Journal of Fiber Bioengineering and Informatics 18:1 (2025) 1–14

Cite as: X. Wang et al.
doi:10.3993/jfbim02951

Advanced Methods for Fabric Hand Digitalization: Enhancing Traceability in Wool Manufacturing

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Abstract

Fabric hand properties significantly influence consumer satisfaction and product quality in the textile industry. This study investigates the application of the Fabric Touch Tester (FTT) and Fabric Big Data (FBD) platform for digitising and tracing fabric hand properties during wool textile manufacturing. The research builds on prior studies, confirming that FTT effectively quantifies hand properties during manufacturing, while the FBD platform enables real-time visualisation and networked access to production data. Results reveal that this approach allows fabric properties during manufacturing to be well monitored and enable manufacturers to consider whether redundant steps could be eliminated to enhance resource efficiency. Additionally, this study demonstrates how integrating digital tools into production workflows aligns with ESG and ESPR goals by reducing waste and optimising resource use. These findings offer practical guidance for advancing sustainable textile manufacturing, laying the foundation for more intelligent and transparent production systems.

Keywords: Fabric Touch Tester (FTT); Fabric Hand; Textile Manufacturing; Digitalization; Traceability.

1 Introduction

The textile and apparel industry accounts for approximately 10% of total carbon dioxide emissions, making it the second largest source of industrial pollution after aviation [1, 2]. Under the current global market and regulatory environment, Environmental, Social and Governance (ESG) are becoming critical considerations in the textile and apparel industry [2]. According to the EU strategy for sustainable and circular textiles, 'making products more durable, reliable, reusable, upgradable, reparable, easier to maintain, refurbish and recycle, and energy and resource-efficient' is important for industries when product design. This includes the implementation of digital product passports for product manufacturing process transparency [3-5].

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Mar. 2025

With the combination of intelligent digital technology and the current demands of ESG regulations, the Fashion Big Data (FBD) platform designed by Digital Clothing Ltd. provides the fashion industry with a comprehensive data digitalisation and product traceability platform [6-10].

The Fashion Big Data Business Model (FBD_BModel) can serve as both a SaaS (Software as a Service) platform and a cloud computing platform. It is specifically designed for the fashion retail and textile industry, integrating an Interactive Design System (IDS) and a Supply Chain and Production Management System (SCPMS) [9]. The FBD_BModel has developed the functional Cloud Computational Interactive Design System (CC_IDS) to transform traditional supply chains into digital, knowledge-based networks, enhancing connectivity and efficiency [6]. It also enables a more responsive, flexible, and efficient supply chain within the fashion industry [7, 8].

In addition to the FBD_BModel, the FBD-Big Data Technology Platform for Textile Supply Chain enables detailed tracking of quality, business, and environmental indicators from the fibre to the finished garment. The Fabric and Garment module also considers biometric fit, hand feel, skin feel, and thermal comfort, which are generally unavailable in most systems. The platform also supports digital data that follows regulatory and standardisation for certifying the functional qualities of fibres, yarns, fabrics, and garments, ensuring comprehensive quality assurance throughout the production process [8, 10].

Fabric hand often be defined as the impressions obtained when fabrics are touched, squeezed, rubbed, or handled [11-16], which is crucial in the wool textile industry and directly influences consumer preference and product value [15, 17-20]. Numerous manufacturing processes are designed to optimise fabric hand quality, especially in the finishing stages [21-23]. However, these processes often involve high energy consumption and resource wastage, making pursuing more sustainable manufacturing practices an urgent need in the industry [24, 25]. In this context, achieving the digitalisation and traceability of hand-made fabric during the finishing stages to improve product quality and energy efficiency is important in wool textile production.

Researchers have developed several measurement methods to evaluate fabric hand properties. Approaches such as Fabric Assurance by Simple Testing (FAST) developed by CSIRO and the Kawabata Evaluation System for Fabric (KES-F) created by Kawabata's research team are prominent in this area [26-28]. Both systems effectively introduced predictive models that assess fabric tactile sensations based on physical properties. However, their limitation lies in the high cost and time required for measurements, as each module must be assessed individually and sometimes even twice for both directions [28]. Other approaches include the comprehensive handle evaluation system for fabrics and yarns (CHES-FY), Wool HandleMeter, PhabrOmeter, Instron, and Fabricometer, which scholars have also developed and utilised for tactile properties testing [15, 28-32]. Nevertheless, these approaches still face limitations. For example, PhabrOmeter will not provide physical interpretations of the test results, HandleMeter can only be used to measure certain characteristics of hand feel [28]. The Fabric Touch Tester (FTT) was developed to address the limitations of previous systems. Four modules (compression, thermal, bending and surface) are integrated into the instrument, which allows simultaneous evaluation of various perspectives of fabric physical properties in a single test within just five minutes [17, 28, 32]. In addition to saving testing time and being highly efficient, FTT also has advantages, including being suitable for all types of fabrics with thicknesses lower than 5 mm, a high degree of intelligence, and comprehensive data collection [32]. According to the FZ/T 01166-2022 'Textile Fabric Touch Determination and Evaluation Method: Multi-Index Integration Method' published by the Ministry of Industry and Information Technology of China, FTT complies with the requirements of this