; while the qualitative research aim is to provide an accurate and deep understanding of the problem.

In order to acquire human perception data, classical survey-based qualitative and quantitative methods have been used. Qualitative data acquisition methods are widely used. Their approaches are less structured than quantitative techniques; they permit a profound understanding of consumer perception [125]. Consumers' reply can include their attitudes and feelings. Thus, these methods enable us to give new insights and reflect society. However, expert knowledge is needed for the interpretation of qualitative data. Commonly, qualitative survey methodologies are in-depth interviews and focus groups [126], survey questionnaires with open-ended questions, but also ethnography or observation studies. In consumer behavior studies, focus group sessions [25, 127] and questionnaires [128] are common methods.

Quantitative methods are, for example, multiple-choice, ranking, and rating method. Moreover, the most common methodologies are surveys with fixed questionnaires and multiple-choice questions. Other quantitative methods are comprised of experiments, physiological measures, and panel and scanner data. Quantitative research can be applied to establish a context-bound general framework (laws and restrictions) of consumer perception and reflect previous assumptions. Table 2-1 provides an overview of qualitative and quantitative methods and shows the general comparative differences [129, 130].

**Table 2-1:** Comparative differences in qualitative and quantitative methods, adapted from [129, 130].

Methods	Qualitative	Quantitative
Purpose	<ul style="list-style-type: none"> <li>- analysis of complex concepts</li> <li>- to profoundly understand all issues</li> </ul>	<ul style="list-style-type: none"> <li>- testing of hypothesis</li> <li>- to give a prediction</li> <li>- to draw wide conclusions for a target consumer group</li> </ul>
Sample	<ul style="list-style-type: none"> <li>- small numbers</li> <li>- usually non-representative cases</li> </ul>	<ul style="list-style-type: none"> <li>- large size, mostly a representative case</li> </ul>
Data	<ul style="list-style-type: none"> <li>- subjective (qualitative) (e.g., verbal responses or text)</li> <li>- un-structured</li> </ul>	<ul style="list-style-type: none"> <li>- objective (quantitative) (e.g., numbers)</li> <li>- structured</li> </ul>
Analysis	<ul style="list-style-type: none"> <li>- non-statistical</li> <li>- for patterns, features or themes (e.g., coding, word clouds)</li> </ul>	<ul style="list-style-type: none"> <li>- statistical</li> <li>- for statistical relationships</li> </ul>
Generalizability	<ul style="list-style-type: none"> <li>- findings are less</li> </ul>	<ul style="list-style-type: none"> <li>- produced results generalizable</li> </ul>

	generalizable	
Examples	- in-depth interview, focus group, or observation	- survey, or experiment

### 2.1.1 Survey

The survey techniques mainly depend on preselected and organized questionnaires aiming at a target group of customers. Participants could respond to various questions related to consumer behavior, and including attitudes, or awareness, as well as demographics. The usage of survey can follow different ways, such as verbal, in writing, using a computer, and responses can be recorded additionally. In a classic type of survey questionnaire, most of the inquiries are fixed response alternative questions. The respondents need to choose from a preselected set of responses. See an example of a survey question using a four point rating scale for consumer agreement towards ethical fashion in Table 2-2.

**Table 2-2:** Example of a survey question.

	Strongly Agree	Agree	Neutral	Disagree
I support ethical fashion products	O	O	O	O

- **Advantages**

Advantages of the survey are for example that it is easy to administer. And, the information acquired is reliable as answers are constrained with regard of choices expressed. And, utilizing established replies lessens inconstancy of outcomes, possibly through the diversity of participants.

- **Disadvantages**

Disadvantages of the survey are for example that the respondent might not be able or reluctant to give the needed information. For example, considering a brand in the sustainable fashion fields, respondents may not be deliberately aware of all brands and their motive for picking the explicit branded products or shops. Hence participants might not give exact insights related to the respective topics. Respondents might also be reluctant to react if the data mentioned is delicate or personal such as ethical discussions.

### 2.1.2 Group Administered Survey

The survey research can be divided into two main groups based on the data collection method, questionnaire survey, and interview survey. The questionnaire survey consists of the

group administered, or mail-in survey, while the interview-based survey includes a personal or telephonic interview-based survey.

In group administered survey, all the respondents are joined together at a common place and at the same time. Further, all the respondents are requested to complete the survey questionnaire in the same room. Respondents should complete their questionnaire individually without interacting with other respondents. This type of format is more convenient for research as a high rate of response is guaranteed. In case if respondents need more clarification on any particular question, they can ask for more explanation about the same.

- **Advantages**

Advantages of the group administered survey are for example, the uniformity in data collection. The researcher can control the conditions under which the survey is completed. And, there is a higher response rate. It is possible to complete a large number of questionnaires in a short period of time and with minimal effort. This leads to rich data collection. Also, it is possible to clear up ambiguities. The presence of the researcher while conducting the survey can be beneficial to clarify and understand the particular questions, which indirectly helps to avoid the errors in while collecting responses. Finally, this type of survey is an inexpensive survey type. [131]

- **Disadvantages**

Advantages of the group administered survey are for example, the presence of the researcher while surveying the same place might affect the anonymity of the respondents. The respondents could feel unsafe and reluctant to express their real opinion and feelings due to their safety. Hence this survey type can be inappropriate while surveying a group on sensitive topics. In this survey type, group dynamics along with the researcher may directly or indirectly influence individual responses. [132]

### **2.1.3 Focus Group**

The qualitative focus group is an often applied method. It is defined as a conversation between a few members, and led by a trained moderator; Mostly, this discussion is less structured to achieve more natural surroundings; While the moderator can be defined as the person leading and structuring the group conversation based on the research aim [130]. The focus group aims to get a deep understanding using the dynamic of the discussion and the comfort of participants who can display individual views. The participants can be asked

questions related to their feelings, emotions, and opinions about products; as well as their perception related to brands, or materials. The focus group study can be carried out for the identification of the customer view on current types of product such as a new brand, fashion product or a new type of textile fabric. This method can also be preferred, when the goal of the study is to gain a profound understanding of the discussed topic. The methodology enables the exchange of and impact on focus group members, giving rich data and a more natural environment [133].

In order to develop the focus group study, it is necessary to take care of the important characteristics. These characteristics are described as follows, see Table 2-3.

**Table 2-3:** Preparation of focus group [134, 135].

Participants	- participants should feel free and comfortable to discuss among each other and selected/recruited accordingly objective of the study - for diverse topics, the focus group can be separated; e.g., men vs. women
Moderator	- a moderator should be experienced, feel comfortable, able to maintain the flow of discussion, able to handle dominant participant
Length	- the usual focus group discussion time is between 60-90 min. - in case the discussion prolongs the group productivity, time can be reduced
Size	- size has to be sufficiently large to create content (data) and allow involving all participants. - in big sizes, care should be taken that any participant should not be left out
Composition	- pre-screened participants, and should be homogenous
Environment	- can be placed in a relaxed environment, members are able to talk freely - and the seating position should be appropriate so that all participants can see each other
Equipment	- in order to stimulate discussions, different means can be used such as the use of storyboards, mood boards, products, or brochure
Discussion guide	- an information sheet, containing the questions and the time assigned for each question, preselected and provided by the moderator. - the selection of questions should be done carefully and appropriately suitable for the discussion topic, easy to answer and able to create content

The mentioned characteristics are crucial to prepare the focus groups, as described in the following Table 2-4.

**Table 2-4:** Design and conducting of a focus group, adapted from [133, 134].

<b>Phases</b>	
Conceptualization	- research problem formulation, definition, and objective - identification of appropriate participants and role of the focus group to accomplish objectives - identification of place for conducting the focus group study - developing an estimation of resources

	<ul style="list-style-type: none"> <li>- specify the procedure, timeline, proposed budget and allow others (colleague or research supervisor) to review the plan</li> </ul>
Interview phase	<ul style="list-style-type: none"> <li>- recruit the participants</li> <li>- preparation and identification of suitable questions (5-6 or less than ten questions)</li> <li>- use of open-ended questions avoiding ‘yes’ or ‘no’ type</li> <li>- allow for unexpected questions</li> <li>- the moderator should be skilled and mentally prepared</li> <li>- run the experimental group and conduct the focus group</li> </ul>
Analysis	<ul style="list-style-type: none"> <li>- systematic and verifiable</li> <li>- collection and recording of short notes, summary, and comments while conducting study</li> <li>- data can be analyzed and reported at three levels, consisting of the following:             <ol style="list-style-type: none"> <li>1) raw data                 <ul style="list-style-type: none"> <li>- represents statements presented by participants</li> <li>- can be organized naturally according to themes</li> </ul> </li> <li>2) descriptive statements                 <ul style="list-style-type: none"> <li>- summarized into participants comments</li> <li>- illustrated using raw data</li> <li>- a further decision should be made on which comments to include and which to exclude</li> </ul> </li> <li>3) interpretation [133]                 <ul style="list-style-type: none"> <li>- complex process</li> <li>- interpretation of descriptive data should result in a meaning</li> <li>- leading to a conclusion rather than a summarization of data</li> </ul> </li> </ol> </li> </ul>

- **Advantages**

In general a focus group study offers several advantages over the other data collection techniques. The main strength of the focus group is that it can derive opinions, attitudes, and beliefs held by participants about discussed topics. This is an advantage since our society is generally busy and isolated to find opportunities to talk about important issues. In the focus group study, after the introductory session, the participants are able to discuss their feelings and emotions about the issues; and while being in a relaxed and comfortable group environment, the level of excitement increases over the topic [136].

Bringing people together to discuss a particular topic enables to collect more ideas, insights, and information in comparison with the individual responses received privately. In a focus group, security to discuss the topic increases. For example, if some participants can find their feelings or opinion similar to another group participant about the discussed topic, then they can reveal their thoughts more freely in comparison if the same topic or question was asked to them individually. The spontaneity involved in a discussion can lead to unconventional and spontaneous responses from the participant. Such responses can provide the correct information about their views. The structure of the group discussion allows



flexibility about topic discussions, and in-depth as targeted by the researcher or moderator. The structure can further be correlated with logical structure as per the participants view, or language. The group discussion is able to provide a close analysis of data collection, as many individuals can participate and validate it. [130]

- **Disadvantages**

There are numerous issues in getting potential participants to participate actively in focus group discussions. Although when they have consented to take part in the discussion, there are problems to find all participating individuals to be available at the same time. In the focus group discussion study, in general, there is less control over the group and uncertainty about information. The data will be able to be collected at the end of the session. The data collected from the focus group study is disorganized and messy. And, such data is difficult for further analysis and interpretation. Unless, the analysis is based on academic support or controlled with a proven methodology for reliable interpretations. Moderators can unknowingly or knowingly bias the outcome by providing indications about what type of result is required. The nature of the outcomes relies on how well the discussion is carried out, and at last on the skill of the moderator. [130, 137]

In general, this type of study is a useful tool. A discussion is able to contribute to large sets of data, for all members have been actively involved and the discussion session is executed successfully. The focus group study ought not to be utilized as a procedure for getting individuals accord or test knowledge.

## **2.1.4 Expert Interview**

An expert interview is a qualitative type of research method developed since the early 1990s to explore expert knowledge. There are many studies published using this methodology, and thus a gap in the methods' literature has been managed a lot to the advantage of many disciplines and areas of research in social and behavioral science. [138]

An expert interview is an interaction between the interviewer and a field of expert, or a group of experts or specialist in the area of a particular field. In comparison with the typical respondent, this type of respondent is having profound knowledge and expertise in the research object, resulted from the actions, responsibilities, and tasks related to a particular position in a specific institution or organization. [139]

The main objective of the expert interview is to obtain additional, reliable information, and authoritative serious opinions and professional assessments of the research topic. The

viewpoints of experts help to broaden the research objective and the validation of information related to the research objective in comparison with the literature study. It is also helpful to improve the quality of data related to the research objective. This type of research consists of an open nature type of questions, which allows an expert to provide their suggestion and viewpoint on issues under research, to evaluate and foresee the potential alternatives. [140]

- **Procedure**

The expert interview procedure maintains the semi-formalizing or non-formalizing type of interviews. In a semi-formalized interview, the questions on the research topic are prepared in advance, but the expectation of answers related to these questions is unclear. In the case of the non-formalizing type of interview, the questions do not need a comparison with the answers. This type of interview is exciting as different respondents provide diverse viewpoints or opinions related to the questions, and the researcher can further select the essential questions during the conversation or questions from a set of pre-prepared questions.

- **Planning and stages of expert interview**

The first stages of the expert interview consist of the research topic planning, and the preparation. The preparation includes the presentation of the research topic, as well as the condition of the interview. Also, the expert interview needs the sampling-identification of potential experts in the relevant field of the research object, as well as the interview-formulation on key research questions or topics to get detailed insights on the research objective. The final steps are the transcript of records, and the analysis and interpretation of data.

In order to carry out a good expert interview, it is vital to identify the required number of experts for the undergoing research objective, and the appropriate selection of experts in the related research area. This step is particularly significant when the phases of the research work are constrained in time and resources. It is necessary to establish a sampling model related to fundamental research questions before conducting directly field interviews. Based on it, a further complete and reasonable selection of experts for the interview can be carried out. Per the criteria that depend upon the selection of experts as an expert, a representative sampling of respondents should be conducted. The criteria for the selection of an expert are consisting of education, skills, work experience in the field of the research object, public recognition related to research objectives, process or technical expertise, as well as the position in the institute or organization.

- **Analysis**

The expert interview is frequently analyzed by subjective interpretation. But due to limited resources, a more detailed word-based analysis is hardly possible. The analysis also includes the process of transcription, paraphrasing, headlining, thematic comparison, and scientific conceptualization. The expert interview transcript forms the basis for the analysis. For resource reasons, often some part of the interview is taken into consideration while the other part is paraphrased or summarized.

- **Advantages**

The expert interview aims at the collection of reliable data since respondents' ability and expertise is high in the particular field of the research objective [141]. Due to the high competence of respondents, further additional screening and elimination of data is not required. This makes the expert interview a less time-consuming method. And, this method is a fast way to obtain specific information and a new or unknown area of the research objective.

- **Disadvantages**

The disadvantages of the expert interview are the time restrictions to conduct an interview, the difficulties in finding appropriate experts, a small set of data, and the possibility of flaws in the information received from an expert.

## **2.1.5 Methodological Criticism**

Despite the importance of acquiring consumer perception, the classical methods can be biased. Previous research on ethical fashion has shown that the perceptual parameter ethical causes methodological issues in traditional data collection tools. For example, the attitude-behavior gap or social bias is a well-known problem in ethical fashion research [25, 100, 127, 142, 143]. The definition of ethical is morally good or correct. In general, ethics affect pro-social behavior, and respondents of surveys including questions related to consumers' ethical commitments are likely to give socially desirable answers. Therefore, even there is more concern about ethical issues, the behavior is not affected, i.e., it does not drive towards sustainable purchase behavior [127]. It is necessary to understand consumers' perception regarding the concept of ethical fashion, by asking them "What is sustainable fashion?" [97] to reduce this attitude-behavior gap and to avoid negative perception such as greenwashing [144]. Furthermore, knowledge gaps exist due to the diverse topic. Classical consumer

behavior studies focus on general consumer perceptions. The relation of fashion design style and ethical perception is less researched.

## 2.2 Sensory-Based Consumer Methods

The sensory evaluation and Kansei engineering methods were considered for the following reasons. Standard sensory analysis is generally used to extract human perception on basic features of industrial products. It is independent of the concerned social and cultural environment and does not deal with human emotions. In the same way, Kansei engineering is used to characterize human emotions on industrial products.

### 2.2.1 Sensory Evaluation

Apart from the classical survey-based human data acquisition, human perception and human behavior can be characterized by using the sensory evaluation and Kansei Engineering (KE) methodology. According to the Japan Society of Kansei Engineering [145], before Kansei Engineering originated, the term Sensory or Sensitivity Engineering was used [146]. The Japanese meaning of Kan and Sei means sensitivity or sensibility. Nowadays, the term is just defined as sensitivity. However, “*sensitivity* is not complete as the meaning as Kansei”, as it also includes taste/sentiment, feeling and emotion [147]. Sensory evaluation is at the interface between Kansei Engineering and fabric objective measurement [148].

The sensory evaluation is a scientific method of studying reactions to stimuli perceived through human senses. The sensory evaluation is defined by the ASTM E253-15a (the American Society for Testing and Materials) as a scientific discipline used to evoke, measure, analyze, and interpret responses to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing [149]. Also, “sensory analysis” is defined by the ISO 5492 (the International Organization for Standardization) (2008)<sup>1</sup> as “science involved with the assessment of the organoleptic attributes of a product by the senses.”

The use of sensory evaluation has been significantly practiced in the product evaluation process. Sensory studies can identify the relationship between human factors, including consumer needs and perception, and product elements, including design appearance or style. Thus, sensory evaluation can be used to analyze consumer perception towards consumer products and support product development. Sensory evaluation is mainly applied in the

<sup>1</sup> This second edition cancels and replaces the first edition (ISO 5492:1992), which has been technically revised.

automotive, food, and cosmetic industry, but also gains more relevance in the fashion industry. Even though the research in the development and application of sensory evaluation techniques has been prominently seen food science area, the same methodology can be useful in non-food product evaluation [150].

- **Sensory panel**

The sensory evaluation can evaluate sensations objectively applying a panel of people, the so called “sensory panel” [151]. This panel is characterized as a group of people united in order to study the sensory attributes of a particular product. As per the British standards BS EN ISO 5492:2009+A1:2017 of sensory analysis, the sensory panel is defined as “group of assessors participating in a sensory test”. The people who participate are the most significant resource of the sensory evaluation process. It is essential that the most eligible and appropriate people are enlisted, screened, and chosen to participate in sensory tests; they ought to be given the vital preparing to enable them to finish the test effectively. In general, all the participants should be treated with respect and considerations [152]. The participants involved in sensory analysis can be divided into different categories, such as the following:

- **Trained/expert assessor:** a person who is a professional expert in a particular field of research objectives and is able to form sensory judgements with a high level of accuracy.
- **Sensory participant:** 1) a participant specialized in qualitative description: a participant is trained and able to evaluate the sensory product attributes using linguistic terminology; 2) participant of free choice: a participant is which is not trained or screened and has been used for sensory evaluation with naïve consumers. This type of participant is able to describe the product attributes or characteristics in their own words. [153]
- **Consumer:** a (potential) user, engaging in the sensory evaluation process in order to provide his/her opinion of products, as defined by ASTM E253-16 [154].

Hence while performing sensory evaluation, it is necessary to consider the panel of evaluators. The identification and selection of appropriate evaluators are essential since people may react in a different way to diverse stimuli. Their sensory abilities can vary the output of evaluation objectives.

- **Sensory evaluation process**

In order to carry out a successful sensory evaluation process, there is the need to consider the following elements which act as a foundation of the sensory evaluation program:

- Selection of research objectives and goal of the evaluation process
- Selection of sensory evaluation panel
- Test facilities
- Ability to use test methods
- The panel of qualified evaluators
- Planning of research program
- Establishments of the evaluator screening process
- Standard test request and reporting procedures
- Data analysis
- Report preparation

These are fundamental elements which are helpful to conduct the sensory evaluation process related to the selected sensory product attributes. These elements can vary depending on the different experimental design and product attributes. For example, the change of the expert panel also depends on the selected type of product for the sensory evaluation. The selection of the questions in the questionnaire should be carried out carefully. This careful selection triggers true and exact perception about the product. The evaluation procedure should aim at extracting the maximum information related to the evaluated product. Also, while designing the experiments for sensory evaluation, the above-mentioned factors such as research planning, strategies, and methodology, play a vital role. These factors can influence the sensory evaluation experiment in terms of preparation of sample size, presentation of sample, or data analysis process.

- **Sensory evaluation methods**

In sensory evaluation, a panel of human evaluators is required to test their perception based on the evaluated product. Further, the perceived data is analyzed using statistical methodologies in order to make inferences and insights about the properties of the products. The sensory evaluation can be separated into two categories of testing: objective and subjective. In the case of objective testing, the sensory evaluation of product attributes can be carried out with the help of a panel of expert or panel of trained people. The experts need to be experienced in sensory evaluation and require a higher level of accuracy. In subjective testing, the sensory properties of the product are measured based on the consumer's reaction.

The importance of sensory evaluation can be determined when these two elements can be combined to understand, how sensory attributes of product drives consumer acceptance and emotional benefits. [152]

A wide scope of techniques have been developed and utilized for sensory evaluation, divided into three main categories, such as descriptive, discrimination, and affective [155]. In the descriptive analysis, sensory attributes of stimulus are described and quantified by the panel of evaluators, as defined by ASTM E253-15a [149]. This descriptive analysis category also consisting of other methods such as Quantitative Descriptive Analysis, Qualitative Descriptive Profiling, or Free-Choice Profiling [155]. In the case of determination of the difference between two or more stimuli, the discrimination methodology is used such as Duo-trio or paired comparison test [149]. Product acceptance and preferences are determined using affective methods of sensory evaluation [155, 156].

- **Sensory evaluation in textile**

Good feelings and sensory attractions significantly drive an increase in a consumer purchase. This tendency can be prominently seen in modern consumer purchase behavior in the garment industry, more than in any other industry [156]. Desirable comfort and feeling aspects are becoming important in successful textile marketing strategies [156]. In textile apparel products, sensory evaluation is mainly focused on its appearance and tactile properties [157]. Considering this, many researchers studied the importance of sensory evaluation in textiles [151, 158, 159]. Schacher et al. [151] summarized the evolution of sensory analysis for textile materials: Sensory analysis for textile materials in terms of wool fabrics was firstly approached by Binns in 1926 [160]; the approach of sensory analysis of tactile feeling of textile fabrics was further advanced in France such as by Depledt [161], Cardello et al. [162], Philippe et al. [156], Chollakup et al. [163, 164], and Bensaid et al. [165]. [151]

In many research articles, the sensory term is used in exchange for tactile or touch sensation. Kwok et al. [166] studied the sensory comfort of denim jeans to understand the lack of information on describing the relationship between human responses and denim wear, considering different product attributes, and the satisfactory level of hand feel along with moisture and pressure comfort. In this study, the authors found that moisture comfort and pressure comfort are the most important considerations for denim apparel purchases in both summer and winter, and denim fabric should be light, smooth and not too thin to provide a satisfactory level of hand feel. [166] Cardello et al. [162] studied the two fundamental psychological aspects of sensations produced by fabrics in contact with skin: The first

dimension related to specific sensory attributes being perceived, for example, roughness or stiffness and another dimension includes the perceived magnitude of that sensation such as very rough or slightly stiff. These dimensions are further analyzed statistically to predict consumer comfort from the sensory and instrumental evaluation [162]. Wang et al. [167] created fashion sensory data for style, color, and image. Pu et al. [168] used successfully sensory evaluation for a children raincoat design development case study based on an objective analysis of user needs using FEA (Functional, Expressive, Aesthetic) Consumer Needs Model.

- **Intelligent modeling in sensory evaluation**

The sensory evaluation process is complicated, time-consuming, and expensive. Hence, there is a need for a reliable mathematical approach to model the relation between various sensory attributes. Furthermore, this can become beneficial for the product development process or quality development. In sensory evaluation, related mathematical models and data processing methodologies vary for sensory data collected from different reliable panel groups. The sensory evaluation depends on the information acquired in a sensorial manner by the panel of specialists that are involved in the evaluation procedure. An appropriate mathematical formulation is very challenging due to the human perception being subjective instead of objective; because the evaluation of sensory attributes provided by individuals is unclear and vague. For example, Birle et al [169] claimed the creation of a model for the quality of a product challenging, due to being affected by our senses and culture.

In the beginning, the sensory evaluation uses the classical computational techniques. These built on statistical and factorial analysis, such as principal component analysis, multifactor analysis, linear regression analysis, or correspondence analysis. These methods are found to be inefficient in dealing with the issues in sensory evaluation. There are uncertainties that have a non-probabilistic character since they are associated with unclear and imprecision in meanings [170]. The use of methods as discussed before will cause significant data loss because a) they compute only, big numbers of numerical data, b) these classical methods are unable to interpret the physical results precisely c) frequently a non-linear relation occurs.

Since there is a need of new methods, intelligent methods such as fuzzy logic, data aggregation, classification, neural networks, or clustering are applied to solve the vagueness in the sensory evaluation field. The reason to use these intelligent techniques in our study of sensory evaluation is that: a) these methods are able to compute linguistic and numerical data



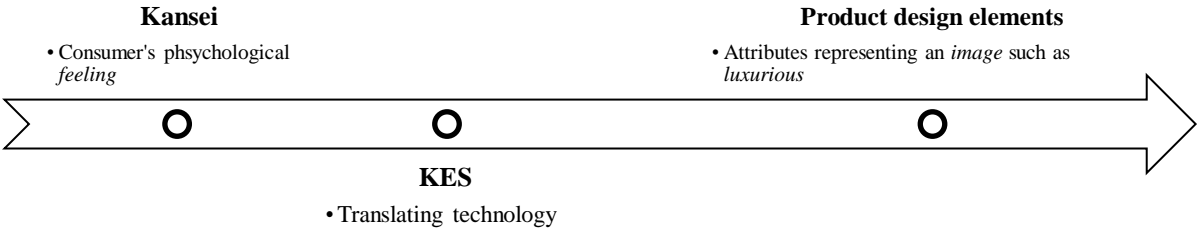
considering vagueness and uncertainty in the data, b) these methods consider non-linear relation in sensory evaluation analysis, and c) these methods are able to interpret the physical results accurately

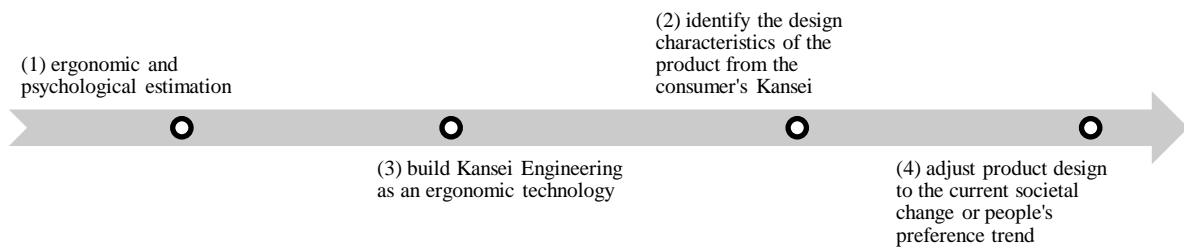
However, till then, no study has published a complete sensory analysis of eco-fashion products giving importance to its eco product attributes, sustainable textile processing technologies, or new fibers. Hence, it is also important to conduct a sensory evaluation in the eco-fashion field, considering these new influential attributes for a better understanding of consumer perception. In this context, sensory evaluation is used to measure the relations between the garment design style and the evaluation criteria of eco-fashion as described in **Section 4.2.**

### 2.2.2 Kansei Engineering

“When a consumer wants to buy something, he or she has an image of the product as *luxurious, gorgeous and strong.*” Consumers have many things which they do not want any more [171]. This consumer behavior is truer than ever; People nowadays are having too many things and are becoming more selective when purchasing new products. Thus, consumption depends highly on a personal preference, including their feelings [171]. From this, it can be concluded that the demand for things is low, but the demand for emotional things is high. Therefore, the question arises what is the image and feel of an ethical fashion product for the emotional conscious consumer?

Previously, the Kansei engineering methodology has been applied in the automotive, food, and non-food industries [171]. Similarly, the sustainable movement has started with non-fashion related products in terms of slow food [32]. Kansei engineering is a methodology combining product and engineering design, also called affective or emotional engineering. This consumer-oriented technology originated from Japan, and was developed as a new product development process; The Kansei engineering system (KES) can show the relationship between emotions (“consumer's feeling and image for a product”) and product attributes (“design elements”) [171], see Figure 2-1.





**Figure 2-1:** The general process of a Kansei engineering system (KES), adapted from Nagamachi [171].

This technology is based on the following four points, as suggested by Nagamachi [171]:

(1) Ergonomic and psychological estimation: “customer Kansei” [172]

Words can be collected from shops or magazines; first, a vast amount of Kansei words (KW) is collected, then, the most relevant words are selected. [171] Thus, KWs are used to measure affective values and to represent consumer perception. For example, for the Slow Fashion concept, word pairs can be “slow – fast” or, “unique – mass”, see Table 2-5. To get the consumer’s Kansei, the semantic differentials (SD) is used, synonym and antonym which was developed by Osgood et al. [173]. The 7 point Semantic Differential Scales is preferred [146, 172–174].

**Table 2-5:** Example of Kansei Words.

Kansei Words			
slow – fast	unique – mass	artisan – modern	costly – cheap

For example, the Semantic Differential (SD) scale for the Slow Fashion concept including the adjectives “slow” and “fast”, can be constructed as a 7-point SD scale with 1 being “extremely slow”, and 7 being “extremely fast”, see Table 2-6.

**Table 2-6:** Example of a Semantic Differential scale for slow-fast.

1	2	3	4	5	6	7
extremely slow	very slow	a little slow	moderate slow	a little fast	very fast	extremely fast

(2) Identify the design characteristics of the product from the consumer's Kansei

A survey or experiment is conducted to find the relations between the KWs and the design elements [171]; whereby most Kansei engineering evaluations involve customer surveys [146].

(3) Build Kansei Engineering as an ergonomic technology

Advanced computer technology can be used to build a systematic framework, using Artificial Intelligence (AI), Neural Network (NN), Model and Genetic Algorithm (MDA), and Fuzzy Logic; these tools can construct the concerned databases and computerized inference system. [171]

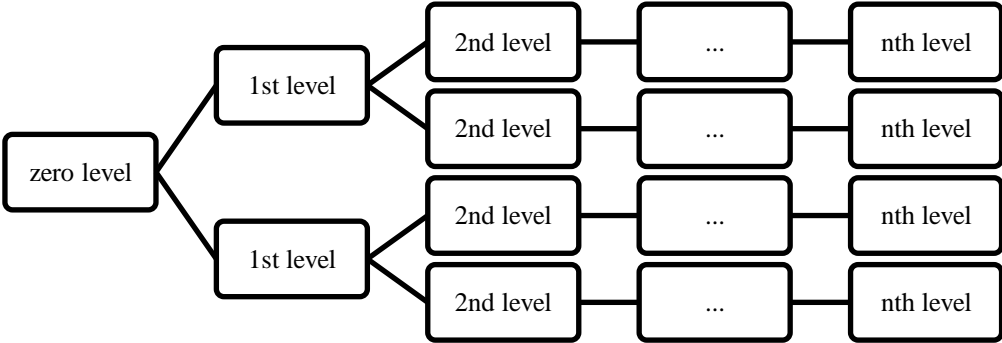
(4) Adjust product design to the current societal change or people's preference trend

The databases can be adjusted to the consumer's new Kansei trend. In Nagamachi's research [171], it was suggested that the new Kansei consumer data can be inputted every three or four years. For the current Kansei engineering research, the fast changes in trends are an important challenge. Schütte [146] now recommends to collect both, new Kansei words and product properties, each time a Kansei engineering study is made due to "trend sensitivity", causing the semantic descriptions to have a short life; quick changes of trends affect the perception of ancient product features quickly [175]. However, the level of trend sensitivity varies between products, with fashion products having a high trend sensitivity and a short product life cycle time [146]. As ethical fashion products intent to have a longer life cycle, their trend sensitivity should be lower, i.e., Kansei words or semantic descriptions and product properties are supposed to change slower than for fast fashion products. This assumption needs to be further researched. To identify new Kansei trend data, current keyword research can be carried out, using, for example, Google Trends Analysis, or Social Media Analysis.

The Kansei engineering procedures include three styles: Type (I) Category Classification, (II) Computer system, and (III) Mathematical model, as suggested by Nagamachi [171]:

(I) Category Classification

In order to identify the design details of a product, its Kansei category is broken down in the tree structure, see Figure 2-2 [171].



**Figure 2-2:** A schema of a Kansei tree structure, Nagamachi [171].

(II) Computer system

The computer-assisted Kansei Engineering System (KES) has four databases: (i) Kansei (word) database (through Factor Analysis, the Kansei word meaning space is developed using the Kansei word process), (ii) Image database (SD scales results are further analyzed with Multiple Regression Analysis, to relate design details to Kansei words), (iii) Knowledge base (rules), (iv) Design and color database (both the parts are combined in the inference system, and displayed in graphics on the screen [171]). The KES can be applied to either supports the consumer's decision ("Consumer-supporting KES"), for example, the FAIMS (Fashion Image System); or the designer's decision ("Designer-supporting KES") [171]. Already, this KE Type II has been applied by Nagamachi et al. [176] to clothing design, i.e., to costume design for a college girl.

### (III) Mathematical model

Mathematical model construction is, for example, the Sanyo Co., using Fuzzy Kansei Logic [171]. In this context, the consumer-supporting KES could be applied for an ethical fashion image system applying mathematical modeling such as Fuzzy Logic.

Concluding, Kansei engineering differs from sensory evaluation as it can include human emotions on ethical fashion design. In this thesis, consumer perception related to an environmentally-friendly image is analyzed.

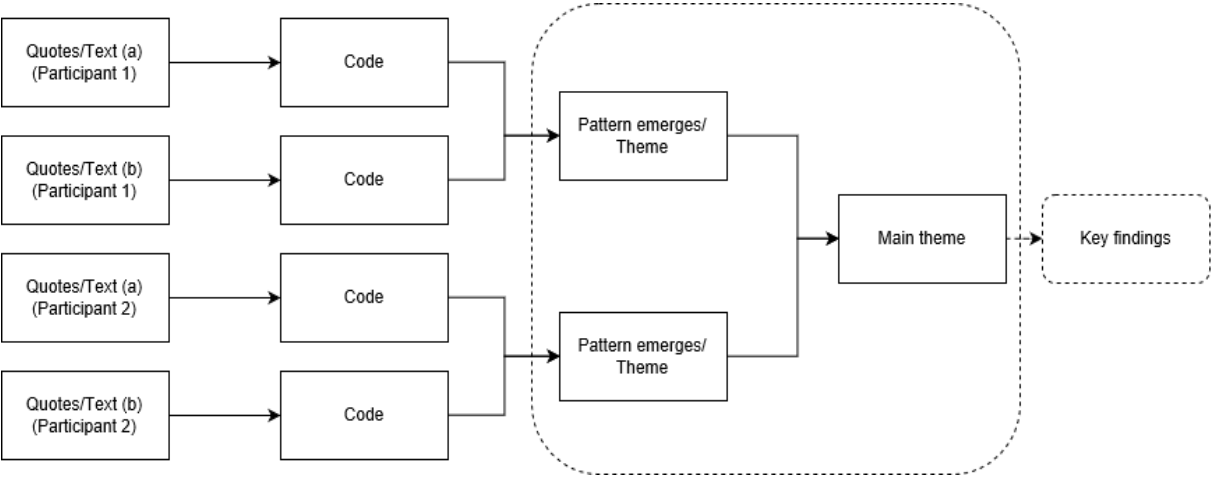
## **2.3 Visualization Tools**

The visualization tools were considered for the following reasons. Word cloud and mood board can easily visualize concepts and data, and support consumer experiments. In the case of ethical fashion, these tools are especially helpful to define the vague and diverse concepts. Accordingly, word clouds were used in Study 1 and Study 2, whereby mood boards were used in Study 2-4. The basic principles of the visualization tools are described in the following.

### **2.3.1 Word Cloud: Counts and Codes**

Visualization techniques and methods such as word cloud and mood board can help to define design concepts. So word clouds are a quick and easy way to visualize large amounts of data [177]. For example, Cappelli et al. [77] used word clouds to analyze the perception of "Made in Italy" characteristics and the leading brands. Qualitative data such as open-ended text responses from surveys or user-generated content from social media can be quantified

using simple frequency counts. Also, coding can be used, see a schematic example of the coding procedure in Figure 2-3 [178, 179].



**Figure 2-3:** A schematic example of the coding procedure, adapted from Johnstone [179].

### 2.3.2 Mood Board

Fashion designers use mood boards as a visual tool to facilitate the definition of products. Mood boards are a collection of images (and objects) to represent a design brief, including particular emotions [180]. The mood should aim to fulfill the expectations of a designed product. Researchers have applied mood boards as visual qualitative methods. Murto et al. [181] used image boards as an interview stimulus in design to identify consumer beliefs for environmental sustainability from the appearance of products related to ship interiors. Carey and Cervellon [182] used mood boards to analyze consumer perceptions of ethical fashion dimensions.

## 2.4 Mathematical Modeling Using Fuzzy Theory

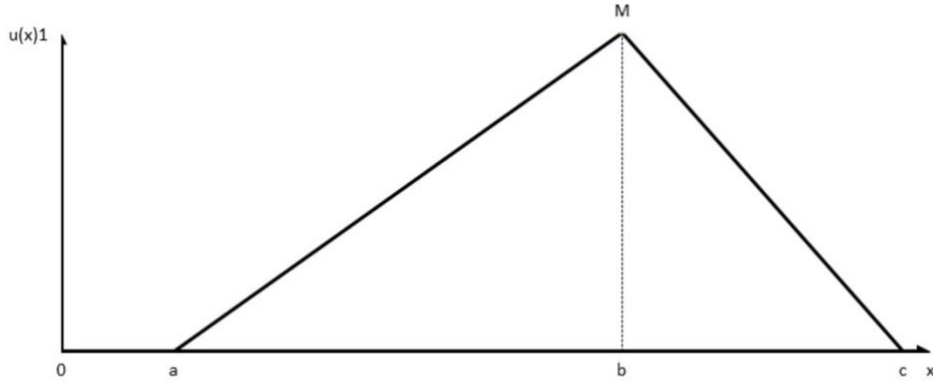
Mathematical modeling tools such as fuzzy logic can process the perception data to give a more objective characterization of the relationship between consumer perception and design parameters. As described before, according to the modelling problem for data analysis due to the uncertainty and imprecision with acquired human data, and especially for ethical fashion data, fuzzy logic is selected. More details about the fuzzy theory are given as follows.

Many customer decisions are based on subjective factors. Mathematic modeling tools such as fuzzy set theory are used to process the perception data. Applied to consumer behavior studies, mathematical models can help to measure data and to forecast product

perception, as well as, group customers with similar data sets into customer segments. The following methods are discussed: Fuzzy Set Theory and Fuzzy Logic.

The data acquisition process has the following principles. The analytical data is collected from trained panels or experts; while the affective data uses untrained personnel or consumers, using smaller focus groups. The collection of sensory data uses pre-selected linguistic descriptors and evaluation scores. Data is often statistically analyzed, including linear regression analysis [183], and principal component analysis (PCA). PCA is used to study primary sensory variables and eliminate redundancy. Being a multivariate technique, the method simplifies and describes interrelationships among multiple dependent variables. PCA is a useful technique for sensory descriptive data when several dependent variables are collinear [125, 184, 185]. Another useful technique is the multiple factor analysis (MFA). This method is regarded as an enriched PCA and aims to evaluate numerous sets of data derived from one observation, using a set of common factor scores to evaluate communalities and discrepancies [186–188]. Other useful methods are the polarized projective mapping (PPM) [189] and correlation coefficient analysis [190], identifying linear patterns. Due to the uncertainty of human sensory data, relations can be nonlinear. And, applying statistical analysis might cause data loss. Also, as precise data is needed and other relations such as association relations cannot be identified. Intelligent computational techniques such as fuzzy set theory [191] can be used to deal with sensory data analysis and modeling.

The theory of fuzzy logic has developed with the fuzzy set theory by Lotfi Zadeh [192] and has been widely applied since then. The fuzzy set theory has some basic operations. The fuzzy set is defined by a membership function (MF) and operates within an interval of [0, 1]. This unit interval defines the degree of membership, where zero does not belong to the set, and one belongs entirely to the set, and in between belongs partially to the set. The linguistic terms of the rating scale can be quantified into triangular fuzzy numbers (TFNs) using n-tuples, see Figure 2-4.



**Figure 2-4:** Schematic sketch of the Triangular Fuzzy Number.

The TFN  $M$  is most commonly used and can be denoted as a triplet, see van Laarhoven and Pedrycz [193]:

$$M = (a, b, c), \quad (1)$$

where the parameters  $a, b, c$ , refer to the smallest, perfect and largest possible value:

$$a \leq b \leq c, \quad (2)$$

with the following triangular type membership function:

$$\mu_m(x) = \begin{cases} 0 & x < a, \\ \frac{x-a}{b-a} & a \leq x \leq b, \\ \frac{c-x}{c-b} & b \leq x \leq c, \\ 0 & x > c, \end{cases} \quad (3)$$

with the following operations for the fuzzy numbers for two TFNs, denoted as  $M_1 = (a_1, b_1, c_1)$  and  $M_2 = (a_2, b_2, c_2)$ :

$$M_1 \pm M_2 = [a_{1\pm} a_2, b_1 \pm b_2, c_1 \pm c_2], \quad (4)$$

$$M_1 \times M_2 = [a_1 \times a_2, b_1 \times b_2, c_1 \times c_2], \quad (5)$$

$$\gamma \times M_1 = [\gamma \times a_1, \gamma \times b_1, \gamma \times c_1], \quad (6)$$

$$1/M_1 = [1/a_1, 1/b_1, 1/c_1], \quad (7)$$

where  $\gamma \geq 0$ .

We used a set of fuzzy numbers to quantify the evaluation degrees, using TFNs for the 5-degrees scale (A-E), defined with the corresponding membership function as shown in the linguistic rating scale in Table 2-7.

**Table 2-7:** Evaluation scores, linguistic terms, and fuzzy numbers (TFNs).

Evaluation degrees	Linguistic term	Fuzzy numbers
A	Excellent	(0.75, 1, 1)
B	Good	(0.5, 0.75, 1)
C	Medium	(0.25, 0.5, 0.75)
D	Low	(0, 0.25, 0.5)
E	Poor	(0, 0, 0.25)

For example, for A (Excellent), the corresponding TFNs are 0.75, 1, and 1. To aggregate the data using Equation (4)-(7), the aggregation Equation (8) is used like the following to define the group decision  $a_m$ , for the group of evaluators  $m$ :

$$a_m = \left( \frac{1}{m} \sum_{j=1}^l a_{ijh} t_1, \frac{1}{m} \sum_{j=1}^l a_{ijh} t_2, \frac{1}{m} \sum_{j=1}^l a_{ijh} t_3 \right), \quad (8)$$

with the following sets:

A set of evaluators called  $h = \{1, \dots, 20\}$ , i.e., consumers C1-C20, and a set of evaluation scores  $a_i$ ,  $i = \{A, \dots, E\}$ , with respect to criteria  $j$ , then,  $a_{ijh}$  is the number of evaluators  $h$  selecting one degree  $i$ , and  $t$  denoted as triplets  $(t1, t2, t3)$ , referring to the triangular fuzzy number values, see Table 2-7. Finally, using Equations (4)-(9), the distance  $d$  between two TFNs can be calculated using the Euclidean Vertex Method [194]:

$$d(M_1, M_2) = \sqrt{\frac{1}{3} [(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2]}. \quad (9)$$

An example of the utilization of Equations (8) and (9) will be presented in **Section 4.2**. Fuzzy logic was applied to process the perception data to give a more appropriate characterization of the relationship with uncertainty between consumer perception and ethical fashion design parameters.



The described classical and sensory methods are able to characterize human perception data of ethical fashion design parameters, including consumer expectation and perception as well as fashion expert perception. The classical survey-based consumer methods have the issue of the attitude-behavior gap but can be used to gain new insights on the topic of ethical fashion.

The following **Chapter 3** will show the research materials and methods in terms of the procedures for data collection, analysis, and interpretation, accordingly. In the following **Chapter 4**, the classical survey-based consumer methods were applied to characterize the relationship between consumer expectations and design parameters qualitatively. To study consumer expectations, researchers used qualitative studies such as focus group studies or individual interviews [37]. As discussed in here, the classical survey-based consumer methods can be biased, but are useful for deep insights of complex concepts such as ethical fashion and the general fashion product.

Marketing research focuses on the product such as information and label; whereby sensory evaluation focuses on the appearance or texture [104]. Sensory evaluation methods “translate qualitative information into numerical data by applying a statistically valid experimental design and controlled testing conditions” [195]. In **Section 4.2** and **4.3**, sensory evaluation and Kansei engineering are used to identify consumer perceptions on ethical fashion design parameters. The methods were selected accordingly to the context: Whereby the first method is more related to the analysis of the ethical fashion product features and uses the fuzzy set theory for sensory data analysis. The second method aims at the inclusion of human emotions to evaluate the environmentally-friendly image of the ethical fashion product. Finally, in **Section 4.4**, a quantitative survey method, including a rating scale, is used to quantify the real environmental impact of a product and the perceptual data.

## Chapter 3. Materials and Methods

In this thesis, we conducted four studies (*Study 1-4*) in order to investigate the issues as mentioned in **Chapter 1**. To address the research questions, primary research was carried out using the classical survey-based and sensory-based data acquisition tools as described in **Chapter 2**. The details about the four studies and their experimental design process along with the sample groups and materials used are described in the following four sections.

### 3.1 Study 1: Consumer Expectations and Awareness of Ethical Fashion through Survey Questionnaire

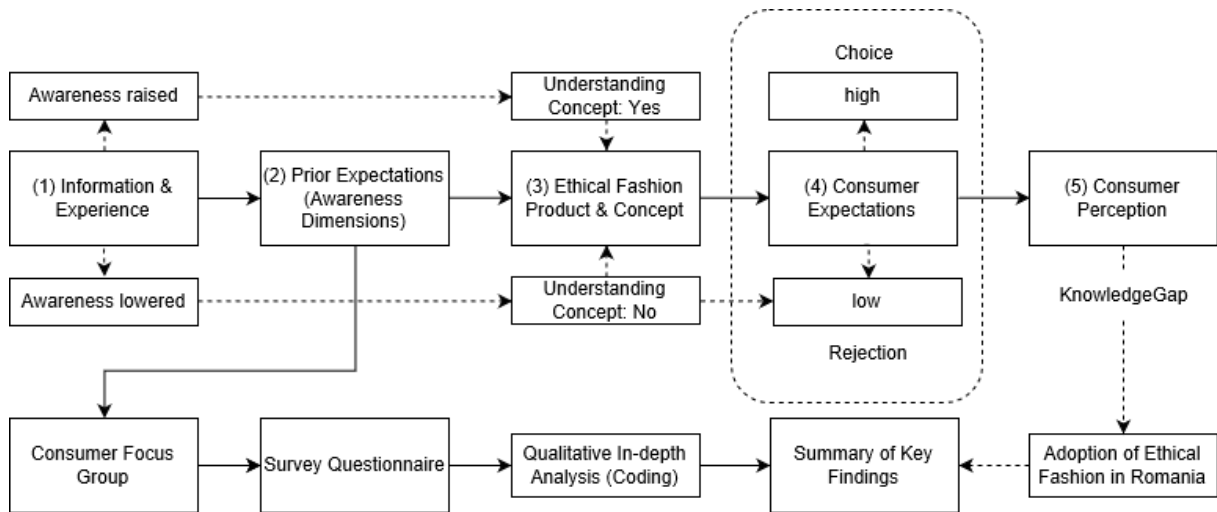
In this initial research stage, focus group and survey questionnaire method were applied in order to explore consumer expectations, perceptions and the attitude-behavior gap in ethical fashion. The awareness of sustainable fashion and its dimensions has been the key missing element among the factors leading to an attitude-behavior gap [112]. Also, a case study was implemented aiming to collect data from Romanian consumers due to a knowledge gap of the ethical fashion adoption in Romania. The research design is presented in Figure 3-1. The design refers to the model by Deliza and MacFie [104], showing the effects of expectations on product selection and product evaluation (See Figure 1-3).

- **Objectives**

In this procedure, the main objectives are the following:

- To evaluate consumer expectations and perceptions on ethical fashion, see Stage (4) and (5);
- To find the reasons consumers choose or reject ethical fashion, see Stage (3);
- To analyze whether design of ethical fashion products influence consumer perception, see Stage (3).
  - How well consumers are aware of the ethical fashion concept and its dimensions
  - To close the attitude-behavior gap, why people do not buy ethical fashion?

The use of the qualitative methods focus group [25, 127] and survey questionnaires [128] are common and appropriate methods in consumer behavior studies, enabling a rich data collection. To visualize data, the word-cloud method was used.



**Figure 3-1:** Research design, adapted from Deliza and MacFie [104].

The research sample and data sources were carefully selected, reflecting ethically interested consumers and will be discussed in this section below.

### 3.1.1 Participants

During a focus group activity with 20 participants, a controlled sample group of 14 survey respondents were targeted. Demographics were collected such as gender, age, academic qualification, and occupation, as demographic variables can influence consumers' awareness, such as gender differences [28]. The group represented normal fashion consumers, having a basic level of knowledge of the fashion concept. Therefore, primarily higher educated individuals were targeted such as academics and students, excluding professionals. This ensured that participants had a certain level of knowledge and active interest in fashion and ethical issues. The survey respondents' age ranged between 21-37 years with more female than male participants. For the demographics of the sample group, refer to Table 3-1. The diverse backgrounds and interests of the participants allowed a rich data collection.

### 3.1.2 Materials

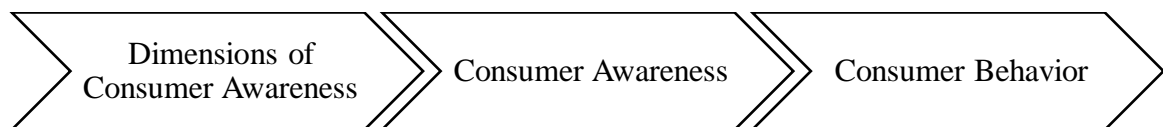
#### 3.1.2.1 Awareness Dimensions

This approach focused on consumer awareness and its dimensions and the influence on consumer behavior (See Figure 3-2).

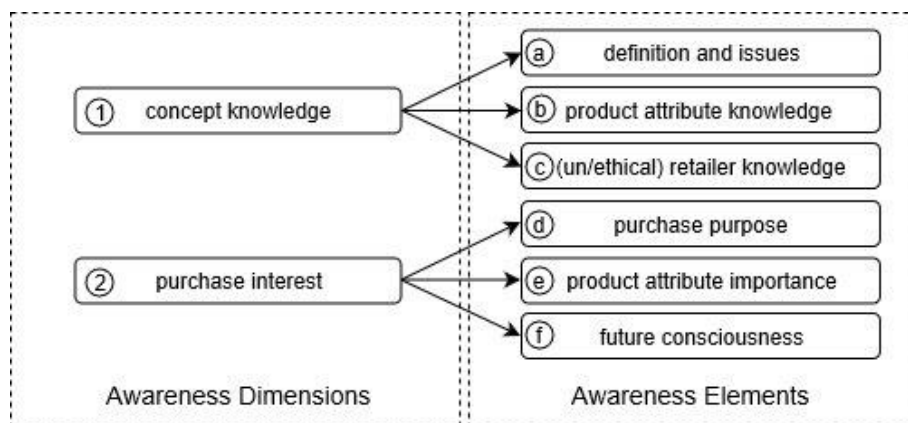
**Table 3-1:** The demographics of the sample group.

Participant	Gender	Age	Academic qualification	Occupation
1	Male	27	Ph.D.	Research Student
2	Female	29	High School	Student
3	Female	22	Bachelor	Student
4	Female	21	High School	Student
5	Female	32	Master	Assistant Student, Artist
6	Male	37	Ph.D.	Professor
7	Male	37	Ph.D.	University Lecturer
8	Female	32	Ph.D.	University Lecturer
9	Female	23	High School	Student
10	Female	22	High School	Student
11	Male	28	Master	Assistant Professor
12	Female	22	Bachelor	Student
13	Female	32	Master	Student
14	Female	22	Bachelor	Student
Total	M: 4 F: 10	21-25: 6 26-30: 3 31-35: 3 36-40: 2	High school: 4 Bachelor: 3 Master: 3 Ph.D.: 4	(Research/Assistant) Student: 10 (Assistant) Professor: 2 Lecturer: 2

Two consumer awareness dimensions including concept knowledge and purchase interest were used, including every three elements (See Figure 3-3). This model can help to describe the level of awareness of consumers from countries with different level of sustainable development, based on the two dimensions including three awareness elements each.



**Figure 3-2:** Research model of consumer awareness.



**Figure 3-3:** Consumer awareness dimensions and its elements.

### 3.1.2.2 Survey Questionnaire

The survey questions were based on the 6 topics (See Figure 3-3), derived from the literature review in **Chapter 1**, and the research model (Figure 3-2). This study developed a survey questionnaire with 12 open-ended questions as shown in Table 3-2.

**Table 3-2:** Survey questionnaire of the ethical fashion concept

<p><u>Dear participants</u>          I am a Ph.D. student from the TUIASI, and my research focus is the design and development of ethical fashion products. This questionnaire was developed in order to collect data related to the ethical fashion concept and related consumer perception.          Thank you for your time and interest.</p>	
<p>1. The Ethical Fashion Concept</p>	
a. Fashion & Ethical Fashion	<p>What does the term mean to you?          _____          What are the main issues or factors in fashion?</p>
b. Ethical Purchase	<p>Which ethical indicators do you know?          _____          When buying clothes which ethical issues do you consider most?</p>
c. Ethical Retailers	<p>Having good ethics - Which do you know and why?          _____          Having an absence of ethics - Which do you know and why?</p>
<p>2. Purchase Interest</p>	
d. Fashion & You	<p>What was your most recently bought item of clothing (for yourself/ others)?          _____          What is its purpose, your reasoning (key factors)?</p>
e. Ethical Attributes	<p>How important are ethical factors for your purchasing decision?          _____          What is the ranking of ethics among other factors?</p>
f. Fashion Future	<p>What do you think will be the future development of ethics in fashion?          _____          If you would have more money would you be more interested (why/ not?)</p>

3. Demographics	
Gender	<input type="radio"/> Male <input type="radio"/> Female
Age	_____ Years
Education	_____ (Highest academic qualification obtained)
Occupation	_____

### 3.1.3 Methods

This study used a focus group discussion to conduct a survey questionnaire. The focus group and the experimental design process of the survey method are described next.

#### 3.1.3.1 Focus Group

The qualitative study determined a 60-minute semi-structured consumer focus group with 20 participants through an organized university workshop on the circular economy in the frame of the Open Source Circular Economy Days (OSCEdays; See <https://oscedays.org>). This event was held at the Gheorghe Asachi Technical University of Iasi (TUIASI) at the Faculty of Textiles, Leather and Industrial Management on 9<sup>th</sup> June 2016. The dynamic panel discussion aimed at the stimulation of data acquisition, whereby the author functioned as a moderator directing the conversation. Firstly, in this focus group session, the participants introduced themselves and discussed their background, followed by their professional experience. Simultaneously, the survey was carried out.

#### 3.1.3.2 Group Survey Questionnaire

The survey was designed using a stepwise approach, based on the structured sequence of the broad, open-ended questions as shown in Table 3-2. The questionnaire type applied was the group administered questionnaire. The controlled group of 14 survey participants was carefully selected as described in Section 3.1.1. In the focus group, the interviewer facilitated the session and was available to give guidance where necessary during the survey to ensure a completed answer-sheet. A classical paper-and-pencil format was used. The sample of respondents was asked to define the ethical fashion term and related associations and asked to respond by expressing their own opinion. Each question was fully addressed and about 10 minutes were given to the 6 principal elements respectively including 2 open-ended questions. Thus, the defined elements were used to guide the responses towards key findings.

### **3.1.3.3 Survey Data Analysis**

The data derived from the 14 survey participants. Previously, the study was conducted with 15 present survey participants with 1 invalid questionnaire being removed as the participant left early without completing the questionnaire fully. The analysis approach for this qualitative collection method was based on interpretation methods such as content analysis and coding techniques refer to Figure 2-3. The data was searched for similarities and differences to categorize and label, and using word count frequencies to make connections and create themes among them.

## 3.2 Study 2: Consumer Perceptions of Eco-Fashion Style through Sensory Evaluation

This second study introduces a sensory evaluation method for eco-designed fashion products to translate qualitative consumer perceptions into quantitative results [195]. This procedure intends to overcome the lack of systematic and objective methods for perception-based analysis of eco-fashion design. This research aimed to evaluate the distinct eco-styles in the garment style accordingly. The research design relates to findings of sustainable fashion design and consumption [78, 80, 89]. Hereby, we are considering fundamental eco-design principles such as the selection of eco-friendly material. See Figure 3-4 for the novel eco-design analysis process for the perception of eco-fashion product appearance. The proposed design process starts with the evaluation of consumer commitment to ethics in order to ensure that participants have an ethical commitment. Otherwise, conventional design analysis processes can be implemented, whereby the designer is the primary actor [84].

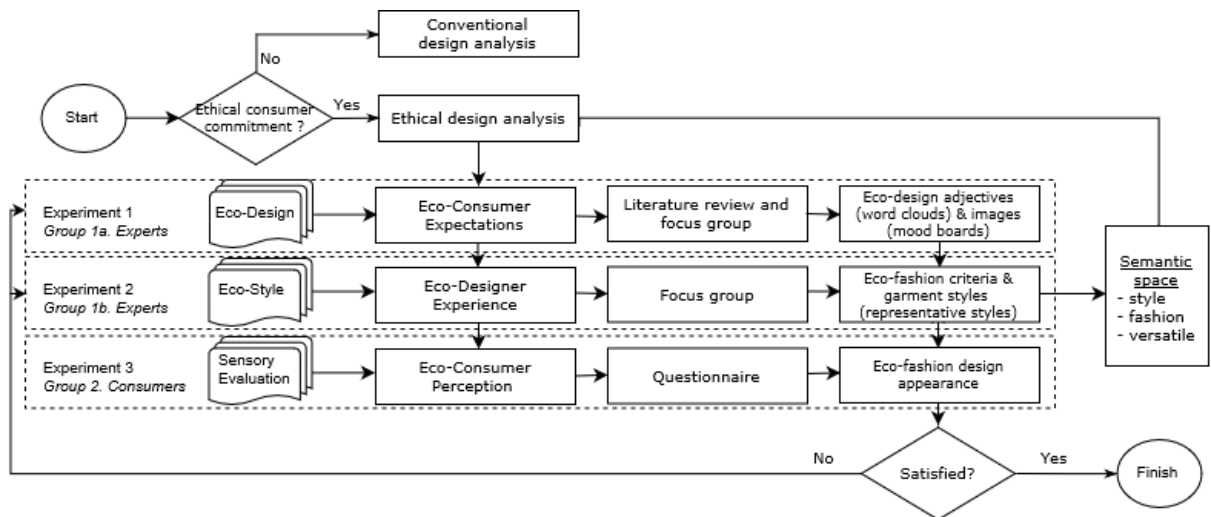


Figure 3-4: The experimental design analysis process.

### 3.2.1 Participants

Controlled evaluator groups were targeted for the experiments, as shown in Table 3-3. This study used both, professional design experts and fashion consumers. The experts formed a mini focus group with a smaller number of 2 to max. 5 participants [196, 197]; this methodology allows for deep analysis of complex issues [198]. And, the consumers formed a small panel. The results from this small scale consumer tests are regarded as a tool to help to identify the proposed products and model [199].



For each *Experiment 1*) and 2), 5 (eco-) fashion design experts were targeted respectively. In Group 1, 10 designers were selected consisting of 4 designers from France and Germany each, and 2 from China. The selection of experts with different nationality can ensure reproducibility and broad expert knowledge. The designers with at least five years of work experience were invited to this study based on their expertise in design and eco-fashion. In this study, Group 2 consists of 20 female consumers from Germany who were invited to participate and to evaluate the selected garment styles in *Experiment 3*).

**Table 3-3:** Evaluator Groups.

<b>Group 1. (D1-D10)</b> <b>(Eco-) fashion design experts</b>		<b>Group 2. (C1-C20)</b> <b>Eco-consumers</b>
<i>Experiment 1</i> ) <b>1a. (D1-D5)</b>	<i>Experiment 2)</i> <b>1b. (D6-D10)</b>	<i>Experiment 3)</i>
5 (eco-) fashion design experts > 5 years of work experience originated from Germany, France, China	5 (eco-) fashion design experts	20 female eco-consumers Age 22-37 (Millennials, born 1981-1996) > 1-2 years of sustainable consumption originated from Germany

The subjects were carefully selected on the basis of their experience and knowledge related to the research topic of ethical fashion. Purposive sampling technique was used as a tool for informant selection, not underlying theories but based on judgment sampling, using, for example, survey and questionnaire [200]. In this study, a short questionnaire was used to screen potential participants for the two evaluator groups with a group of (eco-) fashion design experts and a group of eco-consumers representing sustainable fashion users.

## 3.2.2 Materials

### 3.2.2.1 Designer Questionnaire

The 10 designers from Group 1 (D1-D10), representing experienced experts, were selected to provide useful and objective information for the first and second experiment. They were chosen through a small questionnaire related to their design work experience and competencies. This approach ensured that each designer had at least 5 years of work experience (See Table 3-4).

**Table 3-4:** Eco-fashion designer experience.

<b>How long is your work experience in apparel design?</b>	
< 5 years of work experience	<input type="radio"/>
≥ 5 years of work experience	<input type="radio"/>

Additionally, each expert was required to have at least a “competent” experience in one design area related to fashion or eco-design. The specific question as shown in Table 3-5, used a rating scale of 1-5, where 2 represents a “competent” experience.

**Table 3-5:** Level of work experience.

<b>What is your level of work experience in the following apparel design areas? Please give a rating from 1-5.</b>					
	1	2	3	4	5
	Limited	Competent	Good	Very good	Expert
Apparel Design	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sustainability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Upcycling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Minimalism	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**3.2.2.2 Consumer Questionnaire**

The 20 consumers from Group 2 (C1-C20) were selected for the third experiment, representing consumers that have a good level of knowledge and active interest in ethical fashion issues. They were chosen through a small questionnaire related to their demographics (See Table 3-6) and consumer experience.

**Table 3-6:** Eco-fashion consumer demographics.

<b>What are your demographic characteristics?</b>		
Gender	Female	<input type="radio"/>
	Male	<input type="radio"/>
Year of birth	> 1980: Millennial	<input type="radio"/>
	1961 – 1979: Generation X	<input type="radio"/>
	1946 – 1962: Baby Boom	<input type="radio"/>
	< 1945 Swing Generation	<input type="radio"/>

To determine the consumer experience, the related question was developed using a 1-5 scale to rate consumer knowledge and past purchase behavior. Whereby consumers should have at least a “competent” knowledge, and choose “rarely” (scale rating: 2) as experience for one eco-fashion theme (See Table 3-7). These fashion themes were defined through the discussion in **Section 1.2**.

**Table 3-7:** Eco-fashion consumer experience.

<b>What is your level of experience in the following eco-fashion themes? Please give a rating from 1-5.</b>					
a. Knowledge: How much do you know about this area?					
b. Purchase Behavior: Have you purchased such fashion items before?					
	1	2	3	4	5
Fashion Themes	Limited/	Competent/	Good/	Very	Expert/

		Never	Rarely	Sometimes	good/Often	Always
Organic <sup>1</sup>	a.	O	O	O	O	O
	b.	O	O	O	O	O
Recycled/Upcycled <sup>2</sup>	a.	O	O	O	O	O
	b.	O	O	O	O	O
Etsy/DIY <sup>3</sup>	a.	O	O	O	O	O
	b.	O	O	O	O	O
Minimal <sup>4</sup>	a.	O	O	O	O	O
	b.	O	O	O	O	O
Innovative <sup>5</sup>	a.	O	O	O	O	O
	b.	O	O	O	O	O

<sup>1</sup> garment made from bio/organic cotton

<sup>2</sup> garments made from recycled material such as PET or recycled cotton/garments made using straps from other garments

<sup>3</sup> self-made garments

<sup>4</sup> garment from a capsule wardrobe

<sup>5</sup> garment from a rented wardrobe

### 3.2.2.3 Evaluation Scale

The quantification of consumer perceptions in the third experiment used an evaluation scale, as shown in Table 3-8. The scale was defined to describe the design criteria scores for the perception of the eco-garments, with scores ranging from A to E (A, B, C, D, E), where A refers to Very Sustainable or Excellent and E to Not Sustainable or Poor. For example, if consumer C1 rates S1 (minimal) of Product P1 as A, it refers to Excellent, meaning that P1 is Very Sustainable concerning the minimal design style.

**Table 3-8:** Evaluation scale.

Evaluation Degrees	Sustainability Degree	Linguistic Term
A	Very Sustainable (VS)	Excellent
B	Sustainable (S)	Good
C	Indifferent (I)	Medium
D	Less Sustainable (LS)	Low
E	Not Sustainable (NS)	Poor

## 3.2.3 Methods

### 3.2.3.1 Word Clouds and Mood Boards

Word clouds and mood boards were used as visual qualitative methods to visualize and define the obtained qualitative data. The word cloud quantified expert data using simple frequency counts [77, 177]. The clouds of eco-design principles were created through the software “worditout” (<http://www.worditout.com>).

The mood boards were obtained by the author to represent the word clouds and representative images of the eco-fashion design styles [180]. And, they were used as an interview stimulus [181, 182]. The boards were presented to the consumer to facilitate the rating of the products accordingly.

### **3.2.3.2 Sensory Evaluation**

The experiment procedure within the novel design analysis process is explained as follows. There are three steps of the proposed experiment method to analyze the overall appearance of the eco-fashion style (See Figure 3-4).

- **Step 1) Eco-Consumer Expectations**

The ethical design analysis process started with the analysis of consumer expectations using a literature review and focus group discussion with the first group of designers. After this, we obtained a set of eco-design adjectives and images, as well as classified groups of design principles and mood boards.

- **Step 2) Eco-Designer Experience**

Next, related adjectives reflecting the diverse eco-consumer needs were proposed, as well as typical garment styles. These garment styles are presented to the consumer group for evaluation.

- **Step 3) Eco-Consumer Perception**

The last step included the consumer evaluation of the garment styles regarding the set of eco-descriptors, using an online survey questionnaire. If designers were not satisfied with the design evaluation of the eco-fashion styles for new garment styles, Experiment 2 (possibly including Experiment 1) can be repeated to update the list of design solutions, see Figure 3-4. If designers are satisfied with the eco-styles, the experiment leader finishes the process with consumer evaluation.

- **Experiment 1) Eco-Consumer Expectations**

In the first experiment, the experts of Group 1a (D1-D5) were involved in the creation of word clouds [77], sets of fashion images [167], and mood boards [181, 182] of eco-design styles respectively to represent consumer expectations for eco-fashion products. The detailed process is as the following:

- **a) collection of design criteria**

Related adjectives and images of eco-fashion design were collected to describe eco-consumer expectations [123, 167]. At first, we collected numerous adjectives related to eco-fashion design (~200 words) by referring to literature, magazines, and online (social) platforms related to sustainability and fashion [123, 167]. Then, the five experts discussed the collection through the focus group method, aiming for adjectives to represent eco-fashion design styles. Thus, the participants removed similar and less relevant words until only distinctive words were left. The discussion resulted in classified groups and a one-word representative was chosen for each group. We visualized the groups using word counts and word clouds, using the visualization software “worditout” (<https://www.worditout.com>).

- **b) collection of garment styles**

Simultaneously, we selected many eco-fashion product images (~100 images) from different fashion product categories such as women, men, children and shoes, focusing on sustainable brands or extensions, and collections. Next, the same expert group discussed the images. Again, less relevant images were removed and representative images were selected by the participants into sets of styles. Finally, one representative image per group was chosen.

- **c) creation of mood boards**

Based on these three word-groups and images of eco-fashion design styles, we created the mood boards.

- **Experiment 2) Eco-Designer Experience**

In the second experiment, the experts of Group 1b (D6-D10) were involved in the selection of the final design criteria and garment styles respectively. In the third experiment, this selection was used to analyze the consumer perception of eco-fashion products.

- **a) selection of design criteria**

To characterize the environment-friendly perception of garment design, the five (eco-) fashion designers & experts of Group 1b (D6-D10) created a list of descriptors [167] using the word clouds [77] and the mood boards [181, 182] of the three eco-design categories as visual stimulus. The experts selected the best words after a discussion and voting, choosing six adjectives which reflect the diverse eco-consumer needs. These words are forming the semantic space, used in the sensory analysis to identify consumer perceptions.

- **b) selection of garment styles**

Also, the same designers proposed representative garment styles according to their experience. The evaluators were trained concerning the purpose of the evaluation. The selection was based on the findings of the first experiment, referring to the eco-design principles of the word clouds and the mood boards.

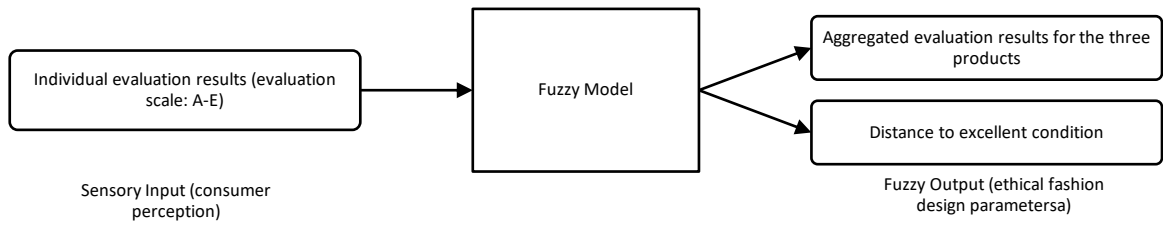
- **Experiment 3) Eco-Consumer Perception**

The third experiment was related to the sensory evaluation of the selected eco-designed garments [123, 167]. The quantification of consumer perceptions uses an evaluation scale, as shown in Table 3-8. A group-decision was calculated by using these evaluation degrees, to assess the perception of the eco-garments according to the six design criteria generated in Experiment 2.

The comparative case study was carried out with a small consumer panel of 20 personnel (see Table 3-3, Group 2). The experiment was sent individually in a digital environment as a questionnaire to the consumer group. The questionnaire shows the pre-selected linguistic eco-style descriptors, displays the three selected eco-garments and provides the evaluation scale. A holistic approach is used to identify the overall product appearance and to categorize the products finally: Please rate the overall appearance of the eco-designed product.

### **3.2.3.3 Data Analysis using Fuzzy Logic**

Finally, the uncertain data was processed using the fuzzy sets theory as described in **Section 2.4**, to measure the subjective data regarding the environment-friendly appearance of eco-fashion style in the garment styles. The fuzzy model as shown in Figure 3-5, presents the data processing flow. The input refers to the consumer ratings of the products according to the sensory evaluation scale. The output of the model using the fuzzy sets theory presents first, the aggregated evaluation results for the three products. The evaluation degrees of the rating scale were quantified using a set of fuzzy numbers as shown in Table 2-7 (See **Section 2.4**). The data was aggregated with Equation 8 as presented in **Section 2.4**. And second, the distance to the excellent condition can be calculated, using Equation 8 to aggregate the data and calculate the distance  $d$  between two TFNs.



**Figure 3-5:** Model presenting the process of data using fuzzy logic.

### **3.3 Study 3: Consumer Perceptions of Environmentally-Friendly Appearance through Kansei Engineering**

This section presents the study of emotional appeal in the design of ethical fashion products, representing an environmentally-friendly appearance. In this third study, the Kansei Engineering methodology was used to evaluate consumer perceptions. Consumer behavior is based on feelings and emotion [147] and influenced by visual appearance [81]. This method of “emotional design” can obtain specific feelings linked with design elements [201]. Based on the previous studies involving consumer perception and sensory evaluation, in here, an approach is discussed to identify the environmentally-friendly appearance in ethical fashion design elements.

#### **3.3.1 Participants**

This study was carried out with two evaluator groups. The first group targeted fashion design experts and the second group aimed at fashion consumers. We selected 6 company experts as well as 63 consumers. It was ensured that all consumer participants were aware of the fashion brand and their environmentally-friendly products for children. The majorities of these survey participants were females from Northern France and aged 20 to 45 years.

#### **3.3.2 Materials**

In this research, expert interview and consumer questionnaire survey were used as discussed in **Section 1.3.1**. The following materials were used.

##### **3.3.2.1 Samples**

In this study, the company experts, i.e., 6 fashion designers chose a range of fashion pictures from the brand’s recent collection present on the website (Spring Summer 2017). These samples were selected by focusing on different styles of girls’ T-shirts. Finally, 10 representative samples for each distinctive garment style were found by the design experts.



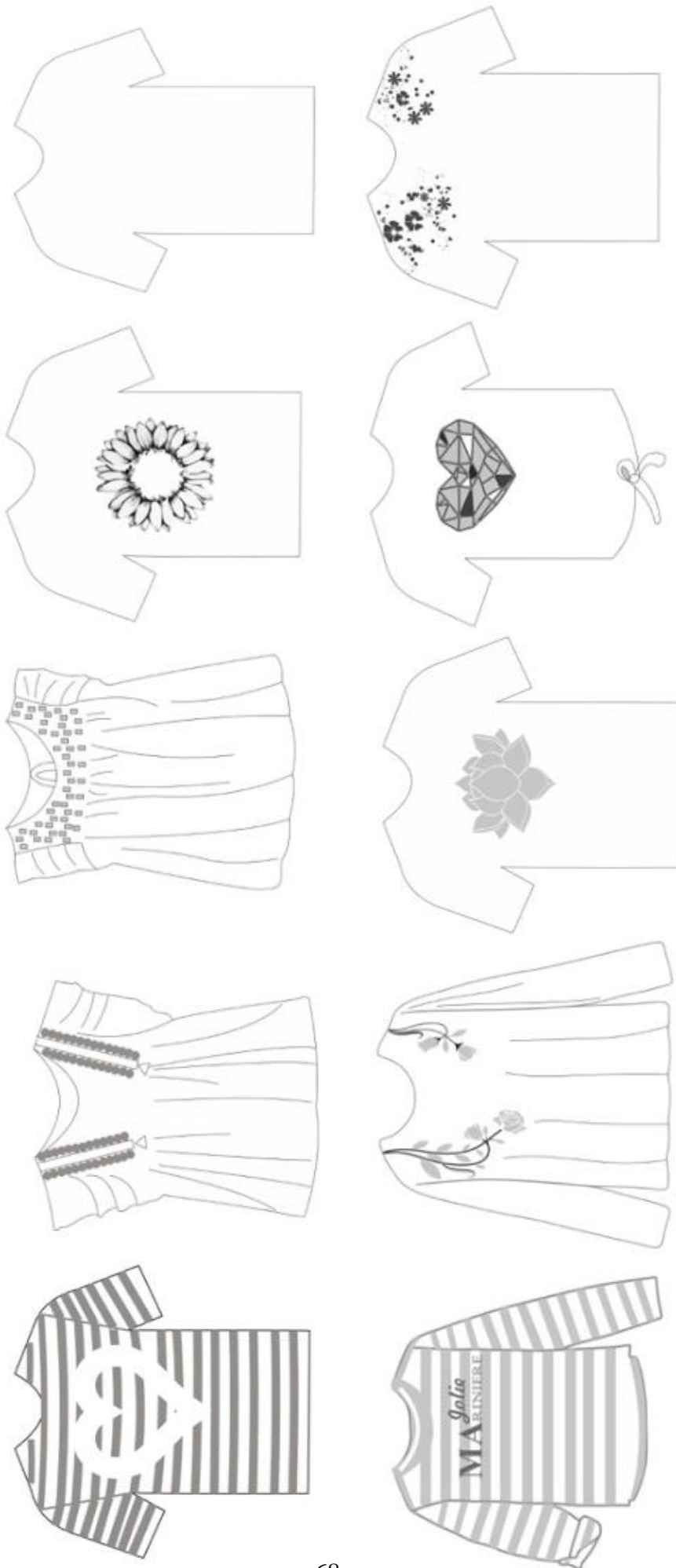


Figure 3-6: The ten samples.

Furthermore, we summarized the style components and design principles for these 10 fashion samples based on material content and design features based on abstract, original and concrete features of the product as shown in Table 4-5 [83]. Then, the samples were used in the final consumer questionnaire survey as representative sketches (See Figure 3-6). The sketches were kept in greyscale to avoid an influence of color on consumer perception.

### 3.3.2.2 Mood boards

Environmentally-friendly themes were represented through mood boards. The mood boards which were created through consumer survey (See Section 4.4) were used by the experts to define the word pairs for the Kansei survey. Also, they were presented to the consumer participants as a visual information tool, representing the webshop atmosphere and supporting the evaluation process. An example of the mood board for organic can be seen in Figure 3-7. All four mood boards are shown in Appendix 4 (Mood board A. Green: Figure A 5, Mood board B. Organic: Figure A 6, and Mood board C. Recycled/Reduced: Figure A 9).

## B. ORGANIC



Figure 3-7: Example of mood board B. Organic.

### 3.3.2.3 Kansei Words

We prepared a list of word pairs based on previously defined eco values and applied from perception studies of materials' sustainability [202] and literature review [78, 203, 204]. The final Kansei words (KWs) for the Kansei survey were carefully selected by the experts. 8 Kansei words were chosen, with 7 word pairs for eco values, and 1 word pair for attractiveness for material and design, see Table 3-9.

**Table 3-9:** Eco values and word pairs.

Eco values	Explanation	Word pair
1.Green 1	usage of chemicals	harmless – toxic [202]
1.Green 2	energy and water input	raw – sophisticated [202]
2.Organic 1	natural	natural – artificial [202–204]
2.Organic 2	dematerialized	meager – luxurious [202]
3.Recycled 1	recycled	classic – trendy [78]
3.Recycled 2	upcycled	functional – decorative
3.Recycled 3	waste reduction	recyclable – disposable
4.Attractive	attractiveness	attractive – unattractive [78]

### 3.3.2.4 Semantic Rating Scale

The participants rated the samples according to a 1-7 semantic rating scale. In Table 3-10 an example is given for the word pair natural-artificial. As defined, the scores range from 1 to 7 (1, 2, 3, 4, 5, 6, 7), with 1 referring to extremely natural and 7 to extremely artificial. For example, if consumer C1 rates Sample 1 (S1) as 1, it refers to extremely natural, meaning that S1 has a very good environmentally-friendly appearance concerning the eco-value natural.

**Table 3-10:** Semantic rating scale for natural.

1	2	3	4	5	6	7
extremely natural	very natural	a little natural	moderate natural	a little artificial	very artificial	extremely artificial

## 3.3.3 Methods

### 3.3.3.1 Kansei Engineering

- **Experiment 1) Expert Perception**

We conducted an expert interview with the company with the 6 selected fashion designers. These experts selected a number of 10 samples for the consumer survey, focusing

on one garment item (Girls' T-shirt). Samples were collected from the brands' recent collection (Spring Summer 2017) present on their website. The samples were presented as representative sketches and numbered from 1-10 representatives to the consumer survey participants. This study focused on visual perception by using sketches kept in greyscale (to avoid an influence of color on consumer perception) and excluding physical comfort. Finally, the products were described by us with the material content and design features (Table 4-5).

- **Experiment 2) Consumer Perception**

Next, the 63 consumer survey participants rated the samples pictures. It was ensured that all consumer participants were aware of the fashion brand and their environmentally-friendly products for children. The rating was carried out according to the selected word pairs and mood boards, using the 1-7 semantic rating scale as shown in Table 3-10. This process evaluated consumer perception towards the environmentally-friendly product appearance.

### **3.3.3.2 Statistical Analysis**

The consumer test data were analyzed using descriptive statistics in terms of median values. Other descriptive statistics such as means and standard deviations are less suitable to analyze data from Likert scales [205], instead, the median should be used as a central tendency [206]. Boxplots were used to visualize the data.

## 3.4 Study 4: Consumer Perceptions of Environmental Impact through Survey Questionnaire

In this last study, the survey questionnaire method was applied in order to explore consumer perceptions towards the environmental impact of ethical fashion products. Based on the previous studies involving consumer perception and sensory evaluation, in here, a quantitative approach is discussed to relate human perception and real life cycle assessment (LCA) and to visualize the gap between. A case study was selected, choosing a simplified life cycle impact assessment of a T-shirt based on secondary data, as described next.

### 3.4.1 Participants

This case study was carried out with consumers, representing normal fashion consumers. The online survey targeted a cohort of 300 survey participants and received 306 voters. The participants were from France, demographics were not collected.

### 3.4.2 Materials

#### 3.4.2.1 Ethical Fashion Themes and Mood Boards

We selected themes to express the concept of ethical fashion. These fashion themes were based on environmental-friendly trends such as a) green, b) organic, c) recycling/re-use, and d) reduced. The themes are visualized through mood boards as shown in Appendix 3 (for the four mood boards used, see Figure A 5, Figure A 6, Figure A 7, and Figure A 8). See Figure 3-8, for an example the mood board for green.

The definitions of the themes are as the following (the French translation is given in Appendix 3):

- a) green

Environmentally considerate practices, having minimal or no harm to the natural environment, such as carbon reduction. (Impact group (IG): Ecosystems) *Atmosphere*

- b) organic

Protection of wildlife and the environment, such as no pesticides and GM. (IG: Ecosystems, Humans) *Water, Toxicity*

306 voters (100%)

## A. GREEN

2. 121 votes (39.54%)



1. 126 votes (41.18%)



3. 117 votes (38.24%)

**Figure 3-8:** Example of the mood board “green”.

- c) recycled/re-used

Processing used materials into new products to prevent waste. (IG: Resources) *Disposal, Resource*

- d) reduced

The process and the policy of minimizing the amount of input, such as reducing the consumption of raw materials, such as water usage reduction. (IG: Resources) *Material, Water*

### 3.4.2.2 Consumer Survey Questionnaire

An online questionnaire was created using the online tool “surveynuts” (<https://surveynuts.com>). Appendix 2 provides details of the methodology we used to collect and interpret data. Figure A 3 shows the questionnaire in the French language.

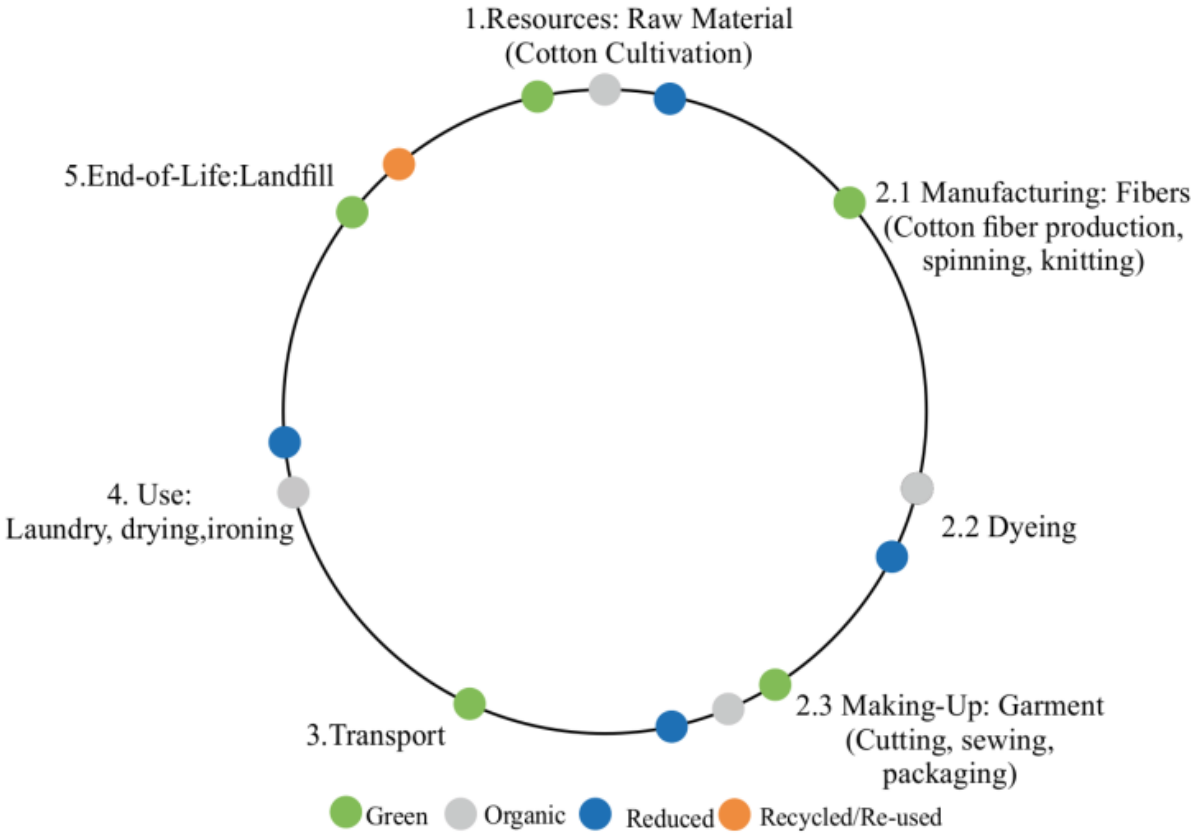
### 3.4.2.3 LCA of a T-shirt

An LCA case study of a “100 % cotton knitted dyed short-sleeved T-shirt” in China was taken from secondary data, using a study of Zhang et al. [20]. The main phases of the LCA case study are shown in Table 3-11.

**Table 3-11:** Main phases of LCA case study, adapted from Zhang et al. [20].

Major Phases of the Case Study
1. Cotton cultivation and fiber production
2. Textiles manufacturing
3. Distribution, consumer use and disposal

The three major phases of the case study (See Table 3-11), are sorted into seven phases as shown in Figure 3-9, presenting the LCA of a T-shirt, and Table 3-12 for the “potential hotspots throughout the life cycle of T-shirts” [20], as well as Table 3-13 for the ten impact categories.



**Figure 3-9:** LCA of a T-shirt, adapted from Zhang et al. [20].

**Table 3-12:** Basis for the simplified LCIA (“Potential hotspots throughout the life cycle of T-shirts”), adapted from Zhang et al. [20].

	<i>Potential hotspots</i>	<i>Impact category</i>	<i>Impact percent (%)</i>	<i>Impact group</i>	<i>EF Theme &amp; Impact</i>
1. Resources: Cultivation cotton	<i>Fertilizer and pesticide use in cotton cultivation</i>	<i>ECP</i>	82.90	<i>Ecosystems</i>	organic, 5 EF
		<i>AP</i>	15.90	<i>Ecosystems</i>	green, 1 EF
		<i>EP</i>	15.70	<i>Ecosystems</i>	organic, 2 EF
		<i>ADP(elements)</i>	10.10	<i>Resources</i>	reduced, 1 EF
		<i>HTPNC</i>	27.90	<i>Humans</i>	organic, 2 EF
	<i>Water use in cotton cultivation</i>	<i>WU</i>	78.90	<i>Resources</i>	reduced, 4 EF
2.2 Dyeing	<i>Coal use in dyeing</i>	<i>ADP (fossil)</i>	18.60	<i>Resources</i>	reduced, 1 EF
		<i>HTPC</i>	45.1	<i>Humans</i>	organic, 3 EF
	<i>Dyes and auxiliaries use in dyeing</i>	<i>ADP (elements)</i>	51.79	<i>Resources</i>	reduced, 3 EF
		<i>HTPC</i>	45.1	<i>Humans</i>	organic, 3 EF
2.3 Making-Up: Cutting, sewing, packaging	<i>Electricity use in making-up</i>	<i>ADP (fossil)</i>	24.80	<i>Resources</i>	reduced, 2 EF
		<i>AP</i>	30.90	<i>Ecosystems</i>	green, 2 EF
		<i>GWP</i>	23.30	<i>Ecosystems</i>	green, 2 EF
		<i>POCP</i>	22.40	<i>Ecosystems</i>	green, 2 EF
		<i>HTPC</i>	15.30	<i>Humans</i>	organic, 1 EF
		<i>HTPNC</i>	26.30	<i>Humans</i>	organic, 2 EF
4. Use: Laundry, drying, ironing	<i>Detergent use in washing</i>	<i>EP</i>	40.60	<i>Ecosystems</i>	organic, 4 EF
		<i>WU</i>	10.50	<i>Ecosystems</i>	reduced,1 EF
	<i>Water use in washing</i>	<i>WU</i>	13.80	<i>Resources</i>	reduced,1 EF
2.1 Manufacturing	<i>Electricity use in spinning</i>	<i>AP</i>	10.80	<i>Ecosystems</i>	green, 1 EF







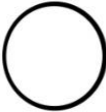
**Table 3-13:** Ten impact categories, adapted from Zhang et al. [20].

Major Impact Categories	Ethical Fashion Themes
1. Abiotic depletion (ADP elements)	d)
2. Abiotic depletion (ADP fossil)	d)
3. Acidification potential (AP)	a)
4. Eutrophication potential (EP)	b)
5. Global warming potential (GWP)	a)
6. Photochemical ozone creation potential (POCP)	a)
7. Ecotoxicity potential (ECP)	b)
8. Human toxicity potential—cancer (HTPC)	b)
9. Human toxicity potential—non-cancer (HTPNC)	b)
10. Water use (WU)	d)

**3.4.2.4 Rating Scale**

The online-survey participants rated the sample according to a 1-5 semantic rating scale as defined in Table 3-14. The scores range from 1 to 5 (1, 2, 3, 4, 5), with 1 referring to more environmentally-friendly (EFR), and 5 to less environmentally-friendly. For example, if consumer C1 rates Sample 1 (S1) as 1, it refers to a more environmentally-friendly impact, representing 1-19% of the impact.

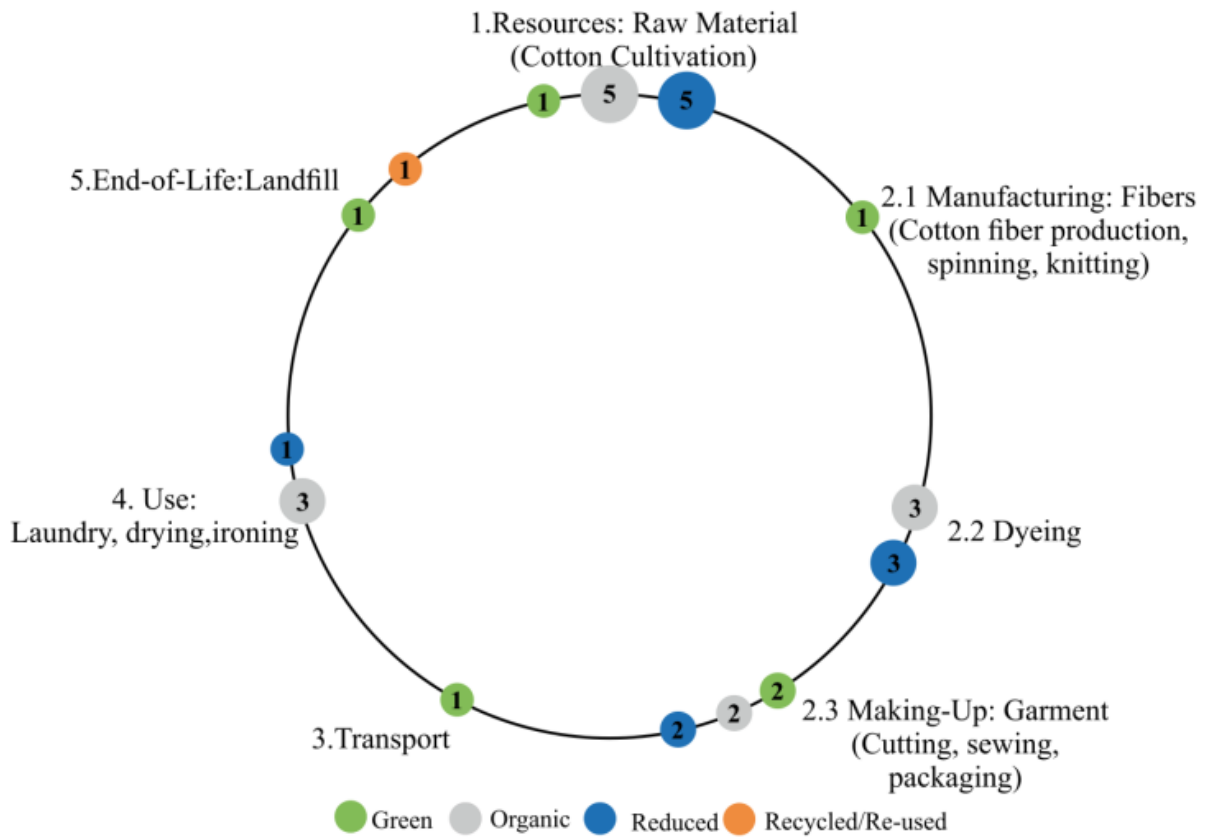
**Table 3-14:** Environmentally-friendly (EFR) rating scale

					
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>EFR</b>	more EFR	a little more EFR	medium EFR	a little less EFR	less EFR
<b>Impact percents (%)</b>	1-19	20-39	40-59	60-79	80-100

<sup>3</sup> Relative contributions to each impact category

**3.4.2.5 Simplified LCA of a T-shirt**

Figure 3-10 visualizes the simplified LCIA, using a bubble chart (each color is associated with the theme, the size of the bubble being related to the intensity of the impact).



**Figure 3-10:** Simplified LCIA of T-shirt Life Cycle.

### 3.4.3 Methods

We collected primary and secondary data on a sample of fashion garments. The LCIA results of a T-shirt have been simplified from a consumer perspective in a visualized way as described by the following four steps:

- a) Selection of ethical fashion themes and consumer communication
- b) Selection of LCA of a T-shirt
- c) Consumer perception training and survey of T-shirt Life Cycle
- d) Comparing simplified and perceived LCA

#### 3.4.3.1 Experiment 1) Consumer Perception

##### a) Selection of ethical fashion themes and consumer communication

The respondents could select for each of the four themes three to five images, see Figure A 4. Then, for each theme, three to four images have been selected to create the mood boards accordingly, see Appendix 3 for the results of the questionnaire for the ethical fashion themes. According to the results, the most frequent selected images were used to create mood boards.

15-20 images per theme were given. Then, a cohort of 300 survey participants (306 voters) were asked to rate the images into the four themes according to their perception of ethical fashion.

### **3.4.3.2 Experiment 2) Expert Perception**

#### **b) Selection of LCA of a T-shirt**

The different phases of the T-Shirt Life Cycle can be sorted into ethical fashion themes. The simplified LCIA is visualized in the life cycle model using a bubble chart, as shown in Table 3-14 as environmentally-friendly rating scale for the impact percentages. Next, the ten impact categories see Table 3-13, were grouped into the four colorized themes a-d and then associated to the seven life cycle phases of the T-shirt where they are dominant (hotspots), see Table 3-12.

### **3.4.3.3 Experiment 3) Consumer Perception**

#### **c) Consumer perception training and survey of T-shirt Life Cycle**

To analyze the perceived impacts from consumers, the LCIA is simplified from a consumer perspective in a visualized way. A group of twenty trained consumers had rated their perception of the four themes in the seven phases of the T-shirt lifecycle from (1) more EFR to (5) less environmentally-friendly. The experiment was carried out with the consumers individually, showing the mood boards and the rating scale, and by noting down the results. A perceived LCIA T-shirt is obtained, in a similar manner as the former.

- **d) Comparing simplified and perceived LCA**

The comparison between the two LCIA's of the T-shirt highlights the gaps between the environmental impacts of the product and the perceived ones. The provision of useful information can enhance the consumer decision-making process for ethical fashion products.

## Chapter 4. Results and Discussion

This chapter presents the results and discussion of the 4 studies and is composed of four parts accordingly. An introduction is given per study, followed by the results and discussion, as well as the conclusion per study. The details about the results of each study are described in the following four sections.

### 4.1 Study 1: Consumer Expectations and Awareness of Ethical Fashion through Survey Questionnaire

This section presents a qualitative study in order to characterize the relationship between consumer expectations, perceptions, and design parameters of ethical fashion. This approach applied the classical survey-based data acquisition methodologies as described in **Section 2.1**. The research design refers to the role of expectations and perceptions as described in **Section 1.3**. And, the context of design parameters of ethical fashion was previously explained in **Section 1.2.3**. Accordingly, this study used a consumer focus group and developed a survey questionnaire. The main aim was to acquire in-depth data to close the attitude-behavior gap. And, to close the gap of knowledge, we applied a real case study. The obtained findings and a set of consumer feelings will be used in the following studies. Finally, the results of this qualitative analysis show the participants' responses. We could identify emerging patterns and themes through coding and analysis (Figure 2-3), and word-cloud method, as described in the following.

#### 4.1.1 Introduction

The purchase of an ethical fashion product involves a complex decision-making process. This process is based on subjective and objective values [207]. Also, consumer expectations and perceptions influence consumer behavior. In this study, consumer awareness dimensions of the ethical fashion concept are modelled. The study aims to understand behavioral variables including feelings better. As discussed in **Chapter 1**, consumers have become more aware of ethical fashion. And, ethical values have become an important product evaluation criterion [3–5, 26, 108]. From the literature review, we have seen that the concept of ethical fashion is broad and includes different dimensions (refer to **Section 1.2**). And, the classical consumer purchase decision-making process has five stages. The process includes need

recognition, information search, evaluation of alternatives, purchase decision, and postpurchase behavior [38]. Whereby, information search is linked to consumer's awareness and knowledge. For example, the more information a consumer has obtained, the more the consumer's awareness and knowledge of the available brands and features increase [38].

In this chapter, we considered the influences of consumer expectations and perceptions. First, we studied consumer awareness and knowledge. Second, we focused on the impact of ethics on the purchase interest. We including product attribute preferences and recent purchases. For example, Galbreth and Ghosh [108] studied the impact of sustainability on consumer behavior and attitudes. They found that two factors influence the level of willingness to pay for a sustainable product. These factors are the consumers' level of "awareness" and "concern" of sustainability dimensions. An increase in awareness can benefit companies; whereby their research focused on the dimension "organic cotton" [108]. In our study, we focused on the level of consumer awareness on different ethical fashion dimensions, using a consumer focus group and a survey questionnaire. Finally, the developed model was applied in a real case study using consumers from Romania.

#### **4.1.2 Case Study: Consumer Awareness in Romania**

This model was applied for Romanian consumers to understand their level of awareness of the ethical fashion concept. The case study was conducted in Iasi, which is the biggest city in Moldavia, thus representing a greater urban area. Romania is located in Central Europe, between Middle Europe, East Europe, and the Balkan. It has been influenced by Ceausescu and communism until 1989, becoming now more western and industrialized [208]: Romania is a NATO-member since 2004, and part of the EU since 1st January 2007. Also, sustainable development is emerging. However, it is still a country with a lower level of sustainable development (refer to Table 1-4). Lakatos et al. [209] highlighted the case of recycling, referring to Europe's 2020 Strategy and the aim of a 50% recycling rate of municipal waste by 2020 [210]. However, the current state still needs more development. Romania had been identified as at risk of missing the 2020 target with a recycling rate (including composting) of 13% in 2016, and one of the highest landfilling rates in Europe of 69 % [211]. It has been seen that there is a knowledge gap of Romanians' awareness about ethical fashion. Lakatos et al. [209] found general awareness of the Romanian consumer towards the circular economy concept, but a lack of awareness towards new consumption behavior. A rise of concern can be seen with more researchers addressing this topic. For example, Lakatos et al. [209] studied

Romanian consumers and their attitudes towards environmental protection. Dabija et al. [118] proofed that consumers' have a preference for retailers which implement sustainable strategies, with Baby Boomers being most concerned [117]. However, research on consumer awareness of ethical fashion in Romania is limited. Carrigan and Attalla [127] suggested, that there are still many consumers with little interest in ethical behavior who need more information. Thus, this study aims at the analysis of consumers' awareness towards the ethical fashion concept, using the example of the Romanian consumer.

### 4.1.3 Results and Discussion

The results showed that all participants had a certain level of awareness and knowledge of ethical fashion. However, this awareness does not directly correspond to their purchase interest. Several barriers were found, such as a high price of ethical fashion. And, it has been seen that there is some misunderstanding about the ethical fashion concept. The self-administered survey resulted in 14 written response sheets, with 150 observations across the data set. Data analysis followed the coding procedure as shown in Figure 2-3. Accordingly, the summary of the research outcome is given in Figure 4-1, Table 4-1, and Table 4-2.

#### 4.1.3.1 Consumer Concept Knowledge

In the following, the concept of knowledge of the participants is described. The first dimension, relating to the ethical fashion concept definitions and issues, gained the highest amount of responses.

##### a) good environmental knowledge

The participants were asked to define the concept of ethical fashion. First, they compared ethical fashion to the conventional fashion system. The importance of conventional fashion was discussed. The most preferred answers among the 13 respondents (13 of 14 participants) referred to “a good look”, and “a way to present yourself”. Based on word counts and coding, two main themes emerged, which are *aesthetical awareness* and *self-consciousness*. Quotations of the respondents were the following, for *aesthetics* and, for *self-consciousness*:

To obtain different styles / styles to be fashionable / constant change / brand / aesthetically / a way of life / way of dressing / using our imagination. (8)

Present / boost / individual presentation/ to express your personality to the world/ (help to) express yourself / mentally / investments. (7)

The *problems of fast fashion* were quite-known. This theme refers to quotes such as: “Fast changes / constant new fashion looks / fast changing trends” (3); additionally, seven respondents found other problems such as:

Low quality; no value for money / too expensive; (4)

People buy too many / too cheap / disposable clothes / no reparation of old clothes / a need to repair and recycle more / throw and buy new. (6)

The quotes refer to the definition of slow fashion. This concept contrary to fast fashion, aims for small lines, high quality and eco-design. Thus, participants have a good awareness of the negative issues in the fast fashion industry. And they are knowledgeable that problems arise due to low quality and fast-changing product offers. Reflecting the aesthetical awareness, problems in fashion can occur as:

Fashion should always be wearable / practical / good looking / fashionable; (4)

Reduce electricity / toxic emissions (2); new / green materials. (3)

Thus, respondents defined the fast fashion concept with some environmental knowledge. Also, participants were highly aesthetically aware. This finding supports the idea of Joergens [25]: Ethical fashion should be not only ethical but also attractive to be interesting for fashion buyers.

The question “What is ethical fashion?” could be answered by all participants to some content. The term demonstrated a good level of awareness. In Figure 4-1, a word-cloud is presented based on the data collection for various definitions of the term ethical fashion. Respondents linked the concept mainly to low-impact and minimalism, quoted as “considering welfare of earth / think about the environment / care for the environment / low impact on environment” (4), and “buying only what we need / what you really need” (2). Other answers reflected materials and production; quoted as “sustainable raw material / fabric / 100% organic materials / bio fibers” (4), and a “sustainable approach / sustainable from production to end of life / sustainable production (products and processes)” (4). Also, social issues were discussed, such as the “development of our community”. There was an agreement regarding the need to “produce goods without affecting others / ethical issues over profit / fair trade / good labor conditions for workers” (4). Another participant showed criticism of the ethical fashion concept, as the fashion choice is also “depending on human factors such as age, but also occasion”.

FAIR TRADE  
 ETHICAL RESOURCE MANAGEMENT  
 USE OF FABRIC  
 THINK ABOUT ENVIRONMENT  
 PAYMENT OF WORKERS TOXICS  
 EXPENSIVE FASHION POLLUTION  
 COMMUNITY DEVELOPMENT  
 BUYING ONLY WHAT WE NEED  
 PRICE REDUCING WASTE NO-FUR  
 RAW MATERIAL TO END-OF-LIFE  
 PRODUCTION WITHOUT AFFECTING OTHERS  
 CONSIDERING WELFARE OF EARTH  
 CARE FOR EARTH  
 100% ORGANIC MATERIALS  
 ETHICAL ISSUES  
 AVAILABILITY NEW PRODUCTS NOT ONLY FOR PROFIT  
 ECO-DESIGN ETHICAL LOW QUALITY  
 SUSTAINABLE APPROACH  
 DEPENDS ON EVENT AND OUR AGE  
 BIO FIBRES

### (ETHICAL) FASHION

What does the term mean to you?

What are the main issues or factors in fashion?

**Figure 4-1:** Summary of research outcome - Consumer definitions for the ethical fashion term and issues.

The same participants who discussed the problems of *low impact* and *minimalism* mentioned that there is a concern of mainly *waste and pollution* issues in the fashion industry, such as “toxics / toxic waste / waste materials / pollution / chemical finishing / processes by-products” (7). Most participants agreed that there is a need to “support the ethical fashion concept”, and recognized the need of more awareness among consumers regarding the impact of consumption and fashion production, while looking after the design: “new products / eco-design / to be you / usage of materials / fashionable” (5).

Also, many respondents were aware of the *price* for (ethical) fashion: “low-quality products are more favored than eco due to cheap price / money we spend, is important / higher costs for eco / expensive” (4). Again, *social* aspects are discussed, mainly focusing on “worker payment / under minimum payment of workers” (2). Proposals were made for both, consumers and the industry, such as “training for producers and consumers / ethical management for human resources and resources” (2).

Thus, the study showed that the term ethical fashion is familiar to most. Respondents were showing aesthetical awareness and self-consciousness towards the fashion concept, and



recognizing the fast fashion issues, having some environmental knowledge. Responses to the ethical fashion concept refer mainly to a *lower impact* due to *less consumption*, and *less waste and pollution*, *better materials and production processes*, as well as appropriate *social circumstances*.

**(b) materials and human rights**

Next, the information regarding the product attribute knowledge was gathered. The participants were asked to define the most important ethical product attributes. Most replies refer to “*materials*” as well as “*human rights*”, along with “*second-hand*” (2). These attributes are quoted as follows:

materials / eco-friendly materials / eco materials / new and eco-friendly raw materials (5); not harming the environment / respecting environment / environmental friendly (5); good labor conditions for workers / not abusing labor / respecting human rights (3).

Next, participants were asked “When buying clothes which ethical issues do you consider most?” In response to this question, consumers discussed how the product is *made of* and where it is *manufactured*. Responses were quoted as follows: “made of / recycled material / comfort and material / organic” (4), and “manufactured in / produced outside countries having problems with labor rights / country of origin / who made my clothes / ethical pay for workers” (5). The importance of recycling, fair trade, made of, and organic has also been found in other studies, for example the awareness study by Shen et al. [112]. Participants knew about the campaign of “Who made my clothes?” (3) (#whomademyclothes) of the Fashion Revolution Week (<https://www.fashionrevolution.org>). This result shows the impact of marketing campaigns and social media. However, from the results of product knowledge, it can be seen that mainly materials, product origin and human rights were considered. Others, such as natural or low impact dyes, or maintenance criteria were not considered. Therefore, *eco-friendly materials* and the *country of origin* could mostly influence the buying process; see Table 4-1 for an overview of ethical product attributes known to the participants.

**Table 4-1:** Summary of research outcome - Well-known ethical product attributes.

Eco materials	Environmentally-friendly	Country of origin	Good labor conditions
recycled material	harmless	who made my clothes	human rights
comfort	second-hand	low wage countries	ethical pay
organic			

### **(c) uncertain retailer knowledge**

The involved participants could not identify fashion retailers having good ethics, except “H&M”. Along with that, the participants mention in general the term “big brand names” or “no-name brands”. Quoted by participants as:

H&M-sustainable line (2); I’m not aware of this topic / don’t know about this / I don’t know anyone that I could consider having good ethics (from my definition of good ethics) (3); big brands especially/important brands (2).

Also, for non-ethical retailers, no names were found. Only, country of origin and working conditions were considered. Nine respondents did not comment on this question. So only five respondents gave answers quoted as:

Poor countries producers / bad working conditions for employees / low priced companies, producers mostly (3); No-name brands / H&M and Inditex (2), I’m not aware of this topic (1).

From the overall responses, it was observed that there was less or no awareness and uncertainty towards what is an unethical or ethical retailer.

### **4.1.3.2 Consumer Purchase Interest**

In the following, the purchase interest of the participants is presented. All three dimensions gained a similar amount of responses.

#### **(d) quality and fashion**

The participants were asked to specify an item of clothing most recently bought. This has seen to be a logical approach in research [120]; Also, to identify the primary product attributes regarding purchasing. The mainly bought items in the data set were the T-shirt, followed by the dress, quoted by participants as “T-shirt / T-shirt for my husband / shirt long sleeves” (5), and ”dress“ (4).

The key factor for the purchase was mainly “quality”, connected with “long-lasting” of clothing. All of the mentioned attributes are primary product qualities. A gender difference [212] was seen in the group. Men have more “practical” reasons, such as “easy to use / good performance / need, to replace the old and broken clothes” (4); whereby women were looking for "fashionable" clothes and "color" in their purchases, due to "changing season or occasion" (2); but, also for other important factors such as the "price" and "comfort". Quotations by participants are as follows:

Quality / quality for apparel and shoes (last long period) / long-lasting / fabric quality / stitches (6);  
Color (4); material / natural materials (3); need of new and fashionable clothing / fashion / need to

replace broken old clothes (3); upgrade wardrobe for hot season / summer is coming (2); prom ball / party (2); design / tailoring (2); price (2); comfort / practical (2).

#### **(e) product attribute importance**

The importance of the ethical factors regarding the purchasing decision is mainly quoted as “very important / very” (4), “7 out of 10 / some importance” (2). The impact of consumption is considered and quoted as:

We can choose to do something good for the environment in a long term / we have to be conscious / aware of the surroundings / have to take care of the planet we have (4).

When the subjects were asked to compare and rank ethics with other factors, the most common answer was the *price*. Eco is "more expensive", quoted as:

Depends on the price we want to spend as eco is more expensive / second after price / after quality and price (3); price, quality, and functionality.

“Comfort” was also found to be more important. As previously mentioned, ethical issues are not always the primary driver; For example, personal needs can be more important than ethics [110]. Even when consumers are aware of ethical issues, but still other factors, such as design, price, availability and the brand can have more importance in the buying process [25, 36]. Other respondents mentioned that ethics are not important, or that they are unsure about it, quoted as: “I must admit, not very high / Not very high” (2) and, “I don’t know” (2).

#### **(f) future consciousness**

When respondents were asked about the fashions’ future development regarding ethics, optimism was expressed. Participants mentioned positive trends such as *recycling, organic, and upcycling*. Quoted as:

Fair trade clothes / ethics in fashion will be hopefully more and more important / in top score / bigger importance of environment / considering environment will have a bigger importance / more fairness towards employees / more and more important / more support of sustainable development in peoples’ communities (8); more recycled plastic-PET-fibers / more organic materials such as bamboo / upcycle your own wardrobe (3).

On the other hand, participants showed uncertainty towards present trends. As defined by Hofstede (2010), Romania is categorized as restraint, showing a tendency of pessimism and feeling that social norms constrain actions. However, participants show more optimism towards the future ethical fashion. The participants were asked if they would have more money they would be more interested in purchasing ethical fashion. Almost all said “yes”, namely quoted as:

Yes, because it is important to take care of our environment / Yes, because it is more expensive to buy clothes that are eco-friendly / Yes, I would like to try / I am curious / Yes, due to environment (6); I would buy higher quality products to use them longer / buy quality product which lasts for a long period such as in earlier times (2).

Therefore, a higher price or the perception that ethical fashion is costlier than conventional fashion can be a main barrier of the ethical concept. Table 4-2 summarizes the possible challenges, barriers, and solutions extracted from the responses.

**Table 4-2:** Summary of research outcome - ethical fashion challenges identified.

<b>Challenges</b>	<b>Barriers</b>	<b>Solutions</b>
Reduce waste and pollution	Limited awareness	Aesthetic design
Improve human rights for workers	No interest; Ethics second in consumer choice: too pricey, need for new low availability of ethical retailers	Quality and value Made of, made by Training and education More retailers selling ethical fashion

#### **4.1.4 Conclusion**

In this chapter, expectations and perceptions of the ethical fashion concept were gathered. Fashion companies are increasingly implementing sustainable development, and ethical fashion is becoming more important [3, 127]. Through a workshop, the level of knowledge and awareness were investigated. We applied qualitative analysis of ethical fashion concept dimensions, using focus group and survey questionnaire method. The research was tested with a group of consumers to address the knowledge and intention-behavior gap in Romania. In this study, we identified such a gap [25, 100, 127, 142, 143] as discussed in Section 2.1.5. Participants had a certain level of knowledge and awareness. But, there was a low interest and intention to purchase. According to the main objectives, we found the following reasons consumers choose or reject ethical fashion. Advantages of ethical fashion are the quality, as well as eco-friendly materials and the country of origin. Several barriers were found, such as the high price or lack of design aesthetics. Thus, improved product and design parameters can increase consumer awareness (expectations) and consumer knowledge and interest (perceptions). However, improved consumer awareness does not necessarily lead to increased consumer interest.

The results of this social research with a group of Romanian consumers indicated an alignment with the ethical fashion theory in other countries. Romanian fashion consumers

responded with some knowledge to the awareness discussion. These study findings show that participants understand the concept of ethical fashion and the difference to the conventional system. Still, awareness is limited. So barriers towards sustainable consumption exist, which aligns with existing literature [80]. Other attributes than ethical were found to be more important, such as mainly the higher price [25, 36]. This finding can also relate to the cultural or economic values of consumers. The knowledge about ethical retailers and the ethical attributes was minimal. Retailers and brands need to take more action, especially the big brands such as H&M which are well known. But still, participants were less aware of their ethical practices. Campaigns such as "Who made my clothes?" can help to create more awareness, especially with social media. More education and information is needed [213]. Demographic differences were not significant. Solely for the purchase decision, men gave more practical reasons; In comparison with women who tend to be more aware of fashionable issues. Regarding the retailer knowledge, mostly the older participants mentioned criticism on brands' ethics.

Using open-ended questions, this qualitative approach avoids a possible bias found in closed-ended questions due to the limitation of answers. This method allows the respondents to include their understanding of the subject of ethical fashion. In the survey responses, participants have included their opinion that they are not aware of some issues. The workshop event was also used to raise awareness among consumers regarding ethical fashion. There is a possibility that the workshop about circular economy and demographical factors of the participants might influence the responses to some extent. Increasing the awareness of the fashion consumer regarding ethics, can change their behavior and influence purchasing behavior [111]. One proposal of participants was that driving the questions throughout the workshop is a better approach instead of continuously surveying for a period.

Limitation of this research is the small sample size of 14 participants, and findings may not be generalized to the Romanian population. It is suggested to transform the results of the open-ended questions into questions for further quantitative research. This study can be considered as a preliminary approach to establish a closed-ended survey instrument, to develop the multiple-choice question. Concluding, this study intended to extend the general knowledge of the Romanian fashion consumer. The results can be valuable for other researchers to create their research based on the emerged topics.

## **4.2 Study 2: Consumer Perceptions of Eco-Fashion Style through Sensory Evaluation**

This section follows up on findings of **Section 4.1** regarding consumer feelings towards ethical fashion design styles. Using the sensory evaluation data acquisition methodology as described in **Section 2.2**, this study describes a quantitative approach to understand the relationship between the garment design style and the evaluation criteria of eco-fashion in terms of eco-fashion style.

### **4.2.1 Introduction**

In practice, applications of environmental performance evaluation of eco-fashion with human subjects are rather limited due to the lack of systematic and objective methods. Thus, to evaluate eco-consumer products including human perception, sensory analysis using experimental design can be applied. The evaluation of fashion style has been studied by several researchers using classical descriptive sensory analysis [123]. The two main types of sensory testing, the analytical and the affective tests, collect either objective data through laboratory instruments or subjective data as perceived through the senses. Participants form representative sample sizes and can be either (non-/trained) experts or consumers. The analytical data is collected from trained panels or experts. While the affective data uses untrained personnel or consumers, using smaller focus groups. This comparative study was carried out with a small consumer panel of 20 personnel (see Table 3-3.). The experiment focused on female eco-consumers born after 1980, i.e., Millennials, respondents' age ranged between 22-37 years.

The main contributions include the following aspects: (1) the originality of this study is the quantification of consumer perception of eco-fashion style in eco-fashion products. Perception has been analyzed before, but with qualitative methods. This procedure will benefit fashion designers and brand managers in sustainable product design and development; (2) the acquisition of perceptual data using a normalized sensory procedure and analysis; (2) the modeling with fuzzy techniques to deal with uncertainty in the acquired data.

### **4.2.2 Results and Discussion**

According to the previously described materials and methods, there are three experimental procedures to analyze the overall appearance of the eco-fashion style. The

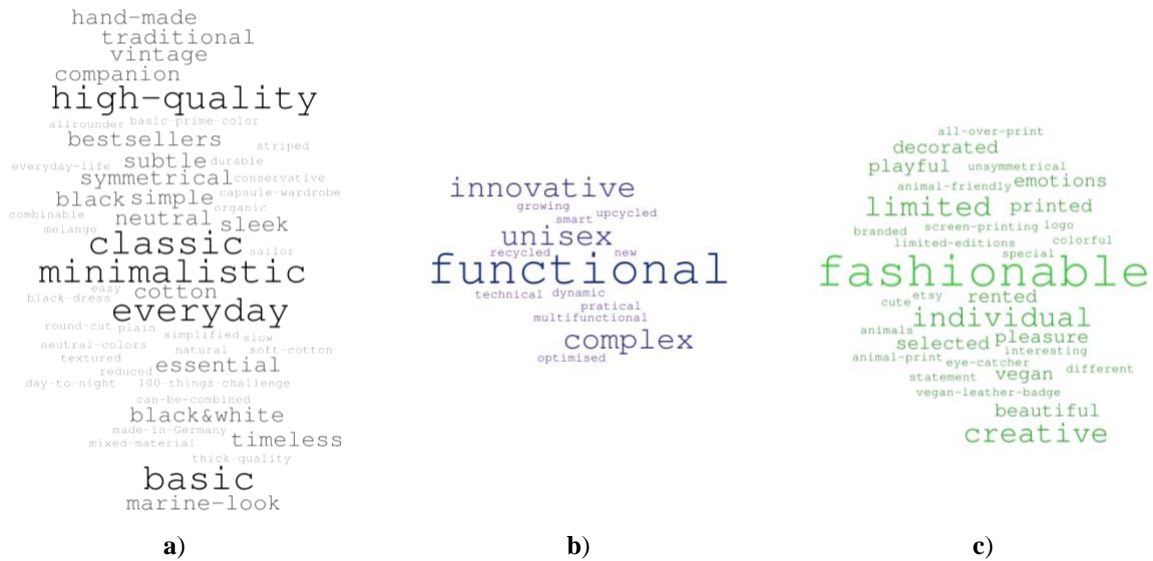
results of the experiments are the following: In Experiment 1) consumer expectations are obtained, Experiment 2) uses the designer experience to create the semantic space and select representative garment styles, and Experiment 3) uses sensory evaluation to analyze consumer perceptions regarding the overall appearance. The detailed results are described in the section below.

#### **4.2.2.1 Experiment 1) Eco-Consumer Expectations**

In this first experiment, the experts of Group 1a (D1-D5) created 3 word clouds, 6 sets of fashion images, and 3 mood boards of eco-design styles respectively to represent consumer expectations for eco-fashion products.

- **(a) word clouds of eco-fashion design**

The experts defined 94 adjectives representing the eco-fashion design. In a group discussion, these were categorized into 3 word clouds, highlighting the most frequently used adjectives as shown in Figure 4-2. Accordingly, word-cloud a) includes 49 words, representing the concept of style orientation with classical, minimal, everyday, basic, and high-quality styles. Word-cloud b) contains 14 words, referring to versatile products such as functional, innovative, complex, and unisex styles. And, word-cloud c) holds 31 words to show the fashion orientation with fashionable, creative, individual, and limited styles.



**Figure 4-2:** Word clouds by experts, presenting expectations of eco-design style in three main concepts: a) style; b) versatile; c) fashion.

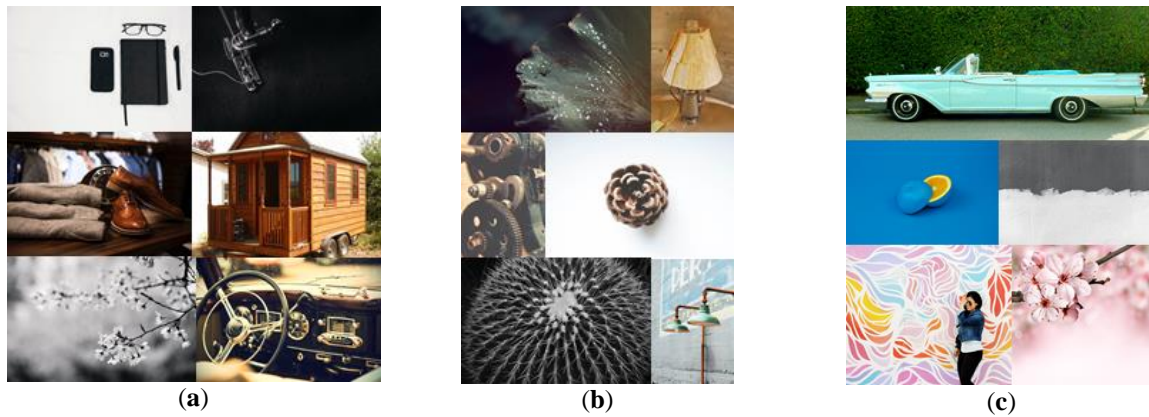
- **(b) fashion images of eco-design**

In the same group discussion, 100 different styles of eco-fashion were arranged into 6 sets of images. These image sets were compared to the word clouds and used as discussion stimulus to verify the selection of adjectives which will be used to analyze consumer perceptions in experiment three. Then, 1 representative image with distinctive style elements was selected per set accordingly, resulting into 6 representative styles: 1. classical styles (e.g., vintage, marine, stripes), 2. natural styles (e.g., natural-textured, denim), 3. functional styles (e.g., unisex, equality, sports, dynamic, multi-functional), 4. upcycled styles (e.g., DIY, handmade, recycled), 5. unique styles and 6. decorative styles (e.g., statement-, animal-prints).

- **(c) creation of mood boards for eco-design**

Based on these three word clouds and representative images of eco-fashion design styles, we created three mood boards as shown in Figure 4-3.





**Figure 4-3:** The image boards used in the experiments: (a) style; (b) versatile; (c) fashion.<sup>5</sup>

<sup>5</sup> All images have a CC0 License: <https://www.pexels.com>, <https://unsplash.com>, <https://flickr.com>.

#### 4.2.2.2 Experiment 2) (Eco-) Designer Experience

- (a) selection of design criteria

This experiment concludes into the following six design descriptors and definitions: (*S1*) minimal and (*S2*) durable, (*S3*) multi-functional and (*S4*) dynamic, and (*S5*) unique and (*S6*) decorated, see Table 4-3.

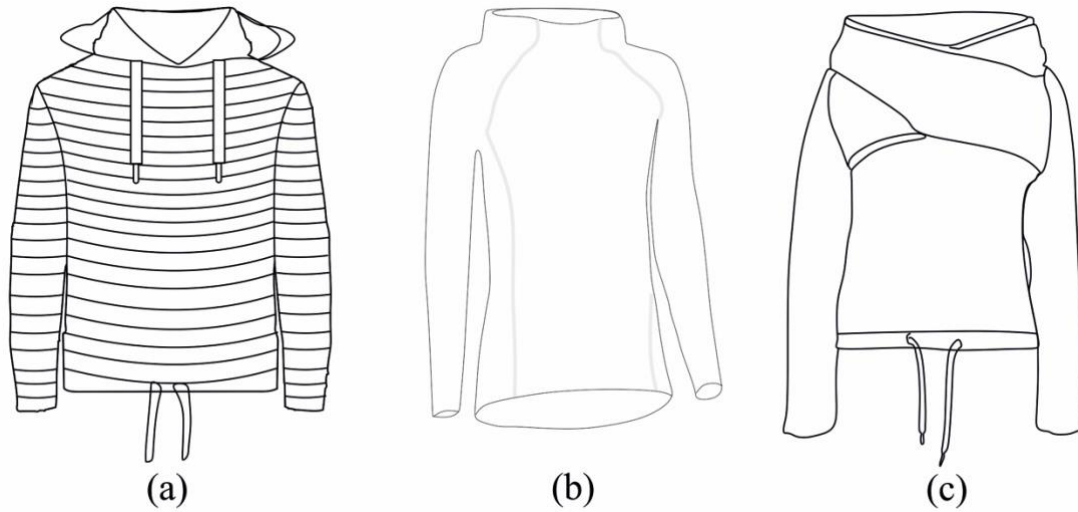
**Table 4-3:** Eco-design descriptors.

Descriptors	Definition
S <sub>1</sub> minimal	reduced, timeless silhouettes
S <sub>2</sub> durable	robust, high-quality fabrics
S <sub>3</sub> multi-functional	functional (e.g., reversible) garment
S <sub>4</sub> dynamic	good fit/size (e.g., adjustable for mobility or growth)
S <sub>5</sub> unique	uncommon style
S <sub>6</sub> decorated	creative/stylish

- (b) selection of garment styles

Three representative garment styles were proposed. The study focused on women sweatshirts (hoodies), using a range of branded products from a multi-brand eco-online shop the “Avocado Store” (<https://www.avocadostore.de>), only selling eco-fashion brands such as People Tree. The evaluators choose for the following three different eco-clothing products: (a) People Tree; (b) Engel Sports; (c) Lovjoi, see Figure 4-4. *P1* ((a) People Tree) is a basic striped hoody in navy-white with adjustable drawstrings through hood and waistband. *P2* ((b) Engel Sports) is a sportive and lightweight, regular fit hoody in sky-blue with seams in

contrasting colors. *P3* ((c) Lovjoi) is a cropped hoody in winter-blossom (rosé) with a large hood crossed over the chest.



**Figure 4-4:** Three representative garment style samples.

### 4.2.2.3 Experiment 3) Eco-Consumer Perception

#### (a) individual results of the consumers

The individual evaluation results of the 20 eco-consumers for the product appearance are presented for each descriptor; see Appendix 5, Table A 7. The data collection recorded no missing data. Besides the product, consumer type can influence the decision. Sustainable fashion is context and person dependent but can have common elements [97]. The experiments were carried out, focusing on female Millennials. For example, Lissitsa and Kol [214] highlighted differences in Generation X and Generation Y (Millennials) as defined by Gurău [1], analyzing their online purchasing behavior. Other consumer groups can be tested.

#### (b) aggregated evaluation results for the three products

The level of eco-style perception of each solution can be presented, using Equation 8 as presented in Section 2.4. The aggregated evaluation results of the consumers are presented for each criterion, including the corresponding distance to the *A-Excellent* condition, see Table 4-4.

**Table 4-4:** Aggregated evaluation results for products A-C.

Descriptors	Aggregated evaluation result			Distance to A-Excellent		
	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
S <sub>1</sub> minimal	(0.6, 0.8, 1)	(0.5, 0.8, 1)	(0.4, 0.7, 0.9)	0.15	0.21	0.27
S <sub>2</sub> durable	(0.5, 0.7, 0.9)	(0.5, 0.7, 0.9)	(0.4, 0.7, 0.9)	0.22	0.25	0.28
S <sub>3</sub> multi-functional	(0.1, 0.3, 0.5)	(0.7, 0.9, 1)	(0.1, 0.4, 0.6)	0.63	0.08	0.55

S <sub>4</sub> dynamic	(0.1, 0.3, 0.5)	(0.6, 0.9, 1.0)	(0.1, 0.3, 0.6)	0.63	0.10	0.59
S <sub>5</sub> unique	(0, 0, 0.25)	(0, 0.2, 0.4)	(0.6, 0.9, 1)	0.54	0.73	0.11
S <sub>6</sub> decorated	(0, 0, 0.25)	(0, 0.1, 0.4)	(0.5, 0.8, 1)	0.58	0.76	0.21

This perception analysis process is repeated with other garment samples, using the same procedure to collect the evaluation results and aggregate the data using Equation 1-8 given in Section 2.4. Based on these results, products can be modified [84, 85]. In here, the aim is to achieve higher environment-friendly perception.

For example, using this method, the perception of the twenty consumers was formulated as a new triangular fuzzy number (TFN) using this method. The values used in this calculation can be found in Table A 7.

For example, for  $P_1$ ,  $S_1$  (*minimal*) (See Table 4-3 and Figure 4-4), for the degree  $A$ , there are three values of the TFNs ( $t_1 = 0.75$ ,  $t_2 = 1$ , and  $t_3 = 1$ ) (See Table 2-7). Out of the 20 evaluators ( $m=20$ ), 7 evaluators choose  $A$  ( $h=7$ ,  $i=A$ ,  $t_1=0.75$ ), 11 evaluators select  $B$  ( $h=11$ ,  $i=B$ ,  $t_1=0.5$ ), 2 evaluators select  $C$  ( $h=2$ ,  $i=C$ ,  $t_1=0.25$ ), and none of the evaluators choose  $D$  ( $h=0$ ,  $i=D$ ,  $t_1=0$ ) or  $E$  ( $h=0$ ,  $i=E$ ,  $t_1=0$ ), then the aggregated value of  $t_1$  is 0.6. The new TFN is calculated as shown below:

$$S_1 = \left( \frac{0.75 \times 7 + 0.5 \times 11 + 0.25 \times 2}{20}, \frac{1 \times 7 + 0.75 \times 11 + 0.5 \times 2}{20}, \frac{1 \times 7 + 1 \times 11 + 0.75 \times 2}{20} \right),$$

$$S_1 = (0.6, 0.8, 1).$$

For example, Product 1 ( $P_1$ )  $S_1 = (0.6, 0.8, 1)$  means that this aggregated evaluation is between  $B$  (*Good*) and  $A$  (*Excellent*), see Table 2-7. By referring to the defined fuzzy numbers in Table 2-7, the aggregated evaluation results can be analyzed as follows. The aggregated evaluation of  $P_1$   $S_2 = (0.5, 0.7, 0.9)$  is between  $C$  (*Medium*) and  $B$ .  $S_3$  and  $S_4 = (0.1, 0.3, 0.5)$  are identically between  $D$  (*Low*) and  $C$ , and both  $S_5$  and  $S_6 = (0, 0, 0.25)$  are identically corresponding to  $E$  (*Poor*).

For Product 2 ( $P_2$ ),  $S_1 = (0.5, 0.8, 1)$  means that this aggregated evaluation is between  $B$  and  $A$ . The aggregated evaluation of  $S_2 = (0.5, 0.7, 0.9)$  is, the same as for  $P_1$   $S_2$ , between  $C$  and  $B$ .  $S_3 = (0.7, 0.9, 1)$  and  $S_4 = (0.6, 0.9, 1.0)$  are both between  $B$  and  $A$ .  $S_5(0, 0.2, 0.4)$  and  $S_6(0, 0.1, 0.4)$  are both corresponding to  $E$  (*Poor*).

Product 3 ( $P_3$ )  $S_1$  and  $S_2 = (0.4, 0.7, 0.9)$  means that both this aggregated evaluation is between  $C$  and  $B$ . The aggregated evaluation of  $S_3 = (0.1, 0.4, 0.6)$  and  $S_4 = (0.1, 0.3, 0.6)$  is between  $D$  and  $C$ .  $S_5 = (0.6, 0.9, 1)$  and  $S_6 = (0.5, 0.8, 1)$  are both between  $B$  and  $A$ . Concluding, all three products  $P_1$ - $P_3$  show different aggregated evaluation results in the

design solutions, except for  $S_2$  durable. Also,  $S_3$  and  $S_4$ , as well as  $S_5$  and  $S_6$  received similar responses.

**(c) distance to excellent condition**

This study calculated the distance to the excellent condition for each eco-style  $S_1$ - $S_6$ . The distances indicate the membership degree of each eco-style to different evaluation degrees; the shorter the distance, the higher the membership degree to the condition of *Excellent* or *Very Sustainable (VS)*. For example,  $P_1 S_1 = (0.6, 0.8, 1)$  and  $A = (0.75, 1, 1)$  means that the distance of  $S_1$  to  $A$  (*Excellent*) is 0.15, see Table 4-4. The distance was calculated with Equation 9 (see Section 2.4) as following:

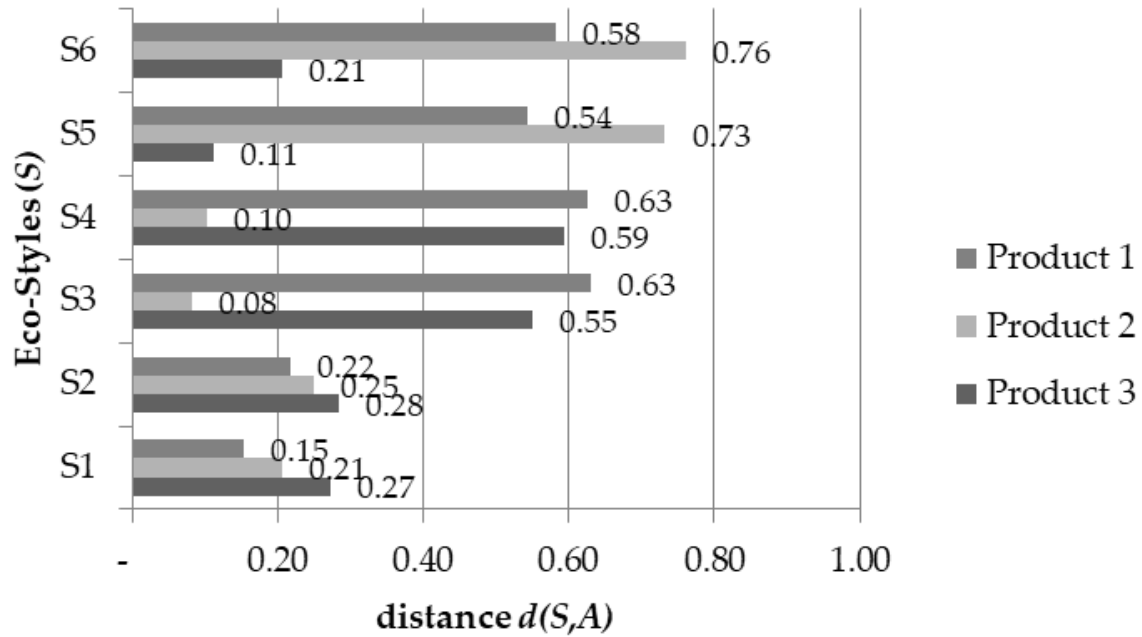
$$d(S_1, A) = \sqrt{\frac{1}{3} [(0.6 - 0.75)^2 + (0.8 - 1)^2 + (1 - 1)^2]},$$

$$d(S_1, A) = 0.15.$$

The distances of the consumers' environmentally-friendly perception for the excellent condition are relatively short for  $S_1$  and  $S_2$  for all three products, see Table 4-4 and Figure 4-5; thus, most sustainable products are seen as more style-based (a), as minimal (S1) and durable (S2).

Comparing the three different garments accordingly, we noticed that all three garments are at least a little minimal (S1) and durable (S2), mostly Product 1. This can be due to the perception of hoodies as a basic garment type. Also, garment styles following the concept of slow fashion can be perceived with a certain degree of durability; slow fashion products of all categories are seen as quality products [34].

For P2, the distances are larger, especially for  $S_5$  and  $S_6$ . Thus the garments' appearance is seen as less fashionable (c) in terms of less unique ( $S_5$ ) and decorated ( $S_6$ ). For P3, its appearance is most fashionable (c) in terms of unique ( $S_5$ ) and decorated ( $S_6$ ), but least versatile (b): multi-functional ( $S_3$ ) and dynamic ( $S_4$ ).



**Figure 4-5:** Distance to excellent condition.

### 4.2.3 Analysis and Validation of Results

In the following, the obtained results of the three products ( $P_1$ ,  $P_2$ ,  $P_3$ ) for the distance to the excellent condition (See Figure 4-5) are related to the product description (style) as given in **Section 4.2.2.2**.

For example, the distance of  $P_1$  ((a) People Tree), for  $S_1$  (minimal) and  $S_2$  (durable, is close to the excellent condition. Accordingly,  $P_1$  was defined as a basic striped hoody. Similarly,  $S_3$  (multi-functional) and  $S_4$  (dynamic) can be found far from the excellent condition.

The distance of  $P_2$  ((b) Engel Sports), for  $S_3$  (multi-functional) and  $S_4$  (dynamic), is close to the excellent condition. Accordingly,  $P_2$  was defined as a sportive and lightweight, regular fit hoody. Similarly,  $S_5$  (unique) and  $S_6$  (decorated) can be found far from the excellent condition.

The distance of  $P_3$  ((c) Lovjoi), for unique ( $S_5$ ) and decorated ( $S_6$ ), is close to the excellent condition. Accordingly,  $P_3$  was defined as a cropped hoody with a fancy hood. Similarly,  $S_3$  (multi-functional) and  $S_4$  (dynamic) can be found far from the excellent condition.

Concluding, the following qualitative recommendations can be given to designers for the creation of a product's eco-appearance.

For example, if a designer is requested to design a new product for meeting the criterion  $S_1$  (minimal), the following qualitative advices can be given: The features of the product related to these specific requirements of eco-style should refer to a basic garment shape and exclude a sportive and fancy style.

Or, if a set of criteria should be met such as for example  $S_1$  and  $S_3$  (multi-functional), the design should combine a basic and sportive style, and exclude fancy details. In the same way, designers can relate to the results of the three products ( $P_1, P_2, P_3$ ) and the product features, using the results of the criterion ( $S_1- S_6$ ).

#### **4.2.4 Conclusion**

This research has proposed an experimental design analysis process for assessing consumer perception of eco-fashion style, according to key eco-design principles; the study has identified three eco-design principles (i.e., style, versatile, and fashion). Thus, garment design style has certain eco-fashion styles such as minimal and durable. Based on the results, products can be modified to achieve higher environmentally-friendly perception; the sustainability perception of garments can be adapted by improving the design according to the eco-criteria.

Since the perception of consumers towards ethical fashion is somewhat subjective, as human perception can be vague and full of uncertainty, this study used sensory evaluation tools as well as the fuzzy logic method to process the qualitative data; No related research on ethical fashion has addressed these points. The data collection makes use of basic visualization and designer tools such as word clouds and mood boards. The data processing of qualitative data applies sensory evaluation and the fuzzy logic method. All the methods have been approved to be useful and could be applied successfully for the case of ethical fashion evaluation. In using these tools, the evaluation of ethical fashion can be improved, referring to the research of ethics and human perception which is rather imprecise.

The results of the case study carried out show that the proposed experimental design analysis process applies to the analysis of garment style regarding of eco-fashion style. By applying the process, the methods can distinguish between the eco-products. This process will benefit fashion designers in sustainable product development. The processed uncertain data using fuzzy set theory can show the environment-friendly appearance: We found that Product 1 is perceived as very minimal ( $S_1$ ) and durable ( $S_2$ ), Product 2 is very multi-functional ( $S_3$ ) and dynamic ( $S_4$ ), and Product 3 is very unique ( $S_5$ ), and a little decorated ( $S_6$ ).

The proposed process can be used in a digital environment, but also a non-digital, to carry out the experiments. In addition, the process has been designed to allow eco-design descriptors to be modified according to the processes of Experiment 1 and 2, see Figure 3-4. Finally, we argued that most eco-designed fashion products can be distinguished in their overall appearance by using these key eco-design principles. Based on the results, the appearance of garment designs can be improved to match the sustainability criteria. As a side note, this study does not support greenwashing but intends to provide valuable insights to fashion designers by assessing consumers' perception of eco-fashion style and ensure the success of sustainable product development. It has been seen that the product appearance influences consumer decisions; products should be designed with a low environmental impact and show the right eco-values in their design. This research did not include consumers' acceptance of the eco-styles in the garment style, as described by Wang and Shen [95]. However, future research can include this aspect. Concluding, the proposed experimental design process applies to the analysis of garment style regarding eco-fashion style. Future research might focus on the evaluation of different garment styles and including a study on consumers' fashion acceptance and sensibility and using large scale consumer tests.

## **4.3 Study 3: Consumer Perceptions of Environmentally-Friendly Appearance through Kansei Engineering**

This section follows up on the study of eco-fashion style in **Section 4.2** and findings of **Section 4.1** regarding consumer feelings towards ethical fashion design styles including environmental-friendliness and eco-materials. This study describes a quantitative approach to understand the relationship between the garment design and material with eco values, using the Kansei engineering data acquisition methodology as described in **Section 2.2.2**. This method links consumer emotions to product attributes, in this case, the environmentally-friendly perception. The development of the mood boards used in this study is shown in **Section 4.4**.

### **4.3.1 Introduction**

Commonly in the marketing literature, a distinction is drawn between the consumer perception of a product's sustainability (feelings, e.g., regarding organic cotton) and conventional product characteristics (attributes) [108]. Accordingly, a sustainable product is defined as a conventional product plus sustainability. On the contrary, the Kansei engineering methodology links consumer emotions to product attributes and is able to design feelings into products [171]. Our modeling approach considers that the ethical fashion product can be designed to bring forward the environmentally-friendly feeling through the appearance of eco-values. Thus, this study considers that sustainability is dependent on product attributes in terms of consumer perception of environmentally-friendly product appearance. Concluding, in this study an approach is made to evaluate the image and feelings of the environmentally-friendly appearance through a case study of T-shirts.

### **4.3.2 Case Study: French sustainable children's fashion brand**

A case study is illustrated to show the effectiveness of the Kansei methodology. The proposed approach was applied through an example of a French sustainable fashion company. This experimental case obtained the environmentally-friendly appearance from real garments. For this study, 10 garments were selected. The garment selection was based on the brand's collection present on their webshop and the fashion themes provided by the company. The fashion trends for the Spring Summer (SS 2017) children's collection are the following:



“playfulness in design”, “emphasis on prints and shape”, “variety of sleeve lengths”, “embroidery”, “classic”, “flower prints”, and “stripes”. In our study, we focused on one fashion item, selecting girls’ Tops and T-shirt styles as references. The samples were selected according to different styles as well as material compositions, choosing several well-known materials such as cotton or cotton BCI (Better Cotton Initiative).

The Better Cotton Initiative exists to make global cotton production better for the people who produce it, better for the environment it grows in (...). [215]




### 4.3.3 Results and Discussion








A case study is reported here to illustrate how Kansei methodology can be used to assess parameters in design appearance.

#### 4.3.3.1 Design Description

We defined the design of the 10 selected samples through a description of material content and design features as presented in Table 4-5. The design description was based on abstract, original and concrete features of the product [83].

**Table 4-5:** Material content and design features of the ten samples.

Samples T-Shirts	Material Content	Design A. Abstract reason: Image style	Design B. Original condition: Contours	Design C. Concrete reason: Design details
1 	95% cotton BCI, 5% elastane	basic	slim fit cut	short sleeved, plain
2 	95% cotton, 4% polyester, 1% elastane	romantic	straight cut	short sleeved, flower print (small, sleeves)
3 	100% organic cotton	romantic	straight cut	short sleeved, flower print (large, front)

4		100% cotton	feminine	straight cut	very short sleeved, heart print (large, front), bow (front)
5		100% cotton BCI	romantic	A-line	curled short sleeved
6		72% cotton, 28% polyester	urban	slim fit cut	short sleeved, sequins (large, front)
7		70% cotton, 30% viscose	romantic	A-line	very curled short-sleeved, embroidered (small, front), pompons
8		99% cotton, 1% polyester	urban	round cut	long-sleeved, embroidered (large, front)
9		60% cotton, 40% recycled polyester	urban	slim fit cut	shirt-sleeved, embroidered (large, front), stripes
10		72% cotton, 26% recycled polyester	urban	round cut	long/short-sleeved (2 in 1), stripes, print (medium, front)

#### 4.3.3.2 Survey Results

The survey results for both, the material and design perception from sixty-three participants are presented in Table 4-6 and Table 4-7 as median values. For example, the consumer ratings for Material, Green 1 for S1 resulted in a median of 2 (=MEDIAN(R1:R63)=2); see Appendix 6, Table A 8 for the individual consumer ratings.

**Table 4-6:** Median values for each sample for material, sample S1-10.

Material	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Green 1	2.00	2.00	1.00	2.00	2.00	4.00	4.00	2.00	3.00	3.00
Green 2	3.00	3.00	2.00	3.00	3.00	4.00	4.00	3.00	3.00	3.00
Organic 1	2.00	2.00	1.00	2.00	2.00	4.00	4.00	2.00	3.00	3.00
Organic 2	2.00	3.00	1.00	3.00	2.00	4.00	4.00	3.00	3.00	4.00
Attractive	2.00	2.00	1.00	2.00	1.00	3.00	3.00	2.00	3.00	3.00

**Table 4-7:** Median values for each sample for design, sample S1-10.

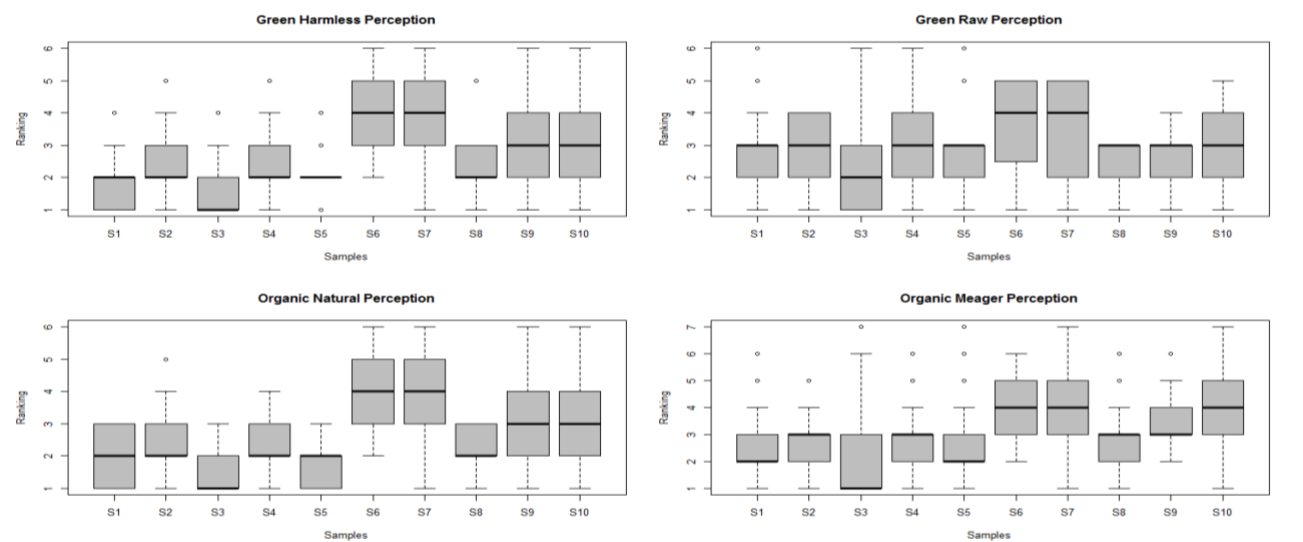
Design	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Recycled 1	1.00	2.00	4.00	4.00	5.00	4.00	4.00	4.00	4.00	4.00
Recycled 2	1.00	3.00	3.00	4.00	4.00	4.00	3.00	4.00	4.00	4.00
Recycled 3	2.00	2.00	2.00	2.00	2.00	4.00	5.00	3.00	4.00	4.00
Attractive	3.00	2.00	2.00	2.00	2.00	3.00	2.00	3.00	4.00	3.00

Results are summarized in Figure 4-6, Figure 4-7, and Figure 4-8 for an attractive rating in a standard boxplot, displaying the 1st and 3rd quartile, the median, and outliers. The boxplot shows ten samples on the x-axis and the rating scale on the y-axis. According to the 1-7 scale, refer to Table 3-10, the closer to 1, the more environmentally friendly is the rating.

Comparing the word pairs for materials' and designs' sustainability, a difference in the rating can be seen, refer to Table 4-6 and Table 4-7. The results obtained from the median values from 40 individual rating for material (excluding attractive) shows that there are 16 rating (40%) below 3 {Green1: 1.S1(2), 2.S2(2), 3.S3(1), 4.S4(2), 5.S5(2), 6.S8(2); Green2: 7.S3(2); Organic1: 8.S1(2), 9.S2(2), 10.S3(1), 11.S4(2), 12.S5(2), 13.S8(2); Organic2: 14.S1(2), 15.S3(1), 16.S5(2)}. 24 ratings (60%) are in between 3-5, and no rating above 5. From the 30 individual rating for design (excluding attractive), there are 8 median values which are below 3 (8 ratings), 22 rating between 3-5, and no median values above 5.

### 4.3.3.3 Data Visualization

For more detailed analysis, boxplots were generated (see Figure 4-6, Figure 4-7, and Figure 4-8). Figure 4-6 shows the results for materials' perception of green (above), for the word pair harmless-toxic (left), raw-sophisticated (right), and of organic (below), for natural-artificial (left), meager-luxurious (right).



**Figure 4-6:** Boxplots of samples for green and organic.

For both graphs of green, the y-axis shows that the rated ratings range from 1 to 6 only, i.e., 7 was not used. The median ranges from 1 to 4 for harmless, and 2 to 4 for raw. Harmless has significantly lower ratings and is less spread than ratings for raw which are higher and more spread. Samples 6, 7 and 9, 10 have no outliers for both green perceptions, and for raw

perception, samples 2-4, and 8 have no outliers as well. Especially samples 1 to 5 show a high difference. Generally, in Figure 4-6, the minimal median score is 1, and the highest median score is 4. For three of the four word pairs, the highest score was 6, only the word pair meager received the score 7 as an outlier for sample 3 and 5, whereby 5 had also outliers for higher attractiveness scores (3-6).

For the material perception, all samples gained a wide range of responses, having low and medium ratings mainly for all word pairs, except for the word pair meager-luxurious; only medium and high ratings are seen, except for sample 3 which was perceived as extremely meager. Sample 3 (100% organic cotton) has the lowest score and is thus perceived as the most sustainable. It is well-known that organic cotton has a lower impact on the soil and environment by excluding toxic insecticides, herbicides, or fungicides, refer to **Section 1.2.2**, discussing the real environmental impacts of organic cotton and polyester. Low scores have been evaluated for BCI cotton samples 1 and 5, and for samples with high cotton content 2, 4 and 8. The BCI cotton seems to be less environmental-friendly perceived than organic cotton; consumers might relate more to social standards, see the definition of BCI cotton in **Section 4.3.2**. Sample 6 (72% cotton, 28% polyester) and 7 (70% cotton, 30% viscose) have the highest score with a median value of 4 compared with others, thus are least sustainable; samples 9 and 10, (recycled material content), are having a slightly higher score compared to the cotton content samples, but samples 6, 7 and 9, 10, i.e., containing polyester/or viscose and cotton, are most luxurious. As discussed in **Section 4.3.2**, synthetic fibers such as polyester have a negative environmental impact as they are derived from petrochemicals and oil, but they need less water in their production. Consumers tend to prefer natural to synthetic fibers [61]. Thus, the more cotton, the more harmless the material is perceived, refer to sample 1-5, and 8, as well as the more natural. Less natural perception is gained for samples that are mixed with polyester and viscose, see sample 6, 7 and 9, 10.

Figure 4-7 shows the results for the designs' perception of recycled, for the word pair classic-trendy (left), functional-decorative (middle) and recyclable-disposable (right). Sample 1 is the most basic and has the lowest ratings, also sample 2 has a more basic design and median values from 2-3. The word pair recyclable has the narrowest range of ratings (samples 2, 3, 5 and 8), and the widest range for samples 9, 10. Sample 5 has the widest range in all word pairs, it is not very classy, but scores low for recyclability. Sample 1 and 2 are classic, others are trendier. Thus, sample 1 is also seen as more functional, whereby others are more decorative. Generally, samples 1-5 are similar in recyclable, and 6-10 in disposable. Samples

6 to 10 received identical results, and samples 6, 9 and 10 are identical for the three word pairs (excluding attractive).

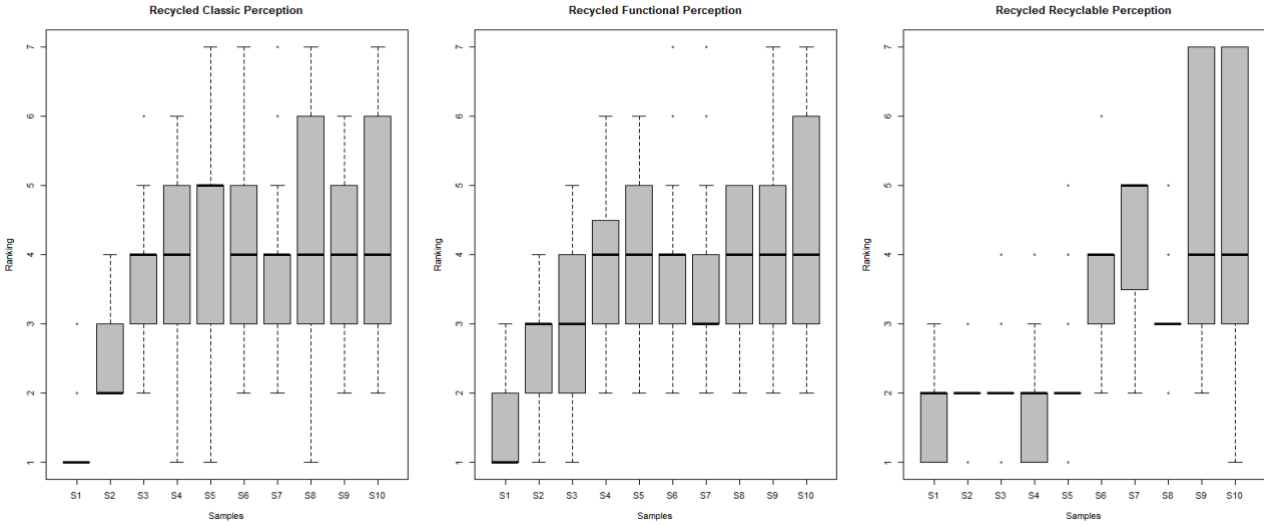


Figure 4-7: Boxplots of samples for recycled perception.

Figure 4-8 shows the results for the perception of attractiveness, for the word pair attractive-unattractive for materials (left) and attractive-unattractive for designs (right). For the attractive rating, the most attractive material sample is organic and BCI cotton (sample 3 and 5), least attractive are these with polyester and viscose (sample 6, 7) and recycled content (sample 9, 10). For the design, sample 4 (feminine, straight cut) and 5 (romantic, A-line) are most attractive, and 9 (urban, slim fit cut) least attractive, as well as sample 1 (basic, slim fit cut).

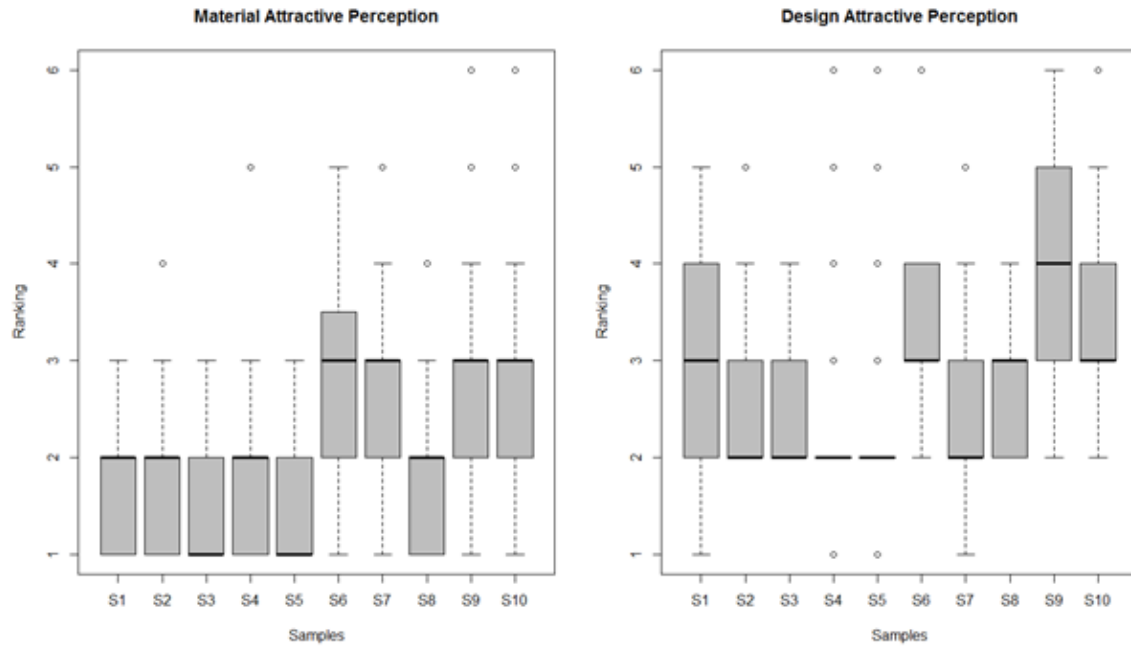


Figure 4-8: Boxplots of samples for attractive perception.

### 4.3.4 Analysis and Validation of Results

In the following, the obtained results of the garment technical parameters and themes, and related advices to designers are discussed, see Table 4-8 for the material parameters and Table 4-9 for the design parameters.

**Table 4-8:** Obtained results of garment technical parameters (material), themes, and related advices.

Technical Parameters	Technical Themes					Related Advices to Designers
	Material Content	Green 1 (harmless/non-toxic)	Green 2 (raw/less water & energy)	Organic 1 (natural/non-artificial)	Organic 2 (meager / dematerialized)	
95% cotton BCI, 5% elastane	(2) very harmless	(3) a little raw	(2) very natural	(2) very meager	(2) very attractive	<i>very sustainable: very green &amp; very organic (a little raw , but very meager)</i>
95% cotton, 4% polyester, 1% elastane	(2) very harmless	(3) a little raw	(2) very natural	(3) a little meager	(2) very attractive	<i>very sustainable: very green &amp; very organic (a little raw and meager)</i>
100% organic cotton	(1) extremely harmless	(2) very raw	(1) extremely natural	(1) extremely meager	(1) extremely attractive	<i>extremely sustainable: most green &amp; organic (most harmless, raw, natural, and meager)</i>
100% cotton	(2) very harmless	(3) a little raw	(2) very natural	(3) a little meager	(2) very attractive	<i>very sustainable: very green &amp; very organic (a little raw and meager)</i>
100% cotton BCI	(2) very harmless	(3) a little raw	(2) very natural	(2) very meager	(1) extremely	<i>very sustainable: very green &amp; very organic (a</i>

					attractive	<i>little raw , but very meager)</i>
72% cotton, 28% polyester	(4) moderate harmless	(4) moderate raw	(4) moderate natural	(4) moderate meager	(3) a little attractive	<i>moderate sustainable: moderate green &amp; moderate organic</i>
70% cotton, 30% viscose	(4) moderate harmless	(4) moderate raw	(4) moderate natural	(4) moderate meager	(3) a little attractive	<i>moderate sustainable: moderate green &amp; moderate organic</i>
99% cotton, 1% polyester	(2) very harmless	3) a little raw	(2) very natural	(3) a little meager	(2) very attractive	<i>very sustainable: very green &amp; very organic (a little raw and meager)</i>
60% cotton, 40% recycled polyester	(3) a little harmless	3) a little raw	3) a little natural	(3) a little meager	(3) a little attractive	<i>a little sustainable: a little green &amp; a little organic</i>
72% cotton, 26% recycled polyester	(3) a little harmless	3) a little raw	3) a little natural	(4) moderate meager	(3) a little attractive	<i>a little sustainable: a little green &amp; a little organic (least meagre)</i>

For example, if a designer is requested to design a product meeting the Technical Theme “Green (harmless & raw)”, the best material choice is 100% organic cotton, refer to Table 4-8. And, the worst choice is the cotton/polyester blend (72% cotton, 28% polyester) or cotton/viscose blend (70% cotton, 30% viscose).

**Table 4-9:** Obtained results of garment technical parameters (design), themes, and related advices.

Technical Parameters			Technical Themes				Related Advices to Designers
Design A. Abstract reason: Image style	Design B. Original condition: Contours	Design C. Concrete reason: Design details	Recycled 1 (classic/non-trendy)	Recycled 2 (functional/non-decorative)	Recycled 3 (recyclable/no-waste)	Attractive	Sustainability Perception of Design
basic	slim fit cut	short sleeved, plain	(1) extremely classic	(1) extremely functional	(2) very recyclable	(3) a little attractive	<i>extremely sustainable: most recycled (extremely classic &amp; functional)</i>
romantic	straight cut	short sleeved, flower print (small, sleeves)	(2) very classic	(3) a little functional	(2) very recyclable	(2) very attractive	<i>very sustainable: very recycled( but a little functional)</i>
romantic	straight cut	short sleeved, flower print (large, front)	(4) moderate classic	(3) a little functional	(2) very recyclable	(2) very attractive	<i>a little sustainable: a little recycled (very recyclable, but less classic)</i>
feminine	straight cut	very short sleeved, heart print	(4) moderate classic	(4) moderate functional	(2) very recyclable	(2) very attractive	<i>moderate sustainable: moderate recycled</i>



		(large, front), bow (front)					<i>(very recyclable, but less classic &amp; functional)</i>
romantic	A-line	curled short sleeved	(5) a little trendy	(4) moderate functional	(2) very recyclable	(2) very attractive	<i>moderate sustainable: moderate recycled (very recyclable, but least classic &amp; moderate functional)</i>
urban	slim fit cut	short sleeved, sequins (large, front)	(4) moderate classic	(4) moderate functional	(4) moderate recyclable	(3) a little attractive	<i>moderate sustainable: least recycled</i>
romantic	A-line	very curled short-sleeved, embroidered (small, front), pompons	(4) moderate classic	(3) a little functional	(5) a little waste	(2) very attractive	<i>moderate sustainable: least recycled (least recyclable)</i>
urban	round cut	long-sleeved, embroidered (large, front)	(4) moderate classic	(4) moderate functional	(3) a little recyclable	(3) a little attractive	<i>moderate sustainable: least recycled (a little recyclable)</i>
urban	slim fit cut	shirt-sleeved, embroidered (large, front), stripes	(4) moderate classic	(4) moderate functional	(4) moderate recyclable	(4) moderate attractive	<i>moderate sustainable: least recycled</i>
urban	round cut	long/short-sleeved (2 in 1), stripes, print (medium, front)	(4) moderate classic	(4) moderate functional	(4) moderate recyclable	(3) a little attractive	<i>moderate sustainable: least recycled</i>

For example, if a designer is requested to design a product meeting the Technical Theme “Recycled 1 (classic/non-trendy)”, the best design choice is a basic style, slim fit cut & short sleeved, and plain (design details), refer to Table 4-9. And, the worst choice is the romantic style, A-line & very curled short-sleeved, and embroidered (small, front), pompons. It is perceived as the most wasteful (least recyclable).

### 4.3.5 Conclusion

In this chapter, we presented the Kansei engineering methodology to study the relationship between environmentally-friendly perception and design and material elements of girl’s T-shirts. The Kansei survey method has been carefully selected according to its ability

of linking consumer emotions to product attributes. In conventional marketing research, the emotional appeal in terms of an environmentally-friendly appearance in the design of ethical fashion products is not considered. In this context, the Kansei engineering method is more efficient for formalizing perceptual data of environmentally-friendly design and can be applied to any kind of garment.

This study focused on visual perception, excluding physical comfort. The results of this study provided useful insights on the environmentally-friendly image of fashion products. In our case study with sixty-three females, as expected, we found that the design and material parameters did affect the consumer perception of the product's sustainability. Survey participants linked sustainability with a basic design, and similarly, high environmental impact with an enhanced and fashionable design. The organic and BCI cotton material had the most meager image, whereby the samples containing polyester/or viscose are seen as most luxurious. Concluding, a more basic design and natural materials increased the environmentally-friendly appearance. A more enhanced/fashionable design and synthetic materials decreased the environmentally-friendly appearance. These results show that consumers have a clear distinction between different garment designs in terms of sustainability perception.

## **4.4 Study 4: Consumer Perceptions of Environmental Impact through Survey Questionnaire**

This section is based on insights of the previous chapters, referring to the sustainable fashion solutions in **Section 1.2.2** and the findings for consumer awareness of ethical fashion in **Chapter 3**. The mood boards used in **Section 4.3** were developed in this study. Using the classical data acquisition methodologies as described in **Section 2.1**, this study uses a quantitative methodology, presenting the relation of perceptual and real data regarding the parameter ethical to visualize the gap of real LCA and human perception, applying a case study of a T-shirt.

### **4.4.1 Introduction**

In a context of growing consumer awareness of environmental issues, tools are required to assess impacts and communicate environmental friendliness. There are diverse ways of communicating with consumers such as by using images. This can be seen from the success of social media platforms such as Instagram, or Pinterest. For example, Pinterest search results related to sustainability have increased, especially by Millennials and Generation Z consumers, searching mostly for “sustainable living” and “sustainable living for beginners”, as well as “sustainable fashion” [216]. Existing literature shows that consumers usually master some knowledge of the fashion industry’s impact on environment and society [3].

This study presents an approach to compare the impacts assessed by the LCA methodology and the perceived impacts of consumers. To do this, the life cycle impact assessment (LCIA) results of a T-shirt have been simplified in a visualized way as described in the following.

### **4.4.2 Results and Discussion**

#### **4.4.2.1 Consumer Perception of T-Shirt Life Cycle**

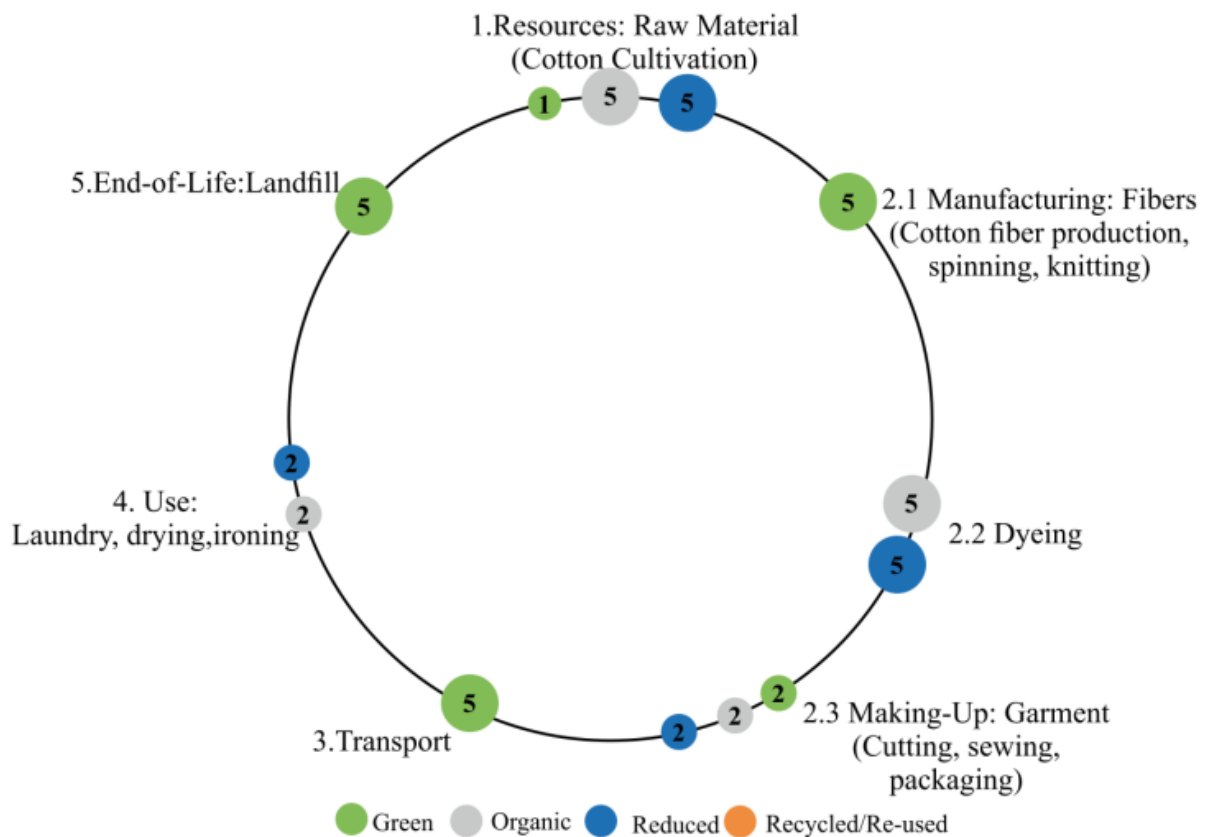
The individual results of the 20 consumer ratings are presented in Table 4-10.

**Table 4-10:** Consumers' evaluation results for the T-Shirt Life Cycle.

	Steps/ Impacts	1.	2.1	2.2	2.3	3	4	5
Simplified LCIA	<i>Green</i>	1	1	-	2	1	-	1
	<i>Organic</i>	5	-	3	2	-	3	-
	<i>Reduced</i>	5	-	3	2	-	1	-
Consumer Perception 1	<i>Green</i>	1	5	-	2	5	-	5
	<i>Organic</i>	5	-	5	2	-	2	-
	<i>Reduced</i>	5	-	5	2	-	2	-
Consumer Perception 2	<i>Green</i>	1	4	-	3	4	-	4
	<i>Organic</i>	5	-	4	3	-	3	-
	<i>Reduced</i>	5	-	4	3	-	2	-
Consumer Perception 3	<i>Green</i>	2	5	-	2	5	-	5
	<i>Organic</i>	5	-	5	2	-	2	-
	<i>Reduced</i>	5	-	5	2	-	2	-
Consumer Perception 4	<i>Green</i>	3	5	-	3	5	-	5
	<i>Organic</i>	5	-	5	2	-	2	-
	<i>Reduced</i>	5	-	5	2	-	2	-
Consumer Perception 5	<i>Green</i>	5	5	-	2	5	-	5
	<i>Organic</i>	5	-	5	2	-	3	-
	<i>Reduced</i>	5	-	5	2	-	3	-
Consumer Perception 6	<i>Green</i>	1	2	-	2	2	-	2
	<i>Organic</i>	5	-	4	2	-	2	-
	<i>Reduced</i>	5	-	4	2	-	2	-
Consumer Perception 7	<i>Green</i>	1	1	-	2	1	-	1
	<i>Organic</i>	5	-	3	2	-	2	-
	<i>Reduced</i>	5	-	3	2	-	2	-
Consumer Perception 8	<i>Green</i>	1	5	-	2	5	-	5
	<i>Organic</i>	5	-	5	2	-	2	-
	<i>Reduced</i>	5	-	5	2	-	2	-
Consumer Perception 9	<i>Green</i>	2	5	-	2	5	-	5
	<i>Organic</i>	5	-	5	2	-	2	-
	<i>Reduced</i>	5	-	5	2	-	2	-
Consumer Perception 10	<i>Green</i>	1	4	-	3	4	-	4
	<i>Organic</i>	5	-	4	3	-	3	-
	<i>Reduced</i>	5	-	4	3	-	2	-
Consumer Perception 11	<i>Green</i>	1	1	-	2	1	-	1
	<i>Organic</i>	5	-	3	2	-	3	-
	<i>Reduced</i>	5	-	3	2	-	1	-
Consumer Perception 12	<i>Green</i>	4	1	-	2	1	-	1
	<i>Organic</i>	4	-	4	2	-	4	-
	<i>Reduced</i>	4	-	4	2	-	1	-
Consumer Perception 13	<i>Green</i>	2	5	-	3	5	-	5
	<i>Organic</i>	5	-	5	3	-	3	-
	<i>Reduced</i>	5	-	5	3	-	3	-
Consumer Perception	<i>Green</i>	2	5	-	3	5	-	5
	<i>Organic</i>	4	-	4	3	-	3	-

<b>14</b>	<i>Reduced</i>	4	-	4	3	-	3	-
<b>Consumer Perception</b>	<i>Green</i>	3	4	-	2	4	-	2
	<i>Organic</i>	3	-	4	3	-	3	-
<b>15</b>	<i>Reduced</i>	3	-	3	3	-	2	-
<b>Consumer Perception</b>	<i>Green</i>	1	2	-	2	5	-	5
	<i>Organic</i>	5	-	5	2	-	2	-
<b>16</b>	<i>Reduced</i>	5	-	5	2	-	2	-
<b>Consumer Perception</b>	<i>Green</i>	1	3	-	2	3	-	3
	<i>Organic</i>	5	-	4	2	-	3	-
<b>17</b>	<i>Reduced</i>	5	-	4	2	-	2	-
<b>Consumer Perception</b>	<i>Green</i>	1	5	-	2	5	-	5
	<i>Organic</i>	5	-	5	2	-	2	-
<b>18</b>	<i>Reduced</i>	5	-	5	2	-	2	-
<b>Consumer Perception</b>	<i>Green</i>	1	1	-	2	1	-	2
	<i>Organic</i>	5	-	3	2	-	3	-
<b>19</b>	<i>Reduced</i>	5	-	3	2	-	1	-
<b>Consumer Perception</b>	<i>Green</i>	2	2	-	2	2	-	2
	<i>Organic</i>	5	-	2	2	-	3	-
<b>20</b>	<i>Reduced</i>	5	-	3	2	-	1	-

One example (**Consumer Perception 1**) of the human evaluation for consumer perception of the simplified LCIA can be seen in Figure 4-9 and the evaluation process will be explained in the following, using this example.



**Figure 4-9:** Consumer perception of T-Shirt life cycle.

#### 4.4.2.2 Comparing Simplified and Perceived LCA

In here the simplified and the perceived LCA are compared. The comparison between the two LCIA of the T-shirt in Figure 4-10 highlights the gaps between the environmental impacts of the product and the perceived ones. One of the seven life cycle phases of a T-shirt match in human perception and the real data, being the first phase of “Resources”. In this example, manufacturing and dyeing is perceived as highly impacting. Generally, impacts are rated as high, i.e., the participant is aware of impacts.

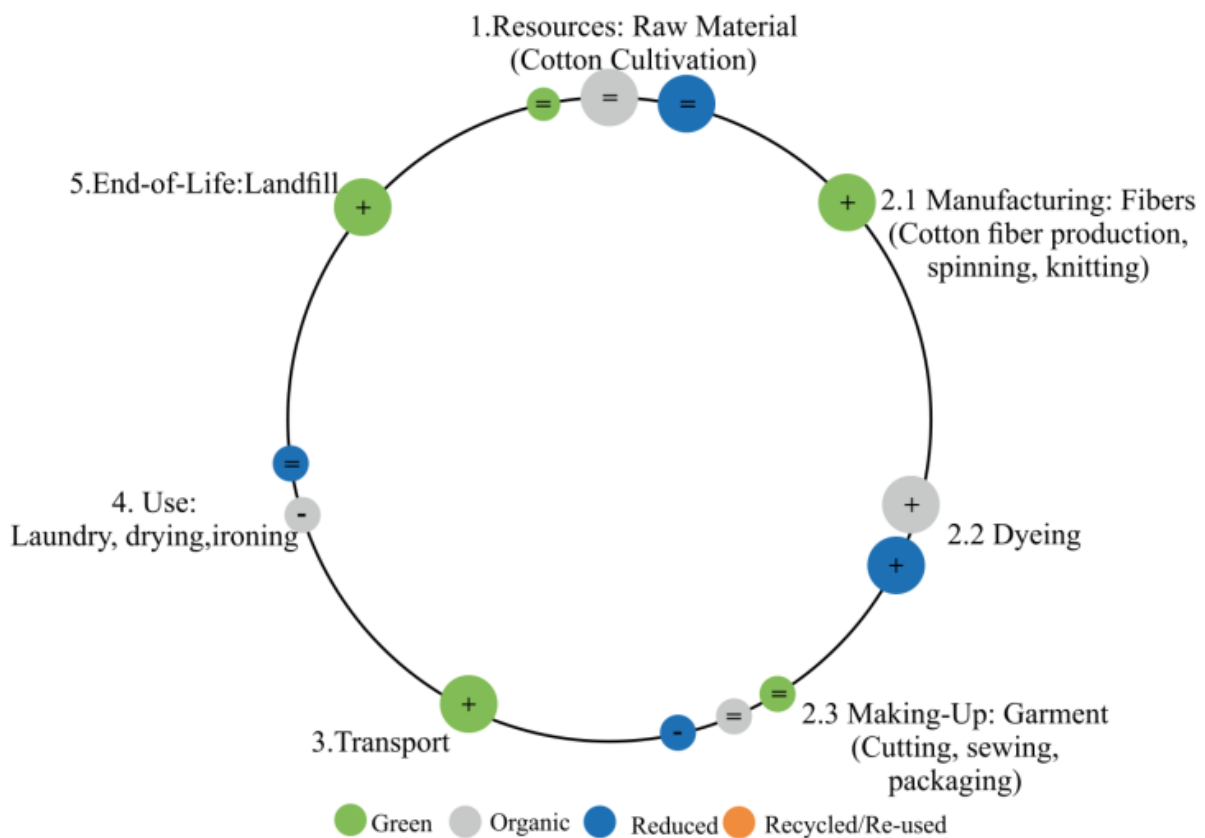


Figure 4-10: Comparing simplified and perceived LCA.

#### 4.4.3 Conclusion

This chapter discussed the development of a tool to identify and quantify the image of fashion products in terms of environmental impact or environmentally-friendly. The qualitative analysis of ethical fashion impact used a survey questionnaire method. It has been seen that contemporary ethical fashion offers several solutions and that there is a necessity for more information as the provision of useful information can enhance the consumer decision-making process for ethical fashion products. To support information, evaluation tools such as

LCA are helpful to determine the real value and can be used as marketing tools to promote sustainable value towards the consumer. Consumer assessment is subjective and can often differ from the real LCAs. In here, perceived impacts match real impacts. And, impacts are perceived as high. Limitations of this study are based on the limitations of the secondary data, as “some life cycle stages are simplified, such as cotton cultivation (background LCIs), transportation, and end-of-life disposal (no recycling).“ [20] Further testing of the acceptance of the concept is needed, including different fashion products, and the phase of recycling.

# General Conclusion and Future Work

This thesis contributes to the developments for methods to evaluate consumers' perception which is subjective and emotional. The fast evolving research topic of ethical fashion has become a broad concept of different environmental and social dimensions. The insights of fashion companies can be beneficial for other sectors which are led by aesthetic and symbolic product values [84]. According to marketing studies, a successful ethical fashion product should be designed in line with consumers, and include their emotions. In this context, we applied qualitative and quantitative data acquisition methods. These methodologies are capable of understanding consumer's vague and uncertain needs and translate them into ethical fashion product attributes. The aim of this research project was to qualitatively and quantitatively characterize the expectations and perceptions of consumers for ethical fashion. Hereby, we used a series of representative textile products. And, their relations with concerned product design parameters were investigated. Therefore, we proposed four evaluation approaches for acquiring and analyzing relevant human data. The conclusions of the approaches are discussed in the following.

*Study 1* in **Section 4.1**, addressed the 1) Attitude-behavior gap. We used a qualitative approach to characterize the ethical fashion concept. We determined a consumer focus group and developed a survey questionnaire. This research provides a consumer model and discussed the different awareness dimensions based on classical qualitative survey methodology. In our case study with Romanian consumers, ethical fashion products have been seen as high quality products. This perceptions aligns with other definitions such as by the Slow Fashion Award [33]. Most important aspects were eco-friendly materials along with the country of origin. Purchase barriers were the high price or unattractive design aesthetics. In literature, these findings have been mentioned by several authors such as Joergens or Shen et al. [13, 25]. However, ethical brands were less known. In research, more brand studies could be carried out, identifying the perception towards ethical fashion brands. One existing example is the case study of Patagonia [21]. Finally, the emerged topics of eco-material and design were further discussed in **Section 4.2 - 4.4**, evaluating the eco-fashion style, appearance, and impact perception.

*Study 2* in **Section 4.2**, addressed the 2) Consumer eco style expectations and design parameters gap. We carried out sensory evaluation of eco-designed fashion products based on an eco-design perception model. We used key eco-design principles i.e., style, versatile, and



fashion. Thus, garment design style has certain eco-fashion styles such as minimal and durable. Sensory evaluation methodology is applicable to measure human perception. And, this tool can be useful in eco-design studies. Its importance has been already approved for textiles [151, 158, 159]. Furthermore, we applied fuzzy logic in the context of a more objective characterization of perceptual data on design parameters.

This experiment considered a target group dedicated to an ethical commitment. The study reflects previous findings such as by Niinimäki [89], who discussed eco-style in fashion. In here, with the help of eco-design descriptors, the style of an ethical garment can be quantitatively described.

In conclusion, this approach can be used as decision support system for designer, as it is able to give recommendations to designers for the creation of garments' eco-appearance in terms of which shape or style should be selected or avoided. This study supported the development of *Study 3*.

Also, *Study 3* in **Section 4.3**, addressed the 2) Consumer eco style expectations and design parameters gap. Kansei engineering was considered as a useful method to evaluate the appearance of environmentally-friendly fashion products. In here, we studied consumer perception towards ethical fashion products, focusing on textile design attributes.

We analyzed the environmentally-friendly perception of garment design and material appearance, using a quantitative approach. In relation to the study by Muenchinger [202] focusing on material sustainability of drinking vessels, this study analyzed the environmentally-friendly perception of garment design.

Similarly to *Study 2*, *Study 3* is able to show how a designer can be supported to design a product meeting environmentally-friendly themes in terms of which material or design should be selected. For example, a basic design and natural materials had a higher environmentally-friendly appearance. Consumers could clearly distinct between different garment designs in terms of sustainability perception.

*Study 4* in **Section 4.4**, addressed the 3) Real LCIA and human perception gap. We studied the environmental performance and overall sustainability impact of the textile product T-Shirt assessed by LCA methodology and its consumer perception using a simplified visualization approach of the life cycle impact assessment (LCIA) results. By this, we could investigate the relation between real and perceived ethical values. The study related to an LCA case study of a "100 % cotton knitted dyed short-sleeved T-shirt" in China from Zhang et al. [20]. In here, perceived impacts match real impacts. And, impacts were generally

perceived as high. The approach is novel and able to quantify the environmental impacts perceived by the consumer.

Limitations of the studies are firstly, the small sample size, and the focus on a specific garment type in terms of a T-shirt and hoody. Future studies should include larger sample sizes and more garment types to generate more representative data. Secondly, the knowledge used in the studies is based on the current expertise of the designers involved. Future studies should re-evaluate the design knowledge to ensure accurate scenarios. Consumers' fashion acceptance and sensibility can be investigated and using large scale consumer tests.

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Lifestyle Ideas, [https://sustainablebrands.com/read/behavior-change/conscious-consumers-flocking-to-pinterest-for-sustainable-lifestyle-ideas?utm\\_source=LinkedIn&utm\\_medium=SBpage&utm\\_campaign=social](https://sustainablebrands.com/read/behavior-change/conscious-consumers-flocking-to-pinterest-for-sustainable-lifestyle-ideas?utm_source=LinkedIn&utm_medium=SBpage&utm_campaign=social)

# Appendices

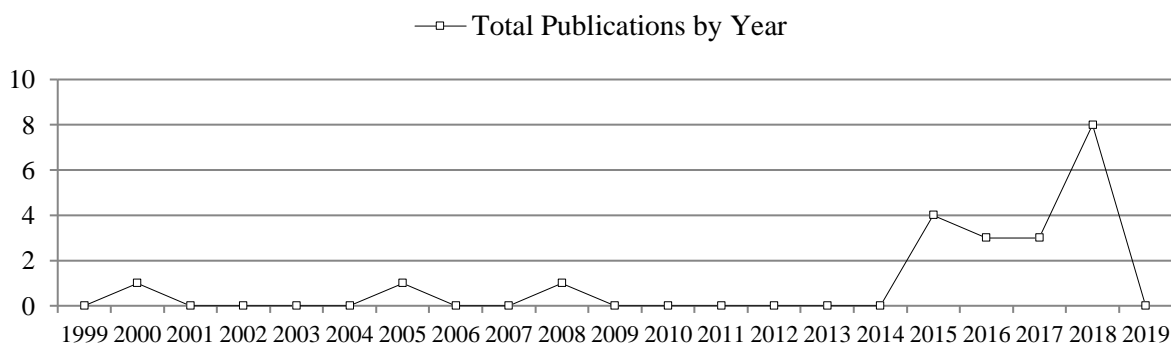
# Appendix 1. Web of Science Search

According to the Web of Science [114] search (06.02.2019, 17:00) for the topic “ethical fashion consumer perception”, this research area has never been more relevant; there has been a significant increase in the year of 2018 in terms of total publications by year, as well as the sum of times cited by year, refer to Table A 1, as well as Figure A 1 and Figure A 2 [114].

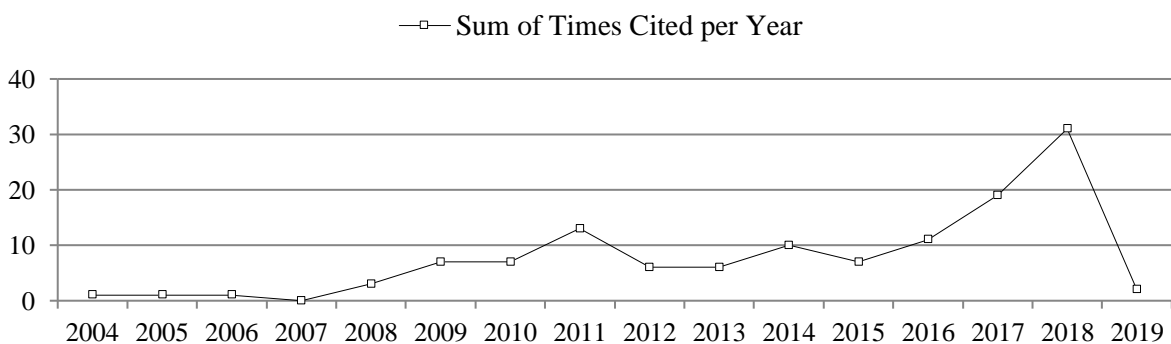
**Table A 1:** Publication Search: “ethical fashion consumer perception” (06.02.2019, 17:00), adapted from Web of Science [114].

<b>Results found <sup>3</sup></b>	
Total Publications	21
Sum of Times Cited	125
Average Citations per Item	5.95
h-index	6

<sup>3</sup> DATABASE: Web of Science Core Collection. TOPIC: (ethical fashion consumer perception). Timespan=All years. Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI.



**Figure A 1:** Total Publications TOPIC: “ethical fashion consumer perception”, adapted from Web of Science [114].



**Figure A 2:** Times Cited TOPIC “ethical fashion consumer perception”, adapted from Web of Science [114].

The Web of Science list of publications is shown below in Table A 2.



**Table A 2:** Web of Science List of Publications, adapted from Web of Science [114].

Title	Authors	Year
Cross-Generational Investigation of Ethics and Sustainability. Insights from Romanian Retailing	Dabija, D.-C. et al.	2018
The moral responsibility of corporate sustainability as perceived by fashion retail employees: a USA-China cross-cultural comparison study	Lee, S. H. N. et al.	2018
Cosmetic dentistry: A socioethical evaluation	Holden, A. C. L.	2018
Consumers' perceptions of luxury brands' CSR initiatives: An investigation of the role of status and conspicuous consumption	Amatulli, C. et al.	2018
ENVIRONMENTALLY FRIENDLY APPAREL PRODUCTS: THE EFFECTS OF VALUE PERCEPTIONS	Moon, H.; Lee, H.-H.	2018
Motivations and barriers to the prolonged use of clothing	Whitson-Smith, J.	2018
The impact of a firm's transparent manufacturing practices on women fashion shoppers	Brandao, A. et al.	2018
The sustainability word challenge Exploring consumer interpretations of frequently used words to promote sustainable fashion brand behaviors and imagery	Evans, S.; Peirson-Smith, A.	2018
Experiential value: Multi-item scale development and validation	Varshneya, G.; Das, G.	2017
Consumer's Willingness to Pay More for Luxury Fashion Apparel Made in Sweatshops	Phau, I. et al.	2017
Fashion in consumer culture	Meamber, L. A. et al.	2017
The values and motivations behind sustainable fashion consumption	Lundblad, L.; Davies, I. A.	2016
The academic conceptualisation of ethical clothing Could it account for the attitude behaviour gap?	Reimers, V. et al.	2016
Survey of community pharmacists' perception of electronic cigarettes in London	Gomes, A. C. N. M. et al.	2016
Advanced and emerging economies Generation Y's perception towards country-of-origin	Tjandra, N. C. et al.	2015
New life luxury: upcycled Scottish heritage textiles	Keith, Sara; Silies, M.	2015
Constraints and Drivers of Growth in the Ethical Fashion Sector: The Case of France	Achabou, M. A.; Dekhili, S.	2015
Offensive advertising in the fashion industry: Sexual objectification and ethical judgments of consumers	Bae, S. Y. et al.	2015
The intention to download music files in a P2P environment: Consumption value, fashion, and ethical decision perspectives	Chen, Y.-C. et al.	2008
Consumers' moral philosophies: identifying the idealist and the relativist	Dubinsky, AJ et al.	2005
The impact and implications of environmentally linked strategies on competitive advantage: A study of Malaysian companies	Slater, J.; Angel, IT	2000

## Appendix 2. Eco Fashion Themes Questionnaire

The online tool “surveynuts” (<https://surveynuts.com>) as shown in Figure A 3 in a screenshot, was used to set up the questionnaire for the ethical fashion themes. Fifteen to twenty images per theme were given. Respondents could select for each of the four themes three to five images, see Figure A 4.

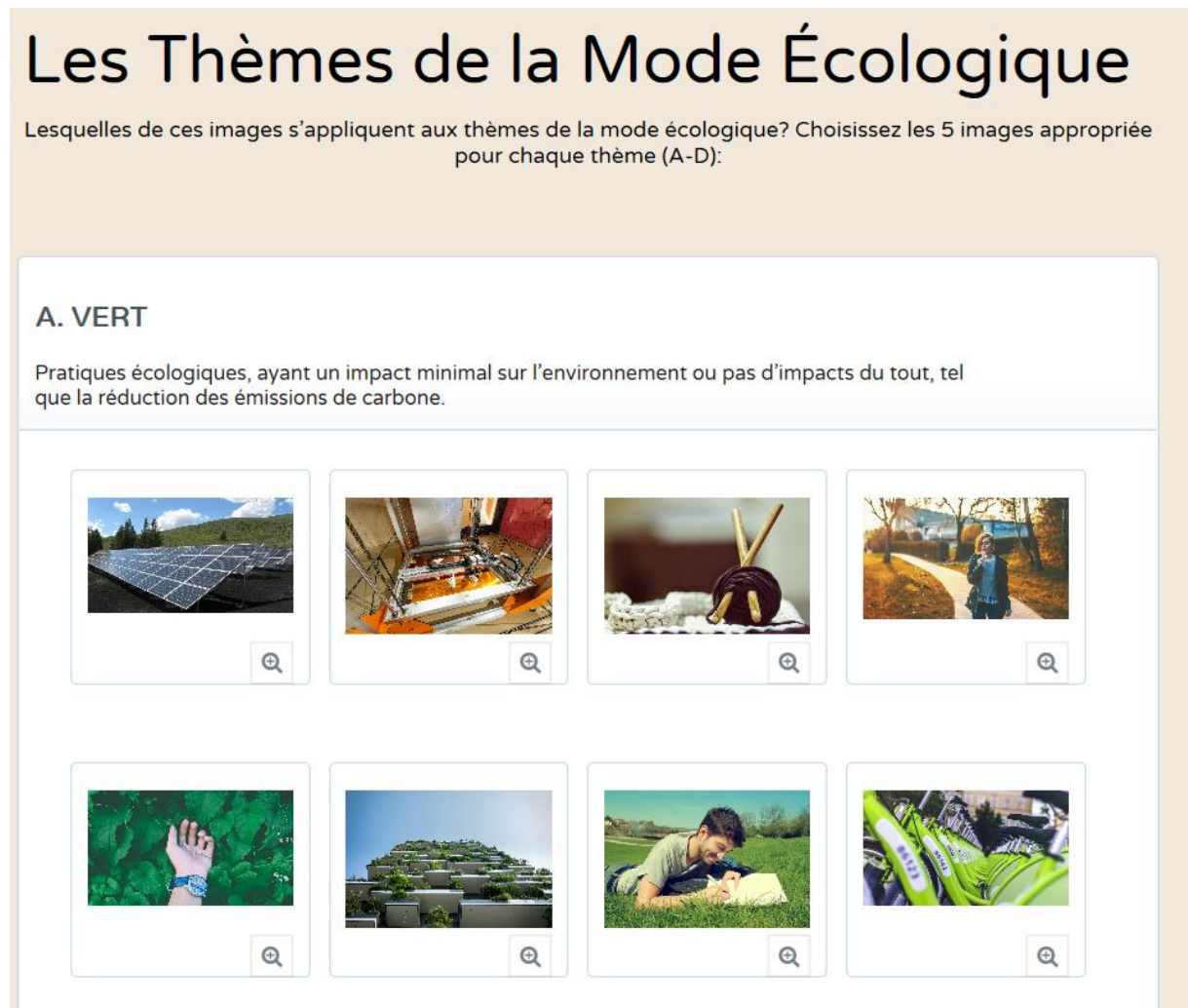
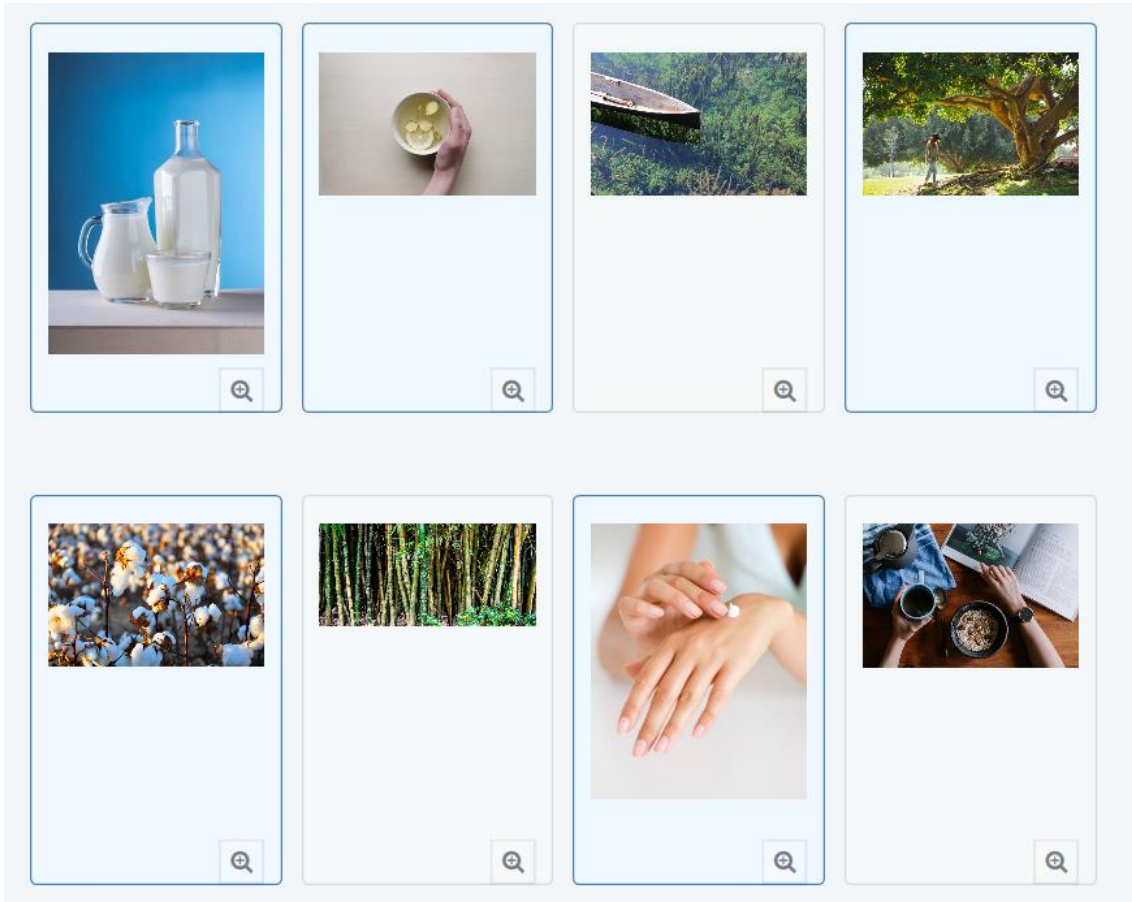


Figure A 3. Ethical Fashion Themes Questionnaire (in French).



**Figure A 4.** Ethical Fashion Themes Questionnaire - Image selection.

## Appendix 3. Ethical Fashion Themes Results

The results of the image questionnaire are shown in Table A 3 - Table A 6.

**Table A 3:** Image questionnaire results A. Green.














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A. VERT


*Pratiques écologiques, ayant un impact minimal sur l'environnement ou pas d'impacts du tout, tel que la réduction des émissions de carbone.*

306 voters

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1.		126	41.18%
2.		121	39.54%
3.		117	38.24%
4.		99	32.35%
5.		99	32.35%
6.		94	30.72%
7.		81	26.47%
8.		81	26.47%
9.		76	24.84%
10.		76	24.84%
11.		63	20.59%
12.		54	17.65%
13.		45	14.71%

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14.		40	13.07%
15.		40	13.07%
16.		31	10.13%
17.		27	8.82%
18.		9	2.94%
19.		9	2.94%
20.		4	1.31%













**Table A 4:** Image questionnaire results B. Organic.

**B. BIOLOGIQUE/ ORGANIQUE**

*Protection de la vie sauvage et de l'environnement, par exemple pas de pesticides et GM (génétiquement modifié).*

306 voters

1.		162	52.94%
2.		130	42.48%
3.		112	36.60%
4.		112	36.60%
5.		90	29.41%
6.		76	24.84%
7.		63	20.59%
8.		58	18.95%

9.		58	18.95%
10.		54	17.65%
11.		54	17.65%
12.		49	16.01%
13.		49	16.01%
14.		49	16.01%
15.		45	14.71%
16.		40	13.07%
17.		40	13.07%
18.		27	8.82%
19.		27	8.82%
20.		27	8.82%

**Table A 5:** Image questionnaire results C. Recycled.
















**C. RECYCLAGE/ RÉUTILISATION**

*Recyclage des matériaux utilisés pour faire des produits nouveaux (pour limiter les déchets).*





306 voters

1.		171	55.88%
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2.		135	44.12%
3.		121	39.54%
4.		121	39.54%
5.		121	39.54%
6.		121	39.54%
7.		117	38.24%
8.		99	32.35%
9.		94	30.72%
10.		85	27.78%
11.		85	27.78%
12.		58	18.95%
13.		54	17.65%
14.		40	13.07%
15.		40	13.07%
16.		31	10.13%

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17.		27	8.82%
18.		27	8.82%
19.		22	7.19%
20.		13	4.25%

**Table A 6:** Image questionnaire results D. Reduced.

D. RÉDUIRE






*Les pratiques et les politiques de réduction des intrants, tel que réduire consommation de matières premières.*

306 voters

1.		148	48.37%
2.		117	38.24%
3.		94	30.72%
4.		85	27.78%
5.		85	27.78%
6.		81	26.47%
7.		76	24.84%
8.		63	20.59%
9.		63	20.59%
10.		63	20.59%



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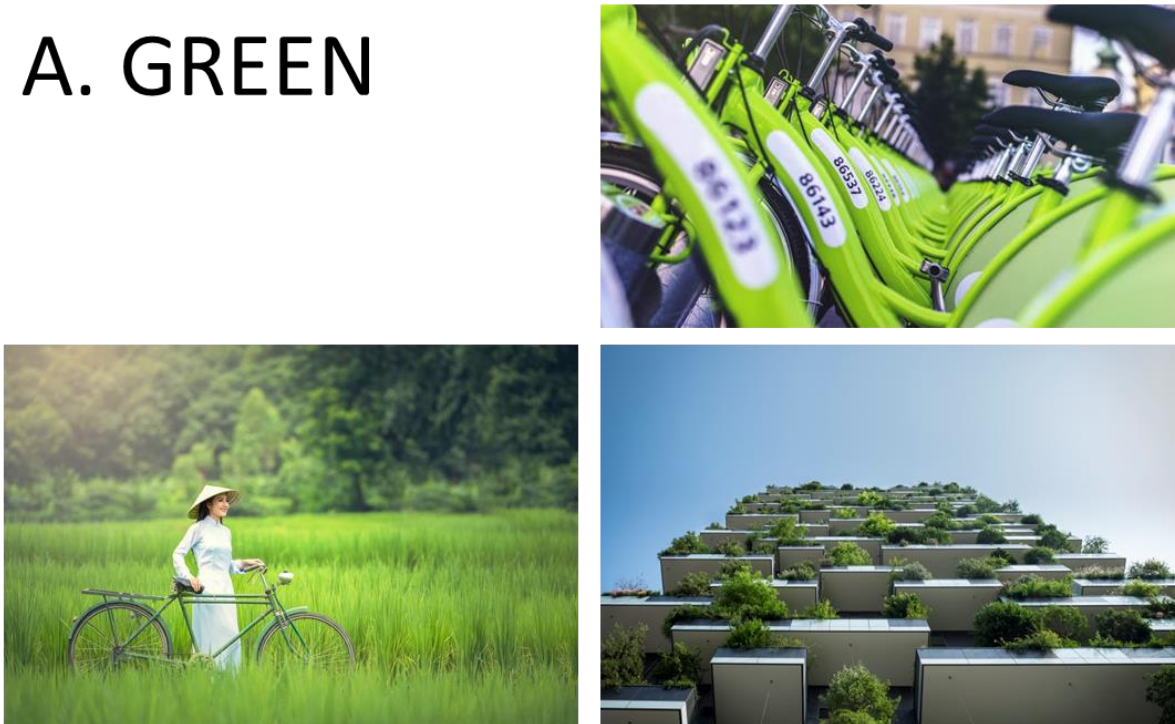
11.		45	14.71%
12.		36	11.76%
13.		22	7.19%
14.		18	5.88%
15.		9	2.94%

---

## Appendix 4. Mood Boards

In order to conduct the experiments, mood boards for four themes were created; see Figure A 5 - Figure A 8. All images have a CC0 License (<https://www.pexels.com>, <https://unsplash.com>, <https://flickr.com>).

### A. GREEN



**Figure A 5:** Mood board A. Green

## B. ORGANIC



Figure A 6: Mood board B. Organic.

## C. RECYCLED



Figure A 7: Mood board C. Recycled.

## D. REDUCED



**Figure A 8:** Mood board D. Reduced.

In order to conduct the Kansei experiments, the mood boards for the two themes *Recycled* and *Reduced* were merged, see Figure A 9.

## C. RECYCLED/ REDUCED



**Figure A 9:** Mood board C. Recycled/Reduced.

## Appendix 5. Consumer Questionnaire Results

The consumer data collected through a questionnaire is shown below in Table A 7.

**Table A 7:** Consumers' evaluation results for three products P1-3.

	P <sub>1</sub>						P <sub>2</sub>						P <sub>3</sub>						
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>5</sub>	S <sub>6</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>5</sub>	S <sub>6</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>5</sub>	S <sub>6</sub>	
C <sub>1</sub>	A	A	A	D	C	D	B	B	A	A	D	D	C	B	C	D	A	A	B
C <sub>2</sub>	B	B	B	D	B	E	C	C	A	B	D	E	C	C	D	E	B	B	B
C <sub>3</sub>	B	B	A	D	C	D	C	C	A	A	E	E	C	C	C	D	A	A	B
C <sub>4</sub>	C	C	A	D	C	D	C	C	B	B	E	E	C	C	C	C	B	B	B
C <sub>5</sub>	A	A	B	D	C	D	B	B	B	B	E	E	C	C	D	D	B	B	B
C <sub>6</sub>	B	B	D	D	D	D	B	B	A	A	E	E	B	B	D	D	A	A	B
C <sub>7</sub>	B	C	E	E	D	E	A	B	A	B	D	E	B	B	E	E	A	A	C
C <sub>8</sub>	C	C	D	D	D	D	B	A	A	A	E	E	B	A	C	D	B	B	B
C <sub>9</sub>	B	C	D	D	D	D	B	C	A	A	E	E	C	C	D	D	B	B	C
C <sub>10</sub>	B	B	D	C	C	C	C	C	B	A	D	D	C	C	C	C	B	B	C
C <sub>11</sub>	B	C	C	C	C	C	B	C	B	B	D	D	B	C	C	C	B	B	B
C <sub>12</sub>	B	B	D	D	D	D	B	B	A	A	E	E	B	B	D	D	A	A	A
C <sub>13</sub>	A	B	C	C	C	C	B	B	B	B	D	E	C	B	C	C	A	A	B
C <sub>14</sub>	A	A	C	C	C	C	B	B	B	B	D	E	B	B	C	C	A	A	A
C <sub>15</sub>	B	B	D	D	C	C	A	A	A	A	D	D	B	A	D	D	A	A	B
C <sub>16</sub>	A	B	C	C	C	B	A	B	B	B	D	D	A	B	C	C	A	A	B
C <sub>17</sub>	B	A	C	C	C	B	B	B	B	B	D	C	B	C	C	C	B	A	A
C <sub>18</sub>	A	B	D	D	C	D	B	B	A	A	D	E	B	C	D	D	B	B	B
C <sub>19</sub>	A	B	D	D	C	D	A	B	A	B	D	D	A	B	D	D	B	B	B
C <sub>20</sub>	B	B	E	E	C	D	B	B	A	A	D	D	B	B	C	C	B	B	B

## Appendix 6. Consumer Questionnaire Results

The consumer data collected through a questionnaire is shown below in Table A 8.

**Table A 8:** Consumers' evaluation results (R=63) for Material, Green 1 for ten samples S1-10.

	<b>S1</b>	<b>S2</b>	<b>S3</b>	<b>S4</b>	<b>S5</b>	<b>S6</b>	<b>S7</b>	<b>S8</b>	<b>S9</b>	<b>S10</b>
R1	3	3	2	2	2	4	4	2	6	6
R2	2	3	1	3	2	3	3	2	2	2
R3	2	3	1	3	2	3	3	2	2	2
R4	2	2	1	1	1	5	5	1	5	5
R5	1	1	2	2	2	4	4	1	4	4
R6	1	1	2	2	2	4	4	1	4	4
R7	2	3	3	4	2	4	3	1	3	4
R8	3	4	1	2	2	4	3	2	5	6
R9	1	3	3	3	2	4	3	2	3	4
R10	4	4	4	5	3	3	3	3	2	2
R11	1	2	2	2	2	2	2	2	2	2
R12	2	2	1	2	2	4	4	2	2	2
R13	1	1	1	1	1	3	3	1	1	1
R14	4	5	3	5	4	6	6	5	3	3
R15	2	2	1	2	3	4	4	2	4	4
R16	2	3	1	3	2	5	5	3	5	5
R17	1	1	1	2	1	3	3	1	3	3
R18	2	2	1	3	2	4	4	2	4	4
R19	2	2	1	2	3	4	4	2	4	4
R20	2	3	1	3	2	5	5	3	5	5
R21	4	5	3	5	4	6	6	5	3	3
R22	1	2	2	2	2	2	2	2	2	2
R23	2	2	2	2	2	4	4	2	2	2
R24	2	3	2	3	2	5	2	3	5	5
R25	2	2	1	2	3	4	4	2	4	4
R26	2	3	1	3	2	5	5	3	5	5
R27	1	1	1	2	1	3	1	1	3	3
R28	2	2	2	3	2	4	4	2	4	4
R29	1	1	1	1	1	3	3	1	2	2
R30	4	5	3	5	4	6	6	5	3	3
R31	1	1	1	1	1	4	2	1	2	2
R32	2	3	1	3	2	5	5	3	5	5
R33	4	5	3	5	4	6	6	5	3	3

R34	1	2	2	2	2	2	2	2	2	2
R35	4	5	3	5	4	6	6	5	3	3
R36	2	3	1	3	2	5	5	3	5	5
R37	2	2	1	2	2	4	4	2	2	2
R38	4	5	3	5	4	6	3	5	3	3
R39	4	5	4	5	4	6	6	5	4	4
R40	1	2	1	2	1	3	2	2	2	2
R41	2	2	1	2	2	4	4	2	4	4
R42	2	3	1	3	2	5	5	3	5	5
R43	2	2	2	2	2	3	3	2	3	3
R44	2	3	1	2	2	5	5	2	5	5
R45	4	5	3	5	4	6	6	5	3	3
R46	1	2	1	2	2	2	2	2	2	2
R47	1	1	1	1	1	3	3	1	2	2
R48	2	2	1	2	2	4	4	2	2	2
R49	2	2	2	2	2	3	3	2	3	3
R50	2	2	1	3	2	4	4	2	4	4
R51	2	3	1	3	2	5	5	3	5	5
R52	4	5	4	5	4	6	6	5	4	4
R53	2	2	1	2	2	4	4	2	2	2
R54	1	1	1	1	1	3	3	1	2	2
R55	2	3	1	3	2	5	5	3	5	5
R56	2	2	2	2	2	3	3	2	3	3
R57	2	2	2	2	2	4	4	2	2	2
R58	1	1	1	1	1	3	3	1	2	2
R59	4	5	4	5	4	6	6	5	4	4
R60	3	3	1	3	3	4	4	3	4	4
R61	2	3	1	3	2	5	5	3	5	5
R62	1	1	1	2	1	3	3	1	3	3
R63	2	2	1	3	2	4	4	2	4	4

## Appendix 7. List of Publications

### Journal papers

1. **Wagner, M.**, Curteza, A., Hong, Y., Chen, Y., Thomassey, S., Zeng, X., 2019. A design analysis for eco-fashion style using sensory evaluation tools: Consumer perceptions of product appearance. **J. Retail. Consum. Serv.** 51.C (IF: 3.585)
2. **Wagner, M.**, Thomassey, S., Zeng, X., Curteza, A., 2018. Qualitative Analysis of Open-Ended Questions to Define Awareness of Ethical Fashion in Romania. **J Fashion Technol Textile Eng**, 6. (IF: 0.26)
3. Pu, L., **Wagner, M.**, Abteu, M., Hong, Y., Wang, P., 2018. Raincoat design for children for age group 7-8 years: A design development case study. **Ind. Textila**. 394–399. (IF: 0.387)
4. Dong, M., Hong, Y., Zhang, J., Liu, K., **Wagner, M.**, Jiang, H., 2018. A body measurements and sensory evaluation-based classification of lower body shapes for developing customized pants design. **Ind. Textila**. 111–117. (IF: 0.387)
5. **Wagner, M. M.**, Curteza, A., Thomassey, S., Zeng, X., 2018. The Appearance of Sustainable Fashion Products. **Curr Trends Fashion Technol Textile Eng**, 2. (Opinion)
6. **Wagner, M.**, Chen, Y., Curteza, A., Thomassey, S., Perwuelz, A., Zeng, X., 2017. Fashion Product Solutions and Challenges for Environmental and Trend Conscious Consumers. **J Fashion Technol Textile Eng**, S3. (IF: 0.26)



## Proceedings

1. **Wagner, M.**, Curteza, A., Chen, Y., Thomassey, S., Zeng, X. 2018. Environmentally-Friendly Perception of Fashion Products: A Kansei Study, in: Proceedings of the 7th International Conference on Kansei Engineering and Emotion Research 2018, Lokman, A.M., Yamanaka, T., Lévy, P., Chen, K., Koyama, S., Eds., Springer Singapore: Singapore, 2018. 369–378.
2. **Wagner, M.**, Curteza, A. 2018. Design Evaluation of Sustainable Fashion, in: International Scientific Conference “Topical Issues of Modern Design”, Kyi, 2018. 273–276.
3. **Wagner, M.**, Chen, Y., Curteza, A., Thomassey, S., Perwuelz, A., Zeng, X. 2017. Fashion Design Solutions for Environmentally Conscious Consumers, in: Proceedings of the 17th Autex World Textile Conference 2017. 1509–1014.
4. **Wagner, M.**, Thomassey, S., Perwuelz, A., Zeng, X., 2017. Simplified LCIA for Consumer Perception of a T-Shirt, in: Avnir Conference Proceedings 2017. 147.
5. **Wagner, M.**, Chen, Y., Thomassey, S., Zeng, X., 2017. A New Approach for Dynamic Data Collection from Ethical Fashion Consumers, in: The First International Forum on Textiles for Graduate Students’ (IFTGS), Tianjin Polytechnic University, 27 Nov 2017.
6. **Wagner, M. M.**, Curteza, A., 2016. A Conceptual Study of The Romanian Ethical Fashion Consumer Decision Journey, in: 16th Romanian Textiles and Leather Conference CORTEP 2016, [ed] Avadanei Manuela, Bucharest: Editura Acreditata de Cncsis Bucuresti, Iasi, Romania 27-29 October 2016. 430–433.
7. **Wagner, M.**, Curteza, A., 2016. Analyzing Awareness Towards Ethical Fashion Using Open Source Networking Tool, in: INVENTICA 2016 Proceedings of The 8th Edition of EUROPEAN EXHIBITION OF CREATIVITY AND INNOVATION. THE XX-TH INTERNATIONAL EXHIBITION OF INVENTICS, RESEARCH AND TECHNOLOGICAL TRANSFER in Iasi, Romania.

## Academic Awards

1. **The First Prize:** The First International Forum on Textiles for Graduate Students (IFTGS), Tianjin Polytechnic University, 27 Nov 2017: A New Approach for Dynamic Data Collection from Ethical Fashion Consumers, Tianjin, China, 2017.
2. **Gold Medal:** Euroinvent 8<sup>th</sup> European Exhibition of Creativity and Innovation: A New Concept for Determining Social Perception of Ethical and Recycled Fashion Materials. Iasi, Romania, 2016.