3D design software and system adoption to streamline supply chain management: A case study of innovators of LincTex Digital

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Rationale. 3D design software and systems are becoming increasingly popular and gradually adopted by brands in the fashion industry. Global leading fashion brands, such as Adidas, Under Armour, and Hugo Boss, have already integrated 3D design software and systems into their workflow. Other brands, such as Zara, are also exploring the use of 3D design in their supply chain. In addition to large brands, many smaller and emerging fashion brands are also adopting 3D design software to stay competitive and improve their design and production processes. The COVID-19 pandemic has also accelerated the adoption of 3D design software in the fashion industry, as brands have had to find new ways to collaborate and create designs remotely. Research and practices (e.g., Behr, 2018; Forrest, 2022; Justice, 2018) have provided evidence on how supply chain management can be dramatically improved through the adoption and integration of 3D design software and systems into the workflow in the fashion industry. These benefits include faster design and prototyping, reduced physical sampling to save cost, improved collaboration, greater sustainability, and more accurate production planning, and production.

Even though 3D design software and systems can help streamline and optimize the fashion industry supply chain, making it more efficient, sustainable, and responsive to consumer demand**.** The adoption of 3D design software and systems is still in its early stages. To truly transform the industry and improve its efficiency of the industry, it is needed to increase the adoption and diffusion of these fashion technologies. According to the theory of innovation diffusion (Rogers, 2010), the S-curve adoption process starts with innovators, which play a very critical role in the diffusion of innovation. The most significant factors affecting innovators' adoption are the innovation's characteristics including relative advantage, compatibility, and complexity. The Technology Acceptance Model (Marangunić & Granić, 2015) also points out that the usefulness, ease of use, and fun of technology are the keys to being accepted. It is important to identify how innovators perceive the fashion 3D digital technologies to promote the diffusion for transforming the industry. To this end, this pilot study is to examine perceived innovation characteristics from innovators' perspective to identify factors affecting adoption and diffusion pace of the 3D fashion digital technologies.

Method. Case analysis was employed. LincTex Digital was selected for the case study. Founded in 2015, LincTex Digital is a Hangzhou-based firm commonly known as Style3D. The company started by developing virtual

Style3D Studio
The 3D fashion workshop
Now, designers can create without constraints, experimenting and inputting any number of variations, and outputting hyper real, ready-to-sell 3D styles.
√ 2D & 3D pattern making.
√ Smart fitting.
√ CPU & GPU render.
√ Virtual avatars.
√ Fashion output presets.

Style3D Fabric
The 3D textile lab.
Curated for fabric developers, Style3D Fabric captures and processes textiles into high-end, ready-to-edit digital twin assets.
√ 5,000 virtual swatches.
√ QR-Link the physical and digital world.
√ Hardware devices.
√ Fashion output presets.
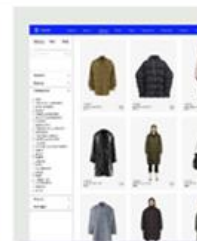
Style3D Market
The largest 3D fashion source.
An ever-growing valuable source of assets, and a key component of the earliest stages of design and development.
√ 40,000+ clothes, fabrics and acc.
√ Monthly trend boards.
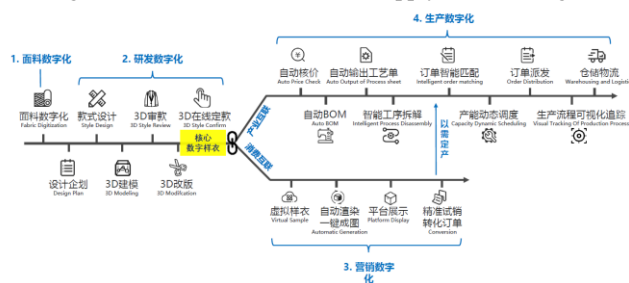√ Monthly new collections.
√ Monthly new avatars and props.

Style3D Cloud
The all-in-one platform for online design, 3D asset management, and collaboration.
√ DAM
√ Libraries.
√ Secure data (RBAC).
√ Online design.
√ Collaboration tools.
√ Virtual showrooms.
√ Trend Books.

try-on technologies and 3D body scanning at the beginning and has gradually expanded its offering to include digital services for fashion designers and manufacturers so they can use big data to design and produce fashion collections. Most recently, it also pivoted to the metaverse, with digital fashion design and technology products. Figure 1 provides a picture of Style3D's ecosystem. Style3D is looking to integrate the design, manufacturing, and online sales of physical clothing with the design and production of digital clothing items. Researchers reached

Figure 2: Kimhaie's Streamlined supply chain management

the LincTex's manager and received company information as well as a client list of adopters including ODM companies, manufacturers, retailers, wholesale markets, e-commerce platforms, and higher education institutions. For this pilot study, we interviewed two ODM companies.

Findings Kimhaie is a Hongzhou-based ODM business established in 2002. It has factories in mainland China, Cambodia, Bangladesh, and Africa. The business owner, Mr. Zhou, claimed to be the earliest 3D fashion digital technology adopter. According to Zhou, Kimhaie actively adopted Style.3D, and its supply chain has been streamlined by using Style3D systems (see Figure 2). The most dominant motive for using Style3D is "having the speed to be competitive". Mr. Zhou said, "Using *the traditional mode, it normally takes 336 hours to turn a product idea into be tech pack; however, it can be shorted to 8 hours using the Style3D system*" The other significant benefit is using a virtual showroom with all products displayed in detail and tracked accurately to efficiently communicate with retail buyers. Kimhaie

Figure 3: An example of vr showroom wall (scan QR code to check detail info

has developed the largest digital fabric bank for suits in the world which facilitates and speeds up product design and development. Now, Kimhaie is more competitive in the global market. Instead of passively waiting for orders, Kimhaie people are more confident and actively searching for chances to expand the market.

Kashion has annual sales of 2 billion RMB with its majority of clients from European countries. Digitalization poses a challenge to traditional businesses like Kashion. Unlike Kimhaie, actively seeking more efficient operation through digitalization, Kashion was pushed to move to digitalization. Many of Kashion's clients have already used digital technologies in their supply chain management. According to Kashion's PR manager, "*It is very hard to switch from the traditional operational way to this new model because of the learning curve. Employees are not willing to make an effort to learn and take extra steps in creating virtual models for design and prototyping. Initially, everything was slow and hard, however, with five years of accumulation, we have developed more than 30,000 styles that can be used to create products easily. Now our designers can easily find a template to design or develop new product lines.*

Also, with all these accumulated digital assets, we can easily provide product styles at a multiplier level". Kashion also gained competitiveness because of speed with the adoption of the Style3D system. This company believes its gained competitiveness will be lasting because its transformation with the adoption of Style3D is systematic across its whole supply chain.

The interviewed companies are not big, but the adoption of Style3D increased their competitiveness in the global market. However, adoption is challenging with a learning curve. Fashion technology providers might want to work on reducing the barriers for more companies to adopt, join, and eventually create a broadly connected and shared fashion metaverse so that even small or micro fashion businesses can develop their competitiveness efficiently.

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