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LABEL CONSCIOUS: Communicating verifiable sustainable impact by labelling garments with smart technology

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Abstract. The circular economy has led to consumers demanding access to trustworthy information about a garment's provenance as well as more detailed transparency on the second hand or recycled products they buy. Emerging digital technologies such as smart tags coupled with blockchain technology are offering solutions which promise to resolve some of the issues surrounding fibre origin, quality and ethical practice. However, although smart tags are accessible through open access, blockchain technology which verifies the claims on the tags, is less accessible, poorly understood and currently not universally available. Through the textual analysis of garment labels and interviews with designers, this study adds to the literature on communicating sustainable practice to consumers through digital garment labelling (smart tags) and contends that consumers as well as technology developers need simplified and standardised information on garment labels not only regarding content and care but ecological impact, to inform conscious sustainable practice and contribute to systems change.

Keywords: Smart tags, communicating sustainability information, blockchain technology.

1 Introduction

In a 2019 tweet, the innovations hub Fashion for Good asked:

Where do the fibers in our garments come from, how big is the climate imprint and what do the working conditions look like in the factories where they are sewn? [1]

The tweet led to the TrusTrace website, a Swedish start up relying on blockchain technology to trace garment production. While this seems a positive step, consumers currently have very little reliable information about the contents of the textile products they purchase. Consumers are unaware if the garments they purchase have been complicit in detrimental processes – whether social or environmental. The fashion industry is guilty of various negligent practices including the application of toxic dyes and solvents, excessive water use, harmful pesticides and other chemicals, soil degradation, human labour exploitation, carbon emissions and vast unwarranted waste [2, 3]. Measures can be taken to reduce these harmful effects. One step is to modify consumer behaviour – to reject the purchase of garments that are produced with questionable processes. Studies show labelling information can be pivotal in purchasing decisions [4, 5]. However, according to Cass [6], consumers require impetus as well as information to change their behaviour. This can come from many channels including media, education and regulation as well as through simple

communications such as labels on garments. If buying behaviour reveals a preference for environmentally friendly garments, according to scholars Niinimäki [7], Joshi and Rahman [8] and Gwozdzet al. [9], brands will adjust their practices, communicate that improvement and meet consumer demand. Therefore, the humble clothing tag could facilitate the drive for change. Unfortunately, current textile product labelling regulations do not require information on environmental impact even though recent technological advancements offer improved communication formats. This information would not only inform, but lead to positive social, economic and environmental effects and transition stakeholders in the market towards 'responsible production and consumption' (UN's Sustainable Development Goal 12).

This study explores one element affecting purchasing behaviour, that is, the information on garment labels. Through the textual analysis and interviews with sustainable fashion brands it finds that consumers are demanding more accurate and verified information regarding the journey of a product through the supply chain. The study finds that despite regulatory measures, label formatting is inconsistent, difficult to read, confusing, incomplete and conceivably inaccurate. If, as Fletcher and Grose [10] and Gwilt [11] suggest, one way to arrest the damage perpetrated by the fashion system is to achieve a shift in consumer behaviour, a commitment to better communication systems needs to take place. The argument in this study is that consumers require simplified yet fulsome and standardised information on garment labels not only regarding content and care but ecological impact, to inform conscious purchase and use to drive systems change. This study contributes to the growing knowledge on the need for data organisation across the textile clothing and footwear (TCF) industry and its verifiable communication to all stakeholders along the supply chain – particularly the consumer. The implications are that new tracking and tracing technologies can facilitate the improved flow of information. It argues that if the consumer is sufficiently invested in the information, the pull from customers will compel the regulation and organisation of data by fashion producers along the supply chain and thereby leverage systems change [12].

The structure of this paper begins with the literature and contextual review surrounding garment labelling practice including initiatives and trends. This is followed by the research design which outlines the textual enquiry methodology. Current garment labelling systems are then analysed, and findings presented. The paper concludes with recommendations on the integration of best practice and next steps.

1.1 Garment labelling standards and practice

Although the basic requirements of care instructions are present, they are generally merely guidelines for laundering and/or dry cleaning and while important, do not necessarily include the fibre content or information on country of origin or sustainability credentials. To be clear, the latter components are not at this time required by law – and vary across jurisdictions. Inducements to accurately tag garments are weak. Several stakeholders are affected by garment labelling including consumers, producers, brands, retailers, importers, wholesalers, distributors,

exporters, garment care and laundering service providers, upstream suppliers, waste managers, marketing managers, industry groups, governmental organisations, and civil groups. Brands will only suffer under the law if a garment is damaged through incorrect dry cleaning resulting from inaccurate care labelling. Garment labelling generally consists of a set of tags including the sew-in neck label bearing the brand's logo, the cloth sew-in garment care label – of innocuous design sewn into an inner seam of the garment, and the swing tag/s - one or a set of paper or plastic stock printed tags that are detachable from the garment and contain information on price, size and style as well as digital codes and other inventory management information such as stock keeping units (SKUs). Other options include removable stickers and matter printed directly onto the inner layers of the garment. Although most customers simply refer to price and size when purchasing, swing tags offer the opportunity for the brand to tell its story and/or communicate its sustainability credentials. Indeed, the swing tag is a central design element in the brand's presentation and packaging. When searching for sustainable credentials customers lean to what Shawet al. [13] refer to as 'imperfect cues', that is representations that allow customers to perceive the brand as sustainable, for example through the use of recycled paper stock and cotton cording. Although important and arguably a steppingstone in the facilitation of consumer behaviour change, swing tags are not the main focus of this investigation. Rather, the modest care labels hidden in the folds of the garment are at the heart of this study. This is because the sew-in label is the subject of regulation and can be standardised by law. It also retains more permanency as it is not discarded at the first wear of the garment. Sometimes the care label is cut off by the customer. Increasingly garment information is either printed onto or embedded in the very fibres of the fabric – offering a more permanent form of data retention. Studies have shown that customers do refer to the sew-in care label. In the study by Feltham and Martin [14] around 70% of respondents used care label information when purchasing apparel and 80% referred to the information when caring for their clothing. Fortunately, there are several initiatives internationally that are exploring improved garment label options, including the International Standards Organisation (ISO). The European union labelling laws are also in review [15]. The integration of new technologies such as radio frequency identifiers (RFIDs), quick response (QR) codes, blockchain and nanotech tracing [16] provide innovative solutions to more comprehensive garment labelling.

1.2 Communicating sustainability credentials

The Fashion Revolution initiative launched the successful 'Who made my clothes' campaign in 2016 to draw attention to the plight of garment workers [17]. This was one of the first moments intentionally drawing the customer's attention to reading the information on the label. The Sustainable Apparel Coalition's (SAC) pilot project Product Environmental Footprint (PEF) sees sizable member players Adidas, Nike and H&M rolling out the PEF label to indicate environmental impact of labelled products in selected European stores. While Swedish menswear firm Asket has

produced an Oxford shirt which offers full traceability on the sew-in label, some brands like A.bch, Honest By and Everlane find there is too much information to place on a label and refer the customer to abundant explanations on their websites regarding their sustainability measures. Asket customers are also able to follow the progress of each garment online. Asket believes its new system could become an industry standard and suggests consumers demand detailed transparency from the brands they buy from [18].

1.3 Certifications

Current practices in garment labelling that go beyond regulation labelling is generally motivated by marketing. The sustainability backstories are well received by customers and this practice is growing in popularity according to Ciasullo et al. [19] and Baker [20]. However, as the additional information added to labels is self-regulated, few authoritative bodies audit the validity of the claims. At times sustainability story telling on labels has been deemed misleading, inaccurate or false [21] leading to allegations of 'greenwashing' and discrediting the idea of self-directed labelling information [22, 23]. In turn this has led to the current rise of certification organisations. These organisations act as impartial third parties that lend brands 'authenticity'. For example, the SAC has developed the Higg Index, a standardised supply chain measurement suite of tools for industry participants. Reports from firms to the index are voluntary and self-generated. The index provides points through a rating system that measures their materials, processes and environmental impact, but there is no independent verification of the inputs [24]. The truth surrounding the production of textiles, garment manufacture and distribution is very complex. According to Greer et al. [25] "There needs to be failing grades" to give accreditation schemes integrity. The 'Green-Button' initiative launched in Germany in 2019 is another attempt to standardise reporting on sustainable practice. Critics say it does not go far enough, duplicates other schemes and is not global [26].

As allegations of greenwashing threaten to ruin reputations, brands are motivated to seek out authoritative organisations that can provide trustworthy credentials. Not surprisingly, organisations that provide environmental credentials in the form of certifications are booming, with currently over 50 accessed by the ratings application Good On You [27]. Membership and or certifications from some of these organisations can command high fees for example \$6000 per style per year. As there are few commonly accepted regulatory standards, the brands are prepared to pay the fees as this improves the perception of the brand in the marketplace. The certification bodies are themselves not all subject to scrutiny. Viewed critically, this system may be subject to corruption and self-interest as the certification agencies are mostly privately run, sometimes by apparel consortiums. It is difficult to assess which organisations are authoritative third parties. This adds weight to the need to engage neutral, regulatory mechanisms to ensure reliable information.

1.4 New technology for labelling and tagging

Numerous forms of technology can identify fibre content as well as the fabrication of the yarn, fabric and construction of the garment as well as trace the transport and logistics [28]. Nano technology is useful in tracking, tracing and giving reliable information on the garment contents through embedding miniscule particles into the fibre which remain attached to the raw material throughout the production process and in some instances beyond incineration [16]. SigNature [29] offers molecular tagging for wool, cotton, leather and recycled polyester promising to tag, test and track the product. This information can be recovered through blockchain technology which serves to improve the communication of the supply chain by documenting information in digital immutable ledgers [30, 31]. Internet platforms like Regain [32], Buycott [33] and Goodonyou [27] provide information and ratings on the sustainability credentials of clothing as well as options and rewards for recycling and/or keeping the garment or its components in circulation longer [34, 35]. This information is accessible through smart tags with QR codes.

Turning to sustainable practice and the circular economy transparency on the materials flowing through the system is key to improving recycling rates. Recycling technologies rely on accurate materials detection and sorting to ensure well-defined material streams (either a single material or well-defined combinations of materials including blends) [36]. This study argues that although firms like Content Thread are researching RFID threads embedded in garments that contain digitised information on composition - to be effective, product identification should begin at the origin – at the farm or plant where the fibre was produced rather than once the garment has been manufactured. Several forms are already offering origin tracing capability including technology companies Applied DNA Sciences, Oritain and FibreTrace which have created bio-based markers that can be embedded in fibres, allowing them to be tracked and identified throughout the value chain. The companies offer similar capabilities. Origin tracing also benefits the fibre commodity exporters and producers as much of the worlds high quality natural fibres are blended with lower quality fibres down stream – but still claim to be high quality or ‘organic’. But tracking and tracing and in particular blockchain technology seems to have had a luke-warm reception in the fashion industry. There are a number of barriers to adoption. One is the high cost of development and integration of the technology, another is accessibility and appropriate user interfaces. Unfortunately, there is currently no universal or open source mechanism that can be accessed by all users. Furthermore, a universal platform would also require an agreed upon global standard of information.

Besides the sophisticated nano tech and bio tracing systems, beacon technologies offer a somewhat more accessible form of digital tracking. QR readers were first introduced around 2012 with the rise of smartphones. However, their popularity waned perhaps firstly because they required a specific app and secondly the information on the websites that the codes led to were not particularly useful to customers. By 2017, smart phone updates provided native QR code scanners. QR Codes are now dynamic rather than static and can be used to deliver augmented reality (AR) experiences. For example, in 2020, Puma launched its LQD CELL

Origin AR shoes, replete with QR codes, offering augmented reality experiences. According to Juniper Research, by 2022, 1 billion smartphones will access QR codes [37]. Near Frequency Codes (NFCs) do not require a camera app to read. Items can be scanned at a distance and are currently used in inventory and stock management in large department stores. Similar to reading cardless payment equipment, NFCs can offer more than just a link to a website. Similarly, geofencing technology can send relevant notifications to customers when they are in the vicinity of their stores and then present virtual in store assistants offering more personalised shopping services. The customer can also select which products and campaigns to engage with.

Platforms currently offering blockchain and smart tagging solutions include tech company FibreTrace collaborating with Melbourne jeans manufacturer Nobody Denim; tech firm Labrys (Brisbane) working with textile waste recovery firm BlockTexx to create a fibre token; TrusTrace (Sweden) adding blockchain to QR codes on garment labels for the fashion brand Residus; Provenance (London) working with designer Martine Jarlgaard; LUKSO (Berlin) creating a mobile app and the 'cultural token' LYX to buy and sell fashion; IOTA an Internet of Things tech provider teaming with luxury brand Alyx to create an alternative protocol, 'Tangle' which can run various transactions simultaneously; Loomia adds an electronic smart layer textile to clothing that can be tracked and traced delivering data about the garment's use to brands; ConsenSys is working with the Lane Crawford Joyce Group to recycle luxury goods; tech firm VeChain is collaborating with Chinese fashion brand Babyghost to track garments and verify authenticity through QR codes; Faizoid is creating a blockchain for the global fashion supply chain; Bext360 is tracing agricultural goods and can make payments directly to farmers; Evrything (Netherlands) is working with Ralph Lauren to ensure brand authenticity [38, 39]; Textile Genesis (Hong Kong) is working with Lenzig and H&M to track and trace fibres and have also created a token (patent pending) called Fibrecoin; Perlin (Singapore) is working with Asia Pacific Rayon (APR) to verify sustainable forestry of their woodchip used in rayon production; diamond trackers Everledger is working with Alexander McQueen as well as the Australian Wool Initiative (AWI) to trace superfine merino wool through the supply chain. These tech companies provide bespoke and costly solutions. Nonetheless, their pilot studies are important in the development and refinement of these technologies not to mention potential accessibility and affordability in the future.

What does this mean for the sustainable brand and the conscious consumer? It is currently possible to track a raw fibre to the exact location on the farm where it was grown or picked, its quality and the health of the soil it was grown in. Tracking information is updated in real time. It is feasible that the consumer will be able to see the conditions under which the fibre was grown and processed, the carbon emitted in its transport across the globe and information on appropriate waste recovery plants to send at the end of life [40]. Furthermore, through augmented reality the consumer can experience the flow of the fibre through the value chain as it undergoes processing. These are the technologies currently in development and promise to enhance tracking and tracing in the future. However, tracking and tracing is currently less accessible and in a more fractured state than one would expect for a number of reasons.

At this point it is important to consider whether consumers will actually take advantage of more comprehensive information – and thus bring about systems change for the better. Consumers do check labels and consider this important in making purchasing decisions, with almost two-thirds of checking for fibre content according to surveys conducted by the Cotton Incorporated Lifestyle Monitor (CLM) [41]. Most are looking for cotton (82%), followed by care instructions (24%), then comfort and feel (11%). The CLM survey of care labeling finds consumers consider the font too small, difficult to read or contains too much information [41]. In another study, Aspers [42] suggests that customers would be happier to make decisions that directly repay the original worker.

2 Methodology

As this paper argues that consumers need simplified and standardised information on garment labels, this study takes a qualitative approach to investigate the current practices in garment labelling, both regulated and self-regulated. Regulated practice requires that written garment care information is included on the label. However, many garment producers add additional information on an ad hoc basis. This study looks at a sample of labels currently in use and used textual analysis [43] to compare garment labelling systems in everyday use by coding the information on the label into groups. The products were chosen as their labelling is subject to regulation and legislation but also includes additional marketing information. The study was enriched with empirical data gathered from interviews with 10 small to medium textile clothing and footwear (TCF) business owners to gain a perspective on the challenges and opportunities of implementing garment labelling information – particularly in the light of new tracking and tracing technologies.

The labels investigated were attached to garments selected from brands available in the city centre of an Australian capital city (Sydney). The brands covered all market segments including high, medium and low price points. The garment style was limited to a linen, knee length, sleeveless summer dress from the brands' seasonal range. Linen is a natural fibre that is not produced in Australia in any great quantity. Photos were taken of the labels and compared for content information. The garments originated from locally as well as offshore product lines. An in-depth analysis was made of garment labelling with 4 specific parameters: fibre content and care instructions (current, anticipated or formerly regulated factors) as well as country of origin, and sustainability measures (self-regulated factors). For the purposes of this study only sewn-in cloth labels were taken into account. However, some images were also taken of swing tags (printed hard stock labels that are removable), if they yielded further information on the 4 parameters. Branding labels (logo tags) were not taken into account for this study unless they contained one of the 4 parameters such as country of origin. Additional information was collected from various sources including the garment brand's websites, government statements, academic literature and industry organisation reports. Although the focus of this study is the state of current garment labelling practice in Australia, data was also collected from global

organisations as the textile industry reaches beyond national borders. For example, information was sought from the International Standards Organisation (ISO) and various certification organisations that are based internationally such as the Higg index and GOTS sites. A matrix was devised to extrapolate results from the data. This helped to visualise emerging patterns. Results were collated according to the original 4 parameters on 70 garments: The table indicates numerically how many times out of the sample of the parameters were presented on labels. Sustainable textile practice includes a variety of practices and choices and processes including traceability, environmentally friendly farming of fibres, recyclability, non-blending of fibres and use of second-generation fibres. For the purposes of this study the specific types of practice have not been classified. As there is currently little to no information on sustainability currently on labels, and also for simplicity, sustainability measures have been encompassed in one parameter. This information on garment labelling will be named 'sustainability credentials'. However, links to specific information could be provided on labels.

Table 1: Summary of information contained on the 70 garment care abels analysed.

Information	Written	Symbols/abbreviations	Technology
Care instructions	70	13 e.g. square and circle	3 QR code: link to website or app with further info
Fibre content	60	12 e.g. PE	
Country of origin	50	14 e.g AU	
Sustainability credentials	10	e.g. GOTS logo	3 QR code, RFID, nano trace etc

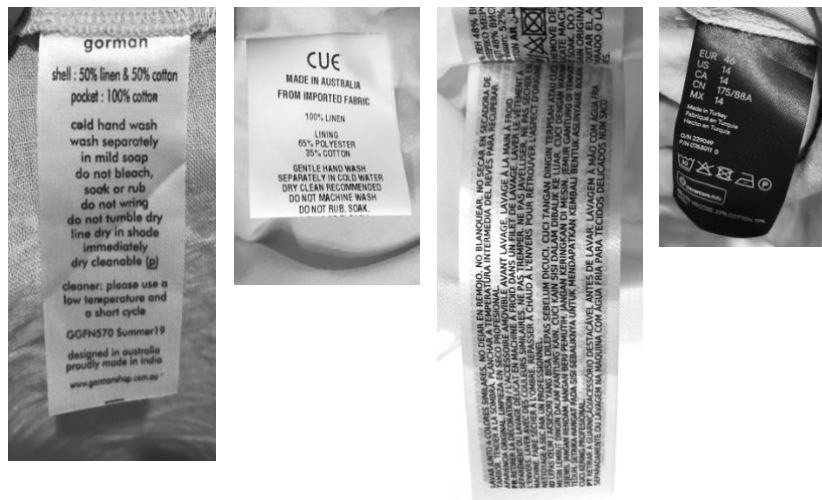


Figure 1: Garment care labels from similar garments showing inconsistency of information. Photo: Heim, H. 2020

3 Findings

3.1 Analysis: garment sew-in labels

Labelling (whether government regulated or self-regulated) can be utilised within the branding package to encourage consumer purchase and therefore is pertinent to the study. The garments are subject to highly competitive markets where branding can determine the purchasing decisions of the consumer. The information and formatting on garment sew-in labels were the subject of analysis in this study. Literature had shown that garment labelling is confusing, difficult to read, incomprehensible and inconsistent. Also, that consumers do not understand the information and how to use it or how it affects them. Finally, little to no information is found on labels regarding sustainability credentials. The data collated in the tables above demonstrate that:

1. 100% of the samples were compliant to mandatory garment labelling standards by including written care instructions in English, however 15 (35% were illegible because of font size and/or print quality or colour/background relationship).
2. 20 % of the labels included non-mandatory information including fibre content, country of origin and/or sustainability credentials.
3. 20% of the labels had country of origin information, 20% was abbreviated.
4. 30% of labels had publicly scannable codes which led to further information on apps.
5. 30% had extra information on detachable tags and /or stickers including certifications and sustainability credentials.
6. 30% had information on end of use.

Data confirms that labels are inconsistent in information and formatting and do not all contain information on sustainable practice. Information communication technology and the use of digital identifiers can extend the amount of information available to the consumer. It can also be laid out in a more comprehensible manner, for example through infographics. This will simplify but also require further investment and development of technologies, adoption by regulators, producers, suppliers and consumers. This represents a significant change but worth the potential positive impact.

3.2 Analysis: small-scale designers' communication of garment sustainability

The small scale fashion enterprises interviewed for this study are constantly seeking affordable means to achieve their goals whether economic, social or environmental. Upon initiating the interviews about 'technology' most assumed they would be discussing social media e-commerce applications. All felt they should not conduct their businesses without the benefits of these customer facing and affordable applications. Turning the conversation to blockchain enabled technology many would say – 'oh I'm no good at technology' or they would 'wait and see' what the others are doing [44, 45]. This points to the classic business phenomenon of market-competitor

advantage [46] and suggests that uptake will only accelerate once competitor firms are adopting the technology.

For example, the founder of the circular label, A.BCH recalls, ‘basically, I discovered Provenance and SourceMap and I was checking out various things and finally realised they didn’t have anything I didn’t already have’ [47]. The designer has listed the provenance of components for each garment on her website ‘by hand’. That is, she has simply provided the information of where the buttons, threads and fibres etc have come from. This is time consuming work but may still be more cost effective for her business model at the moment. It also provides a level of authenticity in telling the story to the consumer.

We do have a QR code, we put that on every label, the story of how our garment was made so the code on the garment which is actually stitched into the garment would basically take me back to that product on our website where you could see the whole story of how it was produced, even if you didn’t buy it yourself (and it has landed in a secondhand market). Or you bought it (second hand) in an op shop or something like that - you can look up where the fibre was grown, and you can see all that information there, its on the site even if the garment sells right down the track. Its very manual and nothing like fancy or foolproof and you know there’s a lot of room for error, its not foolproof [47]

Regarding sustainability credentials, some rely on certification agencies but have a fractured relationship here. For example one founder complains:

I see blockchain as helping us with the weight of the accreditations. I’ve never had the resources to prove any claims that we’ve made on our supply chain and we rely on that, but if blockchain can actually help us you know, not rely on those certifications and actually proved our social impact and minimising our environmental impact we would be interested [48].

The respondent is not convinced that the slew of certifications and sustainability awards his brand carries is any guarantee of firm success. Understandably, the effort required to adopt the technology must not only be commensurate with – but significantly outweigh its perceived disadvantages to the firm [49]. The pattern emerging here is that ease of access, affordability and significant return on investment are factors that may entice a small scale enterprise to adopt emerging technology.

4 Discussion and recommendations

Shifts in important export markets as well as regulatory changes afoot in key consumer markets (EU, UK, US) mean that producers of natural fibres are under pressure to demonstrate traceability. Several tracking and tracing capabilities have been developed by commercial operators, offering technology-enabled tracing of fibres. However, to enable broad uptake of traceability across the wool and cotton industries, and to prepare for integration with global schemes operating downstream

in textile supply chains, the development of a data standard is fundamental. A public comprehensive natural fibres data standard is an agreed-upon data vocabulary and ontology which establishes shared definitions of traceability data from farm, to mill, to fabric, to customer. It supports the interoperability and good data governance that will ultimately enable individual growers to interact efficiently with the tracing system of their choice and/or move between platforms [50]. It will benefit commercial providers who can use the data standard to build new services or expand their existing traceability offerings. The recommendation is that labels:

1. Inform: specifically, care, fibre, country of origin and sustainability credentials including the relationship of care, use and impact on the environment.
2. Simplify: be consistent and simplified in formatting, Be globally agreed upon, accessible and comprehensible
3. Connect: with incorporating digital technology where possible.
4. Regulate: standardise the above requirements can be monitored and enforced.
5. Communicate: Allow for correct fibre separation for recycling

5 Conclusion

The consumer is in a position to drive change toward positive impact by buying sustainably produced goods. One way to facilitate the uptake of sustainably produced garments is by engaging the customer through comprehensive and accessible information interfaces. The above examples demonstrate that consumers need simplified and standardised information on garment labels not only regarding content and care but ecological and ethical impact. New technologies could resolve these issues, but considerable preparation of standards and governance needs to occur for technology to be effective. The integration of blockchain technology although offering the capacity to verify claims, will also require reliable identifiers. Individual efforts are no longer enough, suggesting government intervention is also required to promote regulation and compliance. The imperative for better consumer information can be presented to the regulators to enforce policy change. Improved garment labelling standards would coerce producers/suppliers to comply before the product reaches the consumer. Furthermore, as we move towards the circular economy it will become essential to implement accurate fibre detection mechanisms for the correct sorting of recycled products. Finally, as the industry crosses international boundaries, greater standardisation of global standards will be required.

How much the brand, and ultimately the consumer actually wants to know may be dependent on product and market. Further empirical investigations could be conducted on consumers' intention and action as well as interaction with garment labels once enabled with emerging technologies. Consumer information and education initiatives may also be required for effective implementation. Technology developers will also still need to arrive at solutions that are universally accessible. Brands implementing sustainability missions may not only benefit from valuable marketing opportunities but the ability to better reach their sustainability goals. This study adds to the literature on garment labelling as a means to communicate

sustainability credentials and shift consumer behaviour towards more responsible buying decisions. It serves as a preliminary examination of the parameters needed to create improved garment label standards and contributes to the literature on new communication technologies in fashion.

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