USER-CENTERED APPAREL DESIGN FOR WOMEN CYCLISTS: A QUALITATIVE INVESTIGATION INTO FUNCTIONAL, EXPRESSIVE, AND AESTHETIC REQUIREMENTS*

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Abstract: *This study investigates women cyclists' clothing practices, preferences, and unmet expectations to inform the development of women-specific cycling apparel. While cycling is a recognized sustainable transport mode, a significant gender gap persists, partly attributed to insufficient apparel solutions. Employing a qualitative, user-centered design approach, semi-structured interviews were conducted with 20 women cyclists in Eskişehir, Turkey. Findings reveal that participants often opt for everyday clothing over specialized cycling wear, prioritizing comfort, freedom of movement, and practical safety considerations such as entanglement prevention and visibility. Functional performance expectations, including thermal comfort, weather protection, and secure storage, were strongly influenced by seasonal variations and commuting needs. The research highlights significant market constraints, including limited variety in women's specific designs, colors, patterns, and sizing, often leading participants to compromise with men's apparel. These issues impact not only aesthetic satisfaction but also functional fit, privacy, and the versatility of garments across cycling and non-cycling contexts. The results are interpreted through the Functional–Expressive–Aesthetic consumer needs model, demonstrating that successful women's cycling apparel must holistically address functional (mobility, comfort, protection, visibility), expressive (appropriateness, gendered fit), and aesthetic (style, color, silhouette) dimensions. The study culminates in strong support for a dedicated women's cycling collection, underscoring the potential for user-centered design to generate concrete product criteria and concepts responsive to identified market needs.*

Keywords: **Women cyclists, Cycling apparel, User-centered design, FEA model, Apparel design**

1. INTRODUCTION

Cycling is widely recognized as a sustainable, low-carbon mode of urban transport that promotes public health through everyday physical activity [1], [2]. However, participation remains unevenly distributed across demographics, with a pronounced gender gap where most urban cyclists are young to middle-aged men, and women face disproportionate barriers to adoption and sustained engagement [3], [4], [5]. Beyond commonly cited infrastructural, safety, and normative factors [6], [7], [8], women encounter natural environmental deterrents like inclement weather (wind, precipitation), hilliness, and darkness, which disincentivize cycling more severely for females than males [3]. The clothing worn during cycling serves as a critical, immediate interface between the rider and the activity, directly influencing mobility, thermal and moisture comfort, perceived bodily exposure, modesty, and visibility in traffic [9]. For professional women active commuters, these apparel considerations often prove decisive: restrictive fit compromises range of motion and safety, while overly sporty aesthetics (e.g., bright colors, reflective elements) conflict with business casual dress codes, leading to trade-offs between function, psychological comfort, and workplace appropriateness [9]. Consequently, women frequently resort to everyday clothing rather than purpose-designed cycling apparel, exacerbating practical difficulties such as chain catch, fabric flapping, circulation

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restriction, and soil/stain visibility, which undermine confidence and participation [9], [10].

This research posits apparel as a concrete yet underexplored barrier for women cyclists, particularly in ordinary urban contexts where commuting integrates transport with routine destinations like work or social settings [9]. Studies of professional women biking or walking to business casual environments reveal persistent challenges: garments must accommodate thermal fluctuations via layering and packability, ensure modesty (e.g., fitted necklines, hem lengths, back rise), and balance durability with wrinkle/stain resistance, yet market offerings often prioritize athletic utilitarianism over versatile, feminine silhouettes [9]. Participants report unmet needs for "in-between" items - durable, wicking fabrics in non-sporty appearances that support pedaling without restricting upper/lower body movement or requiring post-commute changes [9]. Such gaps extend to socio-cultural contexts, including developing urban areas like Nigeria or Australia, where spatial, infrastructural, and socio-demographic disparities further compound apparel-related inequities for female cyclists [5], [11]. In parallel, women articulate difficulties accessing tailored market solutions, signaling demand for women-specific designs that reconcile usability with identity expression [4], [9].

A core challenge in apparel development involves distilling multifaceted user experiences-physical, psychological, and contextual-into actionable criteria without reductive focus on isolated attributes like fit or fabric [9], [10]. The Functional-Expressive-Aesthetic Consumer Needs Model, originally proposed by Lamb and Kallal for assessing user needs in adaptive clothing design, offers a validated, multidimensional framework for this purpose [12], [13]. Over 25 years, the model has demonstrated flexibility across consumer groups and product types, guiding needs assessment, prototype development, and validation in sport-specific apparel [10], [12]. Functional needs emphasize in-use performance: mobility (e.g., stretch for pedaling, ease across back/underarm/crotch), protection (windproofing, waterproofing, thermal regulation), visibility/safety (reflective yet discreet elements), and comfort/fit (moisture-wicking, lightweight, non-restrictive) [9], [10], [14]. Expressive needs address identity, self-expression, and social signaling through dress, such as feminine details that convey personal style without "rugged" athleticism, aligning with peer affiliations and role expectations in professional settings [9], [10]. Aesthetic needs encompass sensory appeal-style, color/pattern variety (beyond monotone blacks/grays, including solids/prints), silhouette proportionality, and visual appropriateness for public/workplace visibility [9], [10], [15]. These interrelated dimensions interact dynamically; for instance, functional stretch enhances aesthetic drape, while expressive modesty bolsters safety perceptions [9], [10], [12]. Particularly suited to women's cycling apparel, the FEA model navigates simultaneous demands for usability, safety/visibility, and appearance in diverse environments, as evidenced in prototypes for snowboarding [10] active commuting, [9] and senior bicycle wear [15]. Complementary frameworks, like means-end chains in athleisure, reinforce values-based design linking attributes to consumer outcomes [16].

The aim of this study is to determine women cyclists' clothing preferences, identify cycling-related apparel problems, elicit expectations, and propose a collection informed by these insights, structured around sub-questions on garment types, design/functional attributes, issues/market perceptions, and purchase drivers. Empirically grounded in semi-structured interviews with twenty women cyclists in Eskisehir, Turkey-analyzed qualitatively within a defined urban context of daily routines, climate, and retail landscapes-this approach yields context-specific yet generalizable design implications [9].

This article advances the field through four contributions. First, it furnishes empirical evidence on women cyclists' practices and choice criteria in everyday contexts [9], [15]. Second, it synthesizes these into FEA-aligned design requirements for apparel development [9], [10], [12]. Third, it elucidates market shortcomings and purchase

motivators (e.g., sustainability, health, visibility) for strategic positioning [4], [9]. Fourth, it operationalizes needs into a prototype collection, exemplifying user-centered translation [9], [10], [15].

2. MATERIALS AND METHODS

This section outlines the methodological approach taken in this study, detailing the sequential phases from study design and participant selection to data collection, analysis, and the subsequent design development process.

2.1. Study Design and Overview

This study adopted a qualitative, user-centered apparel design approach, structured into two linked phases. This methodology is consistent with design development case study approaches prevalent in functional apparel research, which emphasize understanding user needs for product innovation [17]. The initial phase involved eliciting women cyclists' needs, problems, and expectations regarding cycling apparel through comprehensive semi-structured interviews. This user-centered focus is crucial for uncovering nuanced requirements that might be overlooked in conventional design processes [10]. In the second phase, the qualitative findings from these interviews were systematically translated into explicit design criteria. These criteria then informed the conceptual development of a women's cycling capsule collection, presented as prototype-level outputs, specifically targeting a spring/summer use context. To provide a transparent overview of the study workflow and the linkage between qualitative need elicitation and the subsequent design-development phase, the research steps are summarized in Figure 1.

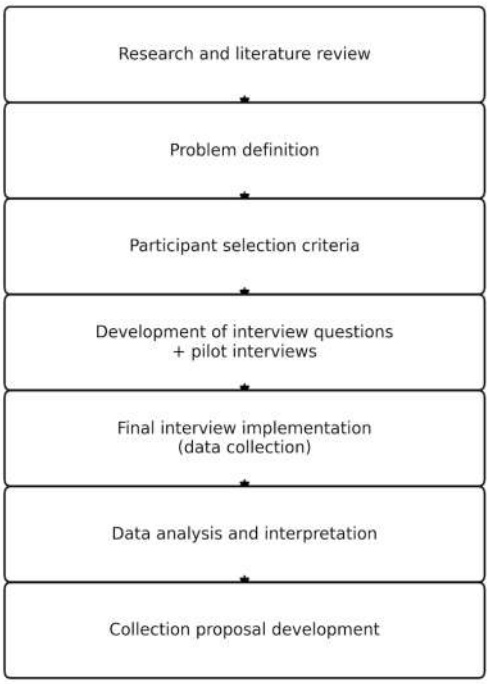


Figure 1. Research workflow used in the study

2.2. Participants and Sampling

Participants were recruited using criterion-based purposive sampling, a strategy often employed in qualitative research to select information-rich cases that directly address the research questions [18], [19], [20]. This non-probability sampling method ensured that

selected individuals could provide deep insights into their experiences as women cyclists [20], [21]. The eligibility criteria focused on women residing in Eskişehir, Turkey, who utilized bicycles for either transportation or recreational purposes. To ensure relevance to the study's scope, participants were required to be non-professional cyclists, cycle at least one hour per week, possess a minimum of one year of cycling experience, and be 60 years old or younger. This approach allowed for a homogeneous sample of active women cyclists, capable of providing detailed accounts of their apparel needs and preferences within their daily commuting and recreational routines [9]. Participation was entirely voluntary, and individuals were included only after providing informed consent to partake in the interview process. The final interview sample comprised 20 women cyclists, a number considered adequate for achieving thematic saturation in exploratory qualitative studies [18].

2.3. Data collection instrument and procedure

Data were primarily collected through face-to-face, semi-structured interviews, a flexible yet focused technique suitable for gaining in-depth insights into participants' lived experiences and perceptions [22], [23]. A detailed interview form was developed specifically for this study, covering three main domains: (i) participant demographics, (ii) cycling-related characteristics, such as bicycle type, features, and riding habits, and (iii) apparel-related preferences, problems encountered, expectations, and market-related considerations. The interview protocol was rigorously refined through a pilot application with a small group of women cyclists, allowing for adjustments to questions for clarity and relevance, a practice shown to improve data quality [10]. The finalized interview form was appended to the thesis for transparency.

All interviews were audio-recorded, strictly with the explicit permission of each participant. Before commencing, participants were thoroughly informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality provisions implemented to protect their identities and responses. This adherence to ethical guidelines, including the right to withdraw and assurance of anonymity, is paramount in qualitative research involving human subjects [24], [25]. Identifying information was meticulously excluded from all reporting to safeguard participant privacy. Each interview allowed for comprehensive discussions, ranging approximately from 25 minutes to two hours, depending on the richness of the participant's responses and the need for deeper probing questions [9], [10].

2.4. Data Analysis

The audio-recorded interviews were transcribed verbatim into written text, creating a comprehensive dataset for qualitative analysis. The qualitative data were then systematically organized around pre-defined themes, which were carefully aligned with the study's overarching questions and sub-problems. Data analysis was conducted using a descriptive analysis approach, which involved systematic coding and categorization of the interview content to identify patterns, similarities, and divergent cases [9]. This process allowed for the exploration of latent meanings and the development of emergent themes relevant to women's cycling apparel [9], [17]. Similar to practices in other apparel research, methods like constant comparative analysis and open/axial coding were implicitly or explicitly employed to ensure thorough examination of the data and to inform design implications [10], [17]. Findings were summarized and interpreted within these established themes to derive concrete user-need statements and actionable apparel design implications.

2.5. Design development and prototyping workflow

The design development phase adhered to a structured apparel design process, consistent with established design-development case study approaches in functional apparel research [17]. This iterative process operationally linked the qualitative user-need

evidence gathered from the interviews to explicit design criteria. Subsequently, these criteria guided the apparel concept development phase. Such systematic approaches are vital for translating abstract user desires into tangible product attributes [17], [26]. In the thesis that this article is based upon, the design work culminated in a women's cycling capsule collection, comprising 10 distinct outfits. This collection was presented with detailed concept sketches and various technical and visual development outputs, including digital illustrations and presentations on virtual figures, demonstrating a comprehensive workflow from conceptualization to tangible design solutions [27], [28], [29], [30]. The design choices considered functional, expressive, aesthetic, and environmental aspects as articulated by the participants, ensuring the prototypes were well-aligned with user requirements [10].

2.6. Ethics, consent, and confidentiality

This study strictly adhered to all ethical principles governing research involving human participants. Participants provided informed consent, ensuring they fully understood the study's purpose, procedures, potential risks, and their rights before agreeing to participate. They were explicitly informed that their participation was voluntary and that they retained the right to withdraw from the study at any point without penalty. Audio recordings of interviews were conducted only after securing clear participant permission. Furthermore, rigorous confidentiality and anonymity principles were consistently applied throughout the data collection, analysis, and reporting phases. This meant that any identifying information was decoupled from the interview data, and findings were presented in a manner that prevented the identification of individual participants, thus upholding their privacy and trust [24]. Such meticulous ethical considerations are paramount in qualitative studies to ensure the integrity of the research and protect the welfare of participants [9].

3. RESULTS AND DISCUSSIONS

This section presents the findings from the qualitative interviews, offering insights into the participant profiles, their apparel use and preferences, functional expectations, market experiences, and ethical considerations surrounding their cycling practices.

3.1. Participant Profile and Cycling Context

The study comprised 20 women cyclists. Reported ages ranged from 26 to 53 years (three participants did not report age), with a mean age of 37.3 years. Cycling experience ("active cycling") ranged from 2 to 360 months (mean: 116.7 months). Participants reported cycling on average 4.5 days per week (range: 1-7 days) (Table 1). Most respondents indicated cycling primarily in the city (55%), while 15% cycled mainly outside the city and 30% reported using the bicycle both in and outside the city. These characteristics situate the sample as relatively experienced and frequent cyclists with predominantly urban riding contexts, consistent with studies focusing on active commuting demographics [9]. This demographic profile is typical for studies investigating women's cycling behavior and apparel needs [4], [32].

Table 1. Participant Characteristics and Cycling Experience Summary

Variable	Summary
Sample size	N = 20 women cyclists (Eskişehir, regular use; non-professional)
Age	Mean age = 37.3 years; age not provided by 3 participants
Cycling experience	Mean = 116.7 months; minimum = 3 months; maximum = 360 months

Table 2. Cycling Context Distribution

Cycling context	Percentage
City	55%
Outside city	15%
Both city and outside city	30%

3.2. Apparel Use and Overall Clothing Preferences During Cycling

Participants' accounts indicate that clothing choice is largely governed by ride comfort and practical safety constraints. A key pattern was the emphasis on lower-body garments: 55% of participants highlighted lower-body apparel as their primary focus when cycling. In the same vein, tights were reported as the most preferred lower-body item, with participants explicitly linking this preference to reduced risk of fabric catching in the drivetrain when compared with loose trouser hems. This finding aligns with previous research on active commuting women, which highlights the need for apparel that prevents entanglement with bicycle components, and addresses safety concerns related to clothing getting caught in bike parts [9].

Beyond garments, accessories were framed as integral to perceived safety. Helmet use was frequently described as "necessary," and 20% of participants explicitly identified the helmet as an "essential" accessory. Supporting items (e.g., gloves, rain and wind protection layers) were positioned as part of a functional riding outfit rather than fashion-driven choices, underscoring the priority of function over pure aesthetics for these cyclists. This priority on functional accessories for comfort and protection is a common theme in cycling apparel [33].

A recurring fit-related criterion was the need to avoid extremes in tightness and looseness: overly tight garments were described as restrictive during effort, while overly loose garments were framed as potentially hazardous (e.g., catching on chain/pedals) [9]. This "balanced fit" requirement functions as a practical constraint that shapes acceptable silhouettes for women's cycling apparel in everyday use, reflecting the balance between mobility and safety [10]. The need for maximum mobility and unhindered movement during cycling is a primary concern for apparel design [9].

Table 3. Participants' Evaluation of the Women's Cycling Apparel Market

Market evaluation	Percentage	Evidence (thesis wording)
Positive (adequate number/quality of stores)	35%	Participants reporting positive views and adequacy of store number/quality
Negative (insufficient variety; does not meet needs)	35%	Participants reporting negative views; variety not meeting demands
No answer / insufficient knowledge	Remaining participants	No response

3.3. Preferred design features: silhouette, color, and visibility cues

When describing design features, participants prioritized forms that support comfortable riding. They also noted that preferred garment silhouette can shift by season (e.g., selecting tighter or looser forms depending on weather), indicating that "design" is not only aesthetic but also adaptive to environmental conditions. This adaptability is a key consideration in functional apparel design, particularly for varying weather conditions experienced during a commute [9].

Color preference was heterogeneous and frequently subordinated to visibility requirements. Among 14 respondents commenting on color: three stated they had "no

color option" because comfort was the primary selection criterion; three described choosing colors based on personal aesthetic preference unless visibility was a concern; and eight indicated preferring colorful/fluorescent options due to the need to be seen and/or to match the visual identity of their bicycles. These accounts position color as both an aesthetic marker and an expressive safety strategy (visibility signaling), rather than solely a style preference, which aligns with the dual functional and expressive aspects of the FEA model [9], [10].

Reflective elements were discussed as an additional visibility mechanism: 15% explicitly emphasized reflectors as increasing visibility in night riding. Importantly, several narratives distinguished between general "reflective details" and the broader visibility system required for safe riding (see Section 3.4), implying that reflectivity alone may be perceived as insufficient without active lighting.

3.4. Functional performance expectations: thermal comfort, weather protection, storage, and safety

Functional expectations were strongly seasonal. Participants described an implicit requirement for high air permeability in summer (to manage elevated body heat) and lower air permeability in winter (to preserve body heat), consistent with the thesis' framing of seasonal thermal comfort requirements in cycling apparel [14]. In the participants' accounts, this translated into pragmatic strategies: adopting multiple layers due to intra-day weather variability and relying on raincoats/windbreakers as common outer-layer solutions. This aligns with the functional dimension of apparel, which prioritizes protection and thermal regulation, and highlights the importance of layering systems for comfort [9], [10]. Studies show that thermal and moisture discomfort are frequent causes of dissatisfaction with cycling apparel [33].

Material performance was also framed in terms of moisture management and odor control (e.g., fabrics that "do not hold sweat" and reduce odor), reinforcing that comfort is operationalized as a combination of thermophysiological and sensory factors during exertion [9]. These considerations are central to the functional aspects of sportswear design [10].

Utility-driven design requirements emerged clearly. The need for pockets/secure storage was reported as a recurrent expectation (carrying personal items while riding) [34]. Safety was articulated not only as passive protection (fit preventing entanglement) but also as visibility assurance [9]. Notably, one participant explicitly foregrounded lighting -especially rear lights- as decisive for whether they would ride at all, suggesting that perceived safety is contingent on an integrated visibility system rather than apparel alone. This underscores the comprehensive nature of perceived safety, extending beyond apparel to external equipment.

3.5. Expectations and problems in women's cycling apparel: aesthetics, fit, and social constraints

Responses to the prompt involving "feeling good and attractive" revealed a bifurcation. Twenty percent stated that they did not associate "attractive" with cycling apparel and emphasized that expectations were oriented toward comfort and functionality rather than visual appeal. At the same time, participants' descriptions of desired cuts (e.g., more body-conforming "women's lines") indicate that "expressive" and "aesthetic" needs remain salient for many, even if not articulated under the label of attractiveness. This reflects the expressive and aesthetic components of the FEA model, which consider identity, self-expression, and visual appeal, and the ability of clothing to communicate identity and affiliations [9], [10].

Structural market constraints were repeatedly highlighted. Thirty percent reported that women's options in the cycling apparel market were limited, making it difficult to find

preferred colors, patterns, and forms; this group reported compensating by purchasing from men's sections and wearing garments with cuts not optimized for their bodies [9]. Another 20% discussed skirts, noting perceived social disapproval of cycling in skirts within a conservative moral-cultural context while still arguing that cycling-compatible skirt designs could be feasible with appropriate design adaptations [34], [35]. These findings highlight socio-cultural barriers and the gender gap in apparel offerings, consistent with broader research on women's experiences in cycling [3], [4], [5].

Concrete product problems were also documented: overly thin tights leading to transparency, padded cycling tights restricting walking, deficiencies in pattern/color variety, and a lack of feminine shaping in jersey patterns. These issues are not merely aesthetic; they directly affect privacy, mobility across ride/non-ride contexts, and the perceived appropriateness of garments for women cyclists' daily lives. The concerns about transparency and lack of appropriate feminine shaping directly relate to expressive and aesthetic needs for modesty and social acceptance [9], [10]. Issues with cycling pads have also been noted in research, with a need for more female-specific ergonomic designs [36].

3.6. Purchasing motivations and market access constraints

Motivations for purchasing new cycling garments were reported as primarily need-driven (e.g., replacement due to wear or inadequacy), while social influence (observing other cyclists' apparel) and a desire to feel "better" in cycling contexts were also mentioned as contributing factors. These motivations align with the functional (need-driven) and expressive (social influence, feeling better) dimensions of consumer choice [16].

Participants' assessments of market adequacy were mixed: 35% described the women's cycling apparel market as sufficient, while 35% found it insufficient. In terms of purchasing channels, reported preferences concentrated in physical retail: 45% in active sports stores and 35% in bicycle shops, with 20% preferring online purchasing. Size availability emerged as a salient access barrier, particularly for petite users (e.g., difficulty finding even "small" sizes and challenges communicating measurements for custom production). This reinforces the interpretation that "limited women's options" is experienced not only as a design/assortment gap but also as a sizing and distribution gap, further exacerbating the challenges women face in finding suitable cycling apparel [9].

3.7. Support for a dedicated women's cycling apparel collection and design implications

Support for developing a dedicated women's cycling collection was strong: 90% responded positively. Participants justified this primarily through (i) inadequate variety in color/pattern, (ii) a perceived male-oriented market structure, and (iii) the mismatch between performance-focused activewear and women's everyday clothing integration needs. They also suggested that ready-to-wear brands could deliver broader variety and more accessible pricing, and some framed a potential collection as a vehicle for social awareness messaging (e.g., environmental pollution, women's rights). These justifications directly echo the identified gaps in expressive and aesthetic needs within the current market [9], [10].

The thesis operationalizes these expectations into a capsule-collection proposition: a 10-look spring/summer concept line including raincoat, windbreaker, t-shirts, cycling jerseys, sports bustiers, pants, Bermuda shorts, and tights. The stated intent is to align design decisions (color/pattern/form) with trend research sources (e.g., WGSN and Pantone) while directly responding to the empirically surfaced needs. This translation of qualitative data into tangible design solutions is a hallmark of user-centered design and product development [17], [37]. The FEA model is a proven tool for guiding designers in

analyzing design problems, generating ideas, and evaluating designs, particularly for specific activities and user groups [17], [37].

From an interpretive standpoint, the findings are coherently explained by a triadic needs structure consistent with the FEA consumer needs framing used in the thesis: functional needs (thermal comfort, visibility, mobility, storage), expressive needs (gendered fit, feeling appropriate in public space, identity alignment with cycling culture), and aesthetic needs (color/pattern variety, preferred silhouettes) [12], [13]. Critically, participants' problem statements indicate that failure in any one dimension (e.g., transparency in tights; absence of women's cuts; inadequate visibility integration) can undermine overall garment acceptance, suggesting that successful women's cycling apparel should be developed as an integrated system rather than as isolated performance features [10]. The understanding of material properties, fit, and pressure distribution through advanced computational modeling is becoming increasingly important for optimizing comfort and functionality in sportswear [38], [39], [40], [41].

4. CONCLUSIONS

This study meticulously examined women cyclists' clothing practices, preferences, and unmet expectations with the aim of informing women-specific cycling apparel development. Findings consistently indicate that participants frequently cycle in everyday clothing rather than dedicated cycling wear, a choice often driven by the inadequacy of specialized options, particularly due to practical difficulties and conflicts with professional dress codes [9]. Their evaluation of apparel is primarily through the lens of comfort and freedom of movement, alongside critical safety-related considerations such as entanglement risk and visibility in traffic [9]. These preferences were clearly expressed through a repeated emphasis on lower-body garment choice, particularly tights, which participants favored due to the reduced risk of fabric catching in the drivetrain compared to looser trouser hems [9]. Furthermore, the need to avoid extremes in tightness and looseness - where overly tight garments restrict effort and overly loose ones pose hazards - highlights a "balanced fit" requirement that fundamentally shapes acceptable silhouettes for women's cycling apparel in daily use [9], [10].

Design expectations extended beyond mere "performance" attributes to encompass crucial visibility cues, including preferences for colorful/fluorescent options and reflective elements, which serve both aesthetic and expressive safety functions [9]. Participants also articulated distinct thermophysiological comfort needs that vary seasonally, such as the demand for high air permeability in summer to manage elevated body heat and lower air permeability in winter for insulation, often met through layering strategies [9], [14]. Utility requirements, such as secure storage (e.g., pockets), were also salient [34]. Importantly, some accounts stressed that perceived safety is contingent upon an integrated visibility system, often encompassing active lighting, rather than solely relying on apparel features, as active visibility treatments like lights significantly increase conspicuity, especially at night [42], [43], [44]. Taking all expectations and preferences into account, fashion sketches and technical drawings illustrating the details of designs developed for female cyclists are presented in the Appendix.

Market-related findings consistently highlight a persistent mismatch between women cyclists' needs and available offerings. Participants reported significant limitations in women's product variety concerning color, pattern, and form, alongside considerable constraints in sizing availability, particularly for petite users, and noted that such market gaps are common in activewear for women [9], [45], [46]. Many described compensating for inadequate women's options by purchasing from men's sections, which often resulted in garments with cuts not optimized for their bodies [9]. These constraints appear to affect not only aesthetic satisfaction but also critical functional fit, privacy (e.g., transparency

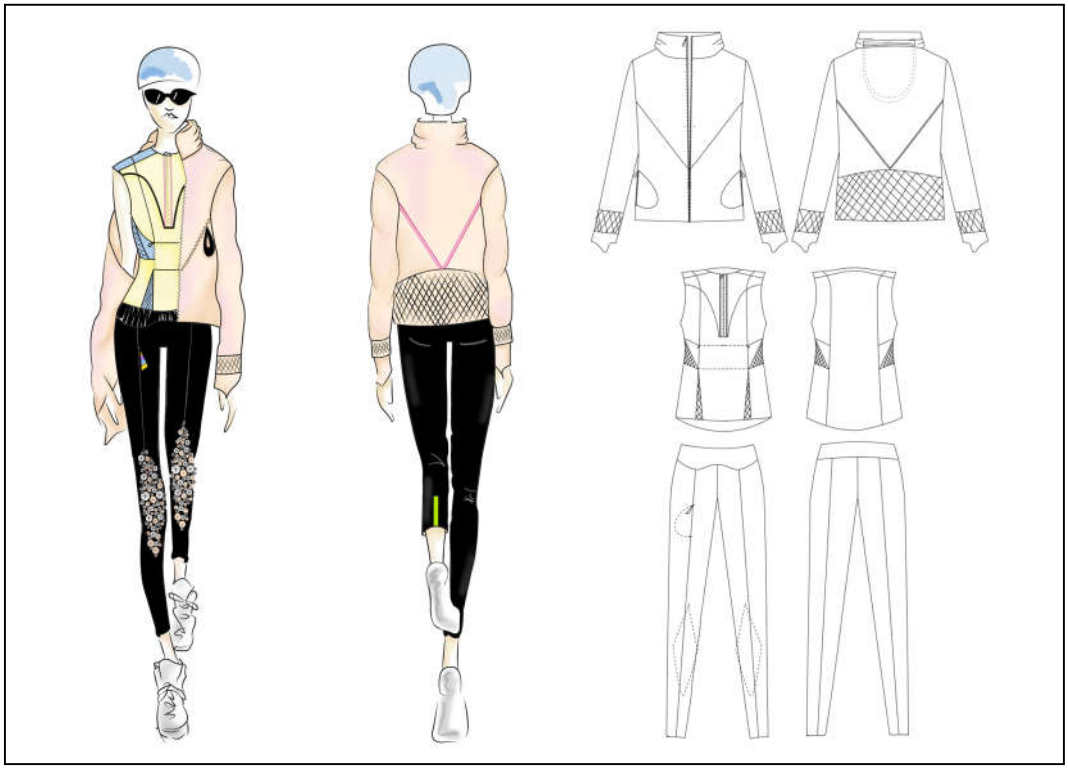
issues in materials), and the perceived appropriateness of garments for women cyclists' daily lives across both ride and non-ride contexts [9], [22].

From a design translation standpoint, the findings coherently align with a multidimensional needs structure consistent with the Functional–Expressive–Aesthetic consumer needs model [10], [13]. In this framework, apparel acceptance hinges on concurrently meeting functional performance criteria (mobility, comfort, protection, storage, visibility), aesthetic preferences (color, pattern, silhouette), and expressive requirements (appropriateness in public spaces and gendered fit expectations) [9], [10]. The strong support expressed by participants for developing a dedicated women's cycling apparel collection, coupled with the thesis' subsequent capsule collection proposal, clearly indicates that user-centered design methodologies can be effectively operationalized into concrete product criteria and tangible concept outcomes that are responsive to local-market realities and user demands [17], [27], [37].

4.1. Limitations

The primary limitations of this study are associated with its qualitative design and context specificity. The sample is limited to 20 women cyclists residing in Eskişehir, Turkey, and reflects their self-reported experiences and preferences rather than experimentally tested performance outcomes. As such, the results should be interpreted as design-relevant evidence for need identification and concept development within the studied context, acknowledging that qualitative studies inherently have limits in generalizability [47], [48]. Future work could further evaluate the proposed design criteria through prototyping and wear trials across broader user segments and diverse seasonal conditions, potentially incorporating quantitative measures of performance and comfort to complement these qualitative insights [23], [36], [49], [50]. Such an approach would allow for more comprehensive validation of design solutions. Moreover, exploring the long-term impact of these design interventions on cycling frequency, safety perceptions, and overall user satisfaction would provide valuable insights into their broader societal benefits [22].

Appendix



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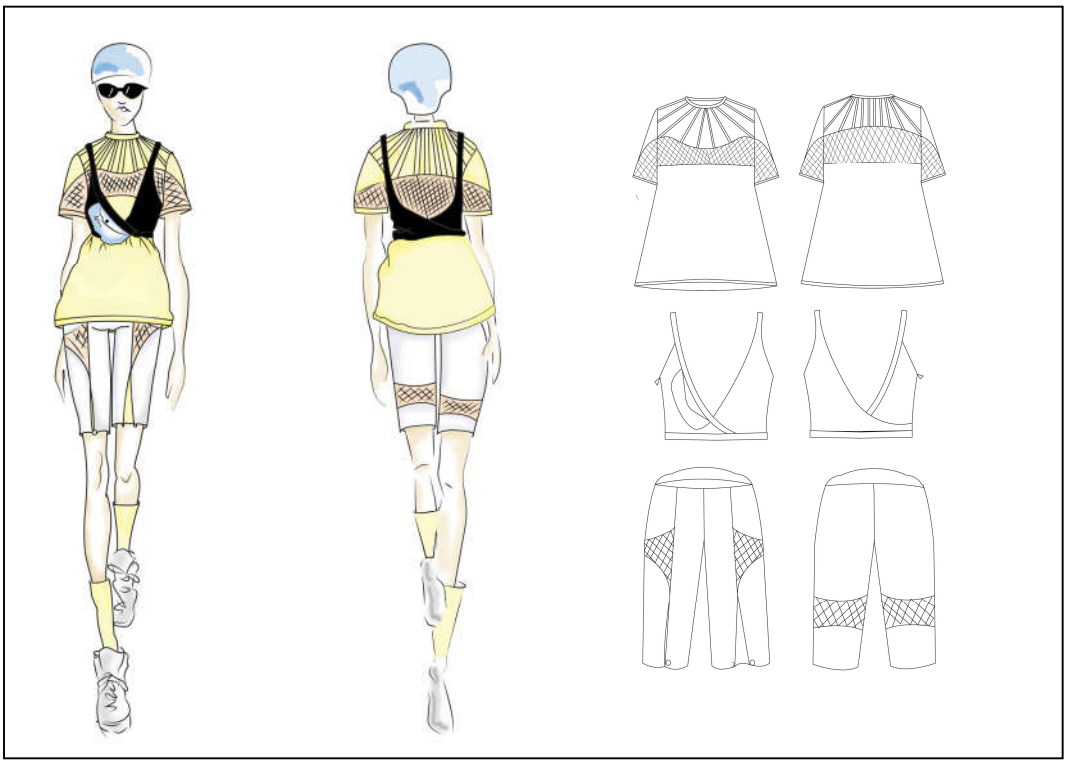

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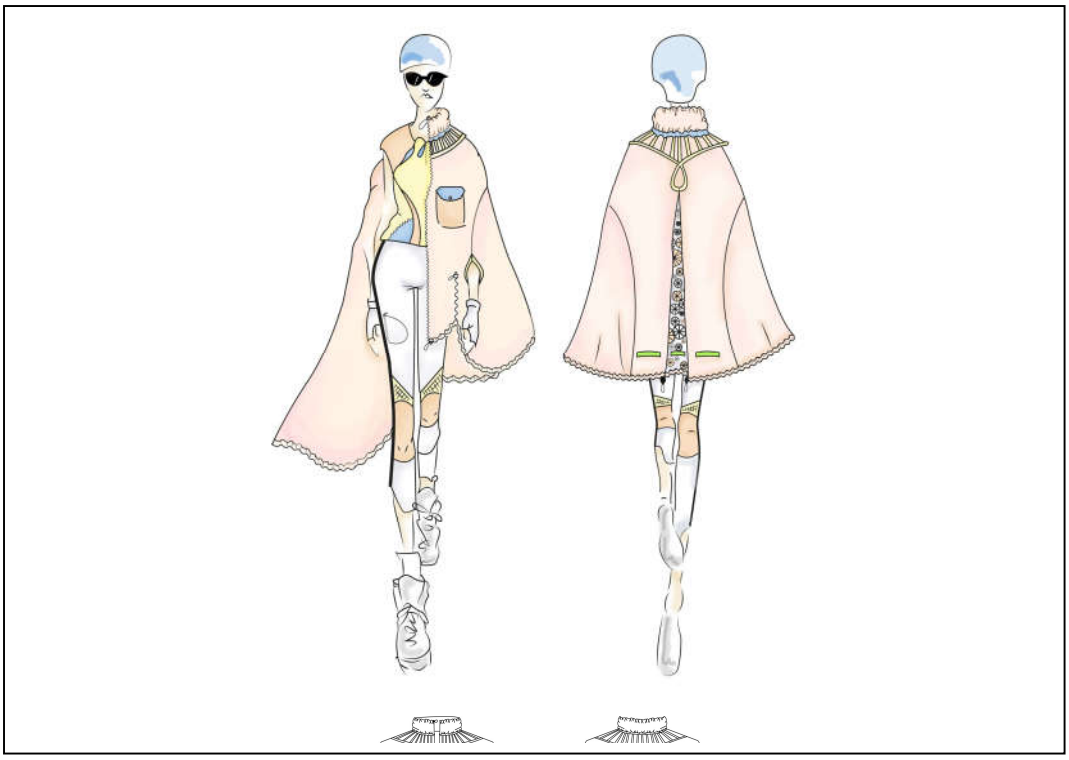

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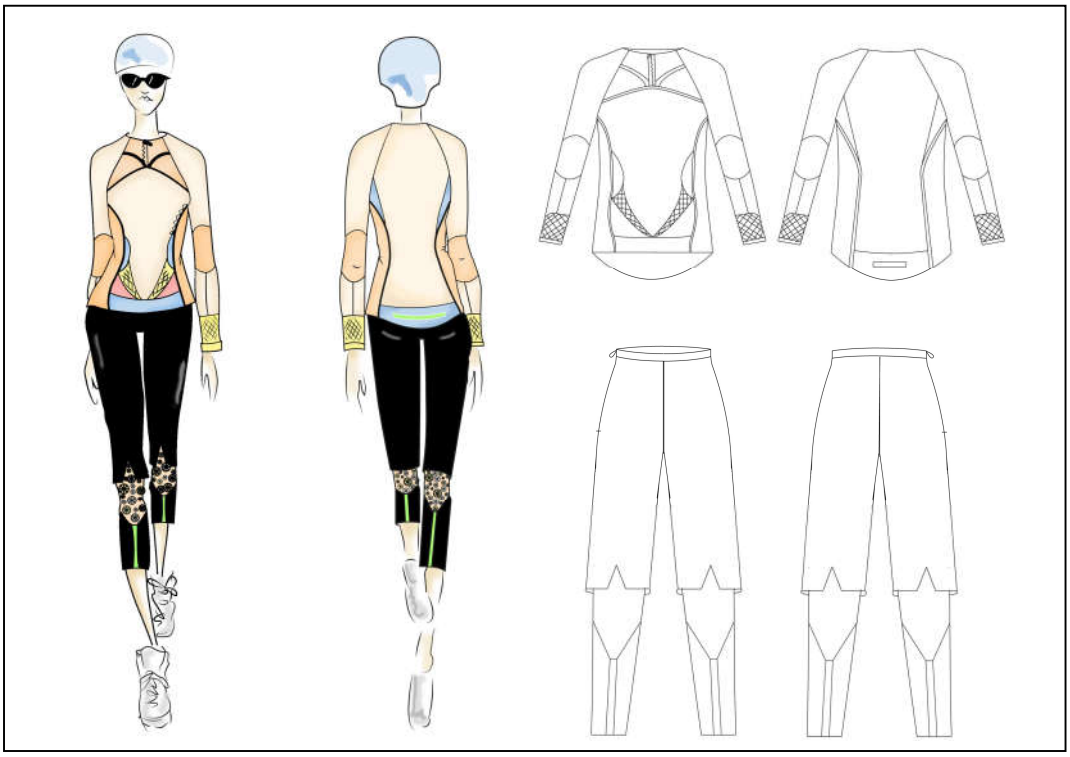

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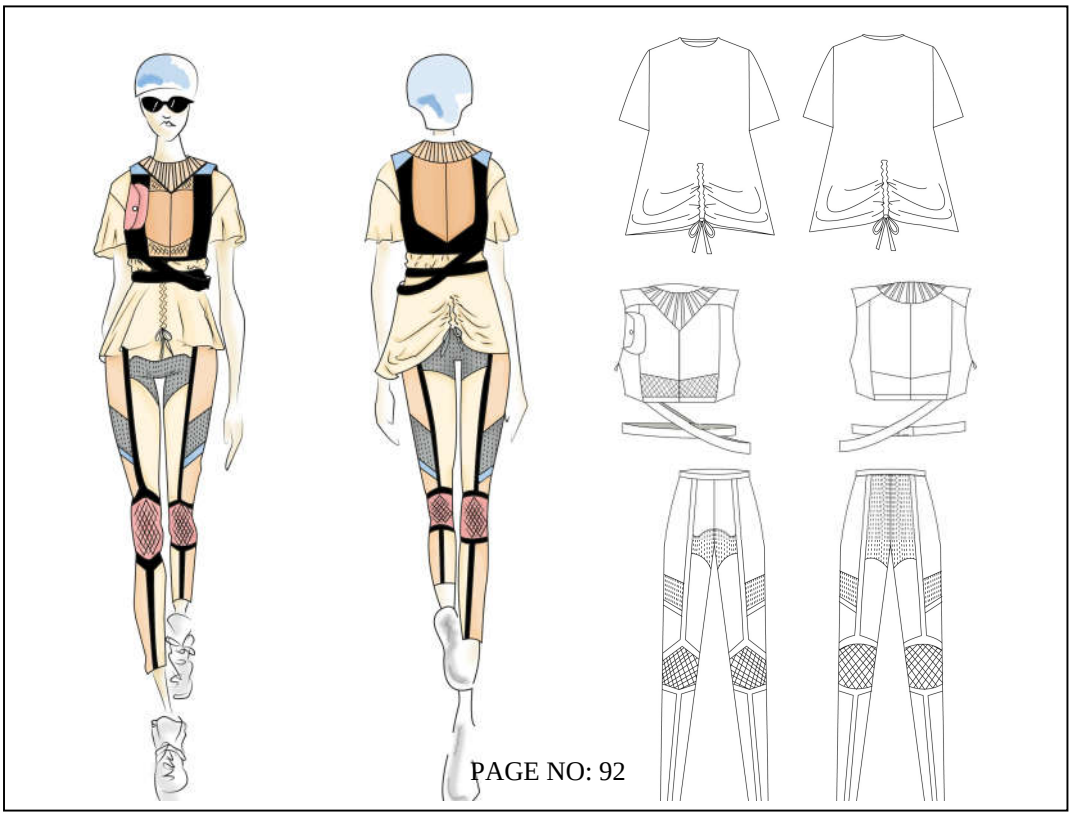

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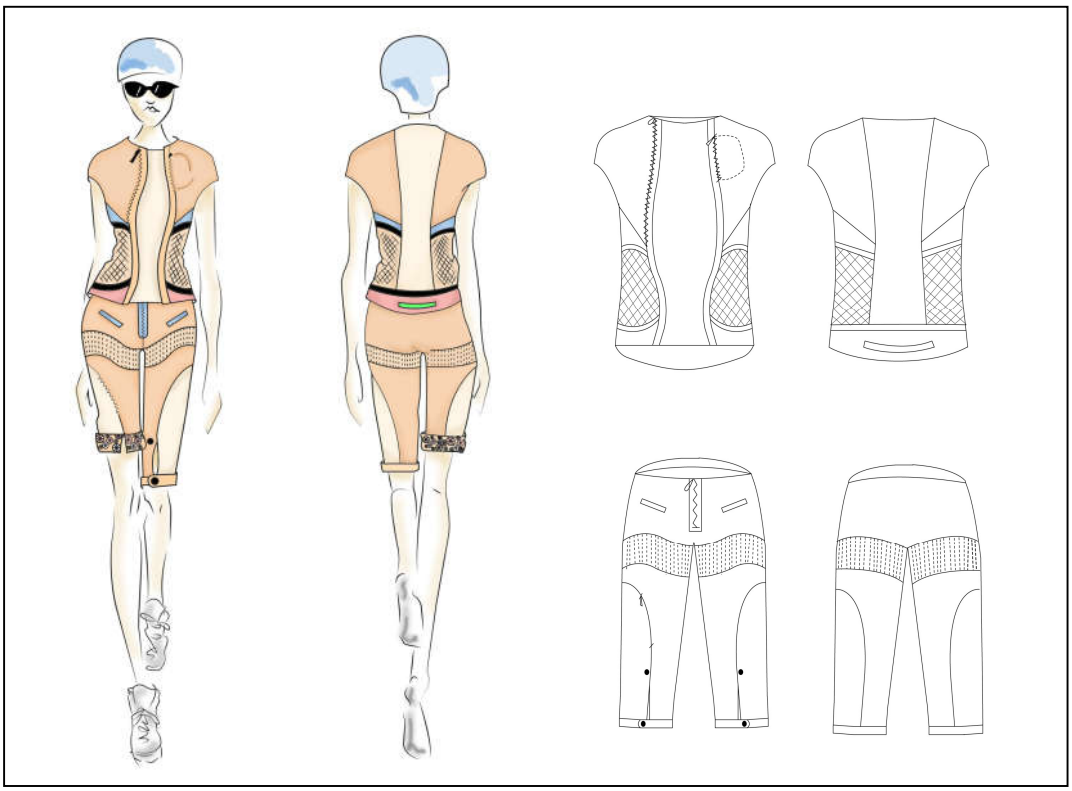

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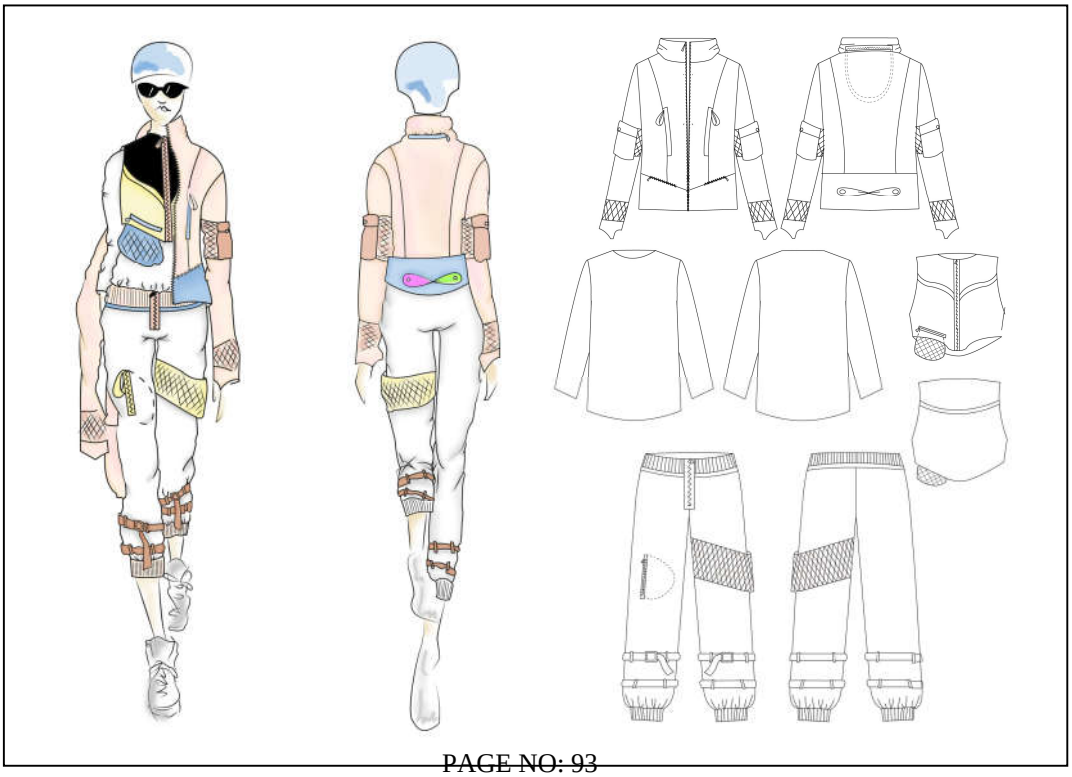

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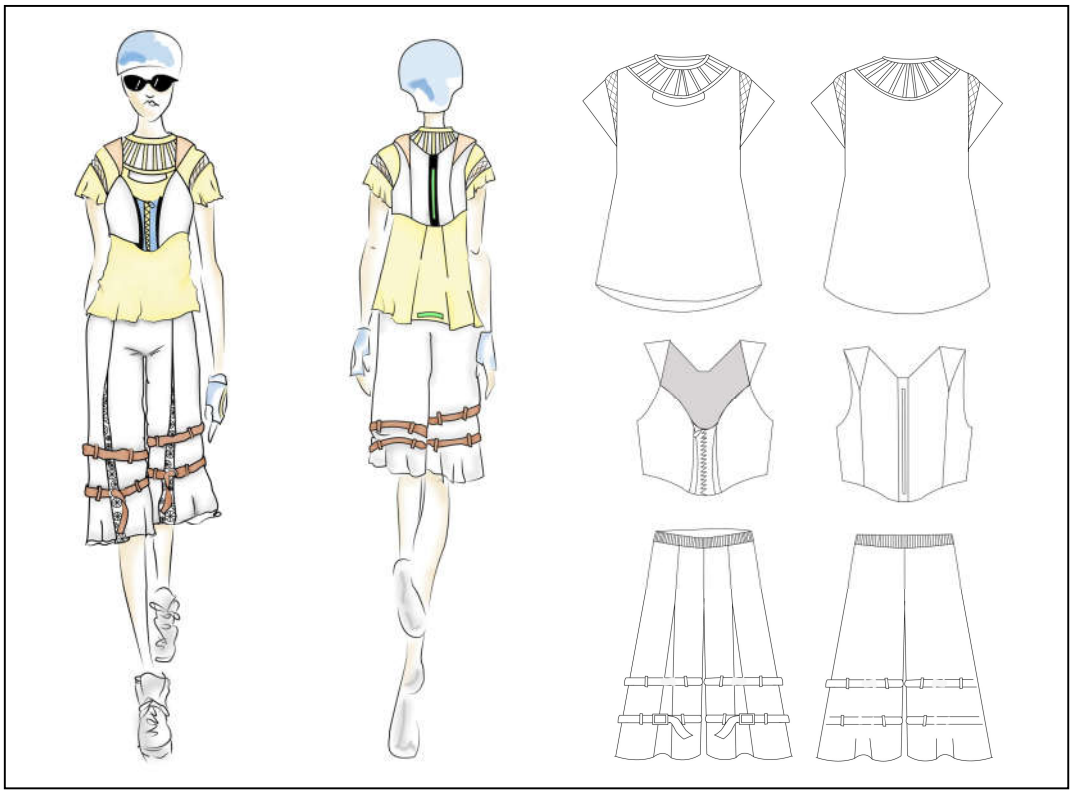

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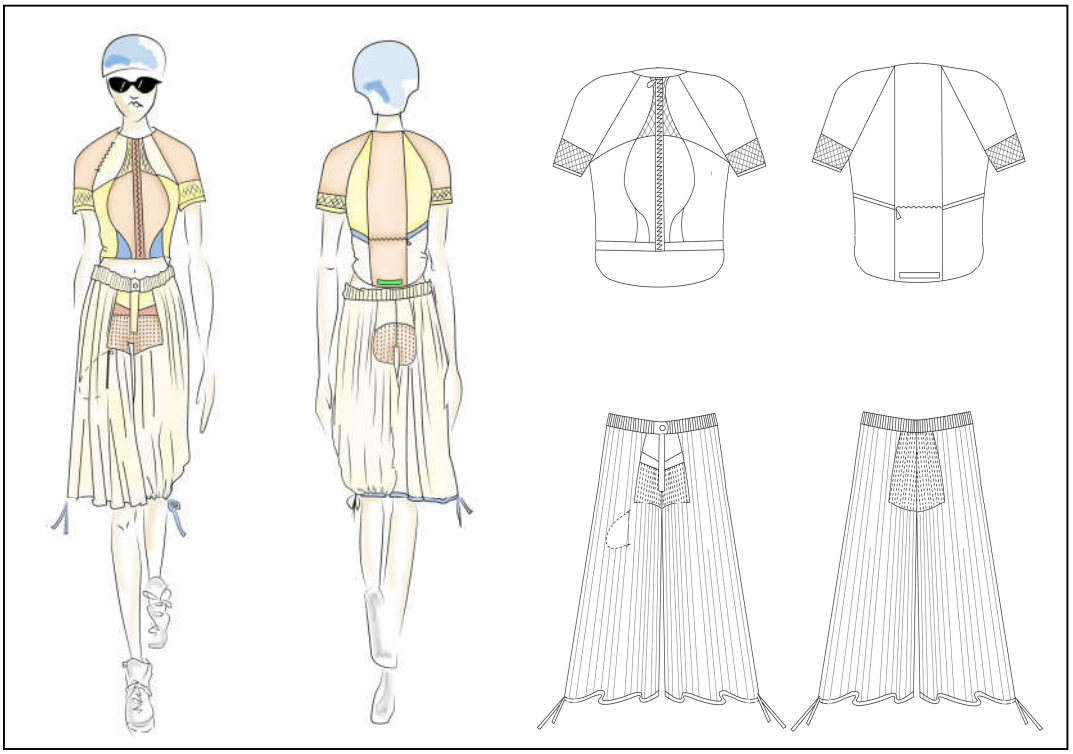
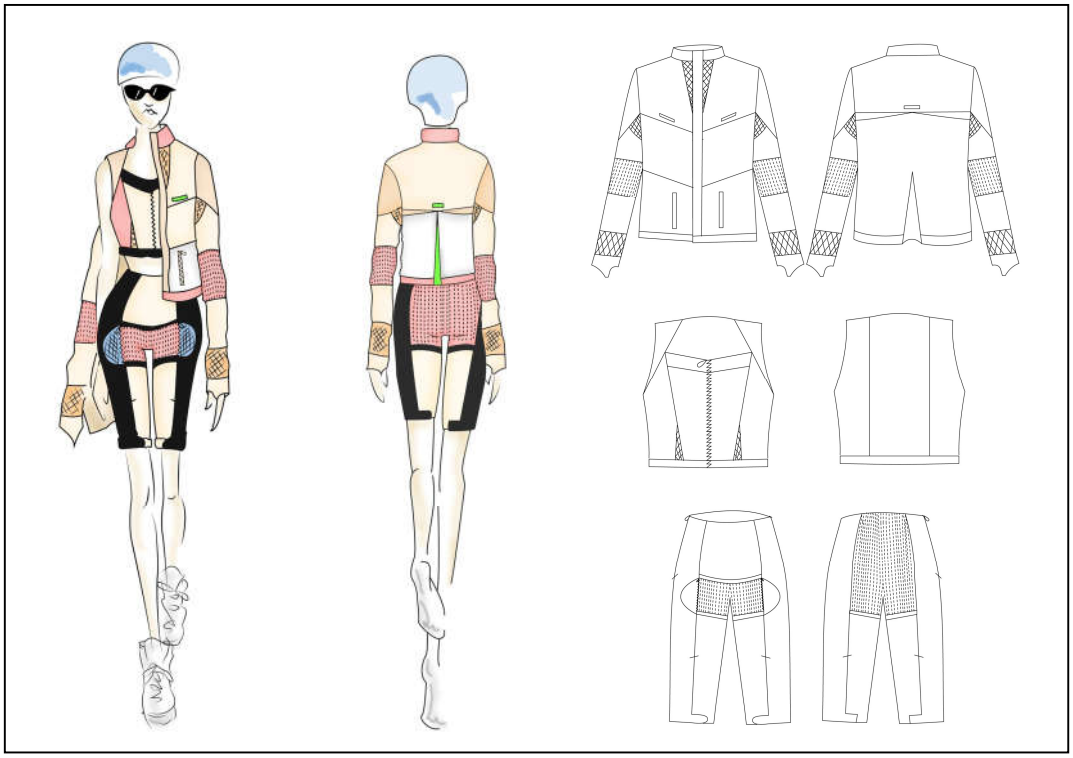


Design Look 9



Design Look 10

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