

Exploring Circular Business Models and Digital Technology Adoption in the Sardinian Textile Sector: A Multiple-Case Study Approach

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Abstract

The textile sector faces significant sustainability challenges, prompting firms to innovate their business models and transition towards circular business models (CBMs). Digital technologies may support this transition through improved traceability, resource management, and production processes. The literature focused on larger firms and overlooked those practices in Micro-Small Enterprises (MSEs). With the aim to fill this gap, this study explores how circular practices are integrated into the BM of Sardinian textile sector firms (mainly composed of artisanal MSEs) as a key component of their sustainability transition and the role of digital technologies in supporting these processes. Using a multiple-case study approach, the research analyses four firms operating within a traditional artisanal textile context characterised by strong territorial embeddedness. The results show that circularity is implemented unevenly, with slowing and narrowing strategies more developed than closing one. Firms combine traditional production logics with selective technological innovation, generating hybrid configurations that balance cultural preservation and production efficiency to achieve sustainability. In this context, digital technologies play an enabling role without radically transforming their BM. The study contributes to the literature by showing how sustainability transitions within artisanal MSEs are shaped not only by technological capabilities but also by relational, cultural, and organizational factors embedded within local production systems.

Keywords: Textile industry, sustainability, circular economy, digital technologies, micro-small enterprises.

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1. Introduction

In recent years, increasing attention has been devoted to the need to address environmental and climate challenges by steering firms towards sustainability. International agreements such as the United Nations Sustainable Development Goals, the Paris Agreement, and the European Commission's climate strategies for 2030 and 2050 (European Commission, 2021; United Nations, 2015 a,b) have strengthened the global commitment to sustainability and encouraged firms across industries to adopt more responsible production and consumption practices. The textile industry is widely recognized as one of the most environmentally intensive sectors, due to its high consumption of water, energy, and raw materials, as well as the large volumes of waste generated throughout its value chain (Parnell et al., 2025). Given these environmental impacts, firms operating in the textile industry are increasingly required to develop a sustainable business model (SBM) (Bocken et al., 2014; Cantele & Zardini, 2018; Schaltegger et al., 2012). The concept of the SBM has emerged as a useful approach for implementing corporate sustainability by integrating economic, environmental, and social value creation (Lüdeke-Freund, 2010). SBMs aim to redesign traditional BMs so that firms generate value not only in economic terms but also through positive environmental and social outcomes. Among the different approaches used to pursue firms' sustainability, the circular economy (CE) has gained increasing relevance as a framework for redesigning production and consumption systems through practices of reduction, reuse, and recycling (Urbinati et al., 2017). Circular business models (CBMs) provide the operational foundation for implementing CE principles, enabling the extension of product life cycles and the minimization of waste (Bocken et al., 2016). In this study, following Geissdoerfer et al. (2018) and Bocken et al. (2016) CBMs are considered as a specific configuration of SBM focused on CE strategies and to pursue economic, environmental and social value creation. In the textile sector, CE strategies mainly involve extending product lifetimes through reuse and repair practices, as well as recycling products and materials (Kirchherr et al., 2017). These approaches correspond to the CBM mechanisms of narrowing resource loops through more efficient resource use, slowing resource loops by extending product lifetimes, and closing resource loops through recycling and material recovery processes (Bocken et al., 2016). Within the perspective of the twin transition, the use of different technologies such as cloud computing, social manufacturing, artificial intelligence (AI), Internet of Things (IoT), or blockchain technology (BCT), known as industry 4.0, is

recognized as a key enabler of CE in businesses (Wiegand and Wynn, 2024). The use of industry 4.0 improves product traceability, resource monitoring, demand forecasting, and communication among supply chain actors (Yu et al., 2022). This means that digitalization may facilitate the development of CBMs by enhancing firms' ability to manage circular practices more efficiently and coordinate sustainability-oriented processes. However, the implementation of circular strategies and the adoption of digital technologies may vary significantly depending on firms' organizational characteristics and resource availability (Schöggl et al., 2023). Larger firms, thanks to greater financial resources, technological capabilities, and organizational structures, are generally better positioned to develop integrated circular models (Linder & Williander, 2015). Accordingly, much of the literature on CBMs has focused on large and technologically advanced firms, often overlooking micro-small enterprises (MSEs) (Reim et al., 2025), which frequently face greater constraints in circular and digital practices (García-Quevedo et al., 2020; Ferasso et al., 2023). This gap appears particularly relevant in sectors such as textiles, where small-scale firms represent 99.5% of European enterprises (European Commission, 2022) and where, especially in more traditional contexts, production systems are frequently characterized by artisanal firms deeply embedded in local territories (Ferasso et al., 2024).

Starting from these assumptions, this study aims to explore how circular practices are embedded within the BMs of artisanal MSEs and how these firms approach digital transition processes in support of circular practices. In addressing these two questions, the study pursues the broader objective of understanding how circular transitions unfold in traditional, artisanal-based production systems that differ structurally from the large firms on which the literature has concentrated. To achieve these objectives, the study adopts an exploratory qualitative approach based on a multiple-case study design (Yin, 2018), analyzing four small-scale artisanal textile firms operating in the Sardinian context. The Sardinian textile sector provides a particularly suitable setting for this study as it is characterized by artisanal MSEs embedded in local traditions and territorial supply chains.

This study contributes to the literature in two ways. First, it provides empirical insights into how circular practices may emerge in artisanal MSEs through bottom-up processes rooted in local knowledge, artisanal traditions, and informal organizational dynamics rather than through formalized strategies. Second, it suggests that digital transition in these firms is an incremental process of facilitation; technologies serve as enablers of coordination rather than drivers of radical structural change, thus preserving

established organizational structures. In this context, circular transitions appear to follow pathways rooted in local culture and artisanal practices rather than formalized innovation processes.

The article is structured as follows: first, a theoretical review on sustainable and circular textiles is presented; this is followed by a description of the research methodology, the analysis of the findings, and a concluding discussion.

2. Theoretical Framework

2.1 Circular Economy in the Textile Sector

The textile sector represents the third most significant manufacturing industry worldwide, after the automotive and technology industries (Jia et al., 2020). At the same time, it accounts for approximately 20% of global water consumption and 10% of global CO₂ emissions (Abbate et al., 2023). The environmental impact of the sector is primarily associated with the use of chemicals in dyeing processes, high energy consumption, and substantial waste generation (de Oliveira Neto et al., 2022). The emergence of fast fashion has further exacerbated this situation by accelerating production and consumption cycles, reducing the perceived value of garments, and increasing textile waste (de Aguiar Hugo et al., 2021).

In response, the European Union has promoted several strategic initiatives, including the New Circular Economy Action Plan and the EU Strategy for Sustainable and Circular Textiles (European Commission, 2020; 2022). These initiatives are grounded in the principle of the waste hierarchy (Directive 2008/98), which prioritizes reduction, reuse, and recycling as the primary “R-strategies” underpinning the CE. The implementation of circular strategies requires substantial investments and significant organizational changes (Furferi et al., 2022), representing a particular challenge for smaller firms (Abdelmeguid et al., 2022). Moreover, the isolated adoption of circular practices by individual firms is insufficient; rather, a transformation of the entire value chain is required (Jia et al., 2020). According to the Ellen MacArthur Foundation (2019), the CE is based on two main dimensions: the biological cycle, which is linked to natural regeneration processes, and the technical cycle, which focuses on reuse, repair, recycling, and regeneration. Reuse is widely considered one of the most effective and accessible strategies, as it enables the extension of material lifecycles while generating relatively low environmental impacts (Ramírez-Escamilla et al., 2024). Repair practices, in turn, enhance the value of traditional craft techniques

and support the growth of second-hand markets (Persson & Hinton, 2023). Recycling, however, often requires complex and costly industrial processes, making it less advantageous in many contexts (Ellen MacArthur Foundation, 2013). Furthermore, recycling may generate materials of lower – or perceived lower – quality, thereby reducing the value of the final product, a phenomenon commonly referred to as downcycling or transformed into products with higher functional, aesthetic, or economic value than the original material (upcycling) (Sandin & Peters, 2018). According to Dissanayake and Weerasinghe (2022) four key strategies for integrating CE principles within the fashion sector can be identified. First, resource efficiency is achieved by using both sustainable raw materials and adopting waste reduction practices. Both strategies imply the reorganization of the productive process and the adoption of innovative technologies and present limited applicability for artisanal MSEs given their structural rigidity and restricted capacity for process reconfiguration (Franco, 2017; Abdelmeguid et al., 2022). Second, circular design, which enables product disassembly and recyclability raises analogous concerns. Artisanal firms with a strong linkage with cultural heritage are constrained in product modification by the need to preserve traditional forms and techniques. Furthermore, the extension of product lifetimes through repair, rental, leasing, or second-hand platforms appears compatible with artisanal productions where durability is intrinsic to the value proposition and repair services constitute a natural extension of the producer's role (Persson & Hinton, 2023). Finally, end-of-life circularity, aimed at recovering value through recycling or regeneration processes also offers concrete opportunities for artisanal firms that may engage themselves in regenerative activity by recovering old goods and refurbishing them into newer, more valuable products (Sandin & Peters, 2018). Adopting circular practices in textile firms requires a relevant effort accompanied by a positive attitude of internal and external actors (Furferi et al., 2022; Abdelmeguid et al., 2022). The relationship between CE adoption and the preservation of artisanal and cultural heritage constitutes a distinctive challenge for artisanal MSEs that have been overlooked by CE literature. Small-scale firms face different challenges and usually selectively adopt strategies (Franco, 2017; Ferasso et al., 2024). Furthermore, locally embedded firms with an artisanal orientation may identify a potential conflict between the need to redesign products and production to align with CE and the need to preserve traditions (Johnson & Schaltegger, 2016). In this sense, it emerges the need to integrate the literature, usually focused on larger-scale firms, by studying CE implementations by MSEs. This study addresses that gap by examining MSEs operating in Sardinia's traditional textile sector.

2.2 Digital Technologies for Sustainability and Circularity

To date, digital technologies are widely implemented by textile firms to support cost and organizational efficiency, lower raw material consumption and reduced waste. According to Abdelmeguid et al. (2022), the lack of CE-oriented technologies is one of the key challenges hampering textile firms in transitioning to CBMs. Digital technologies are expected to play a critical role in promoting CE practices (Wiegand and Wynn, 2024) by supporting recycling and reuse practices pivoting on greater data availability (Alves et al., 2022; Cagno et al., 2021), and fostering collaboration among producers, consumers, and policymakers (Ghoreishi and Happonen, 2021).

Main digital technologies implemented in the textile sector can be broadly grouped into two categories: 1. traceability technologies (e.g., BCT, sensors, IoT) facilitating recycling, reuse, and product life-cycle management, and the verification of sustainability claims (Bressanelli et al., 2022; Akram et al., 2022) supported by real-time access to production and supply chain data (Cagno et al., 2021); 2. communication technologies (e.g., social media) supporting sustainability-oriented communication by enabling firms to interact with customers, promote product transparency, and disseminate information about materials and production processes (Wiegand and Wynn, 2024). Bigger and more technologically advanced firms would also benefit by adopting data-driven technologies (Luoma et al., 2022; Rudisch et al., 2021) and advanced production and fabrication technologies (e.g., computer-aided design – CAD; 3D printing, robotics) to enable more efficient product design and manufacturing processes (Wynn and Irizar, 2023). Despite the potential of these technologies, existing research on digitalisation for CE has mainly focused on large firms, often overlooking smaller-scale firms. Although these firms face significant financial, technological, and organisational barriers to adopting advanced digital solutions (Abdelmeguid et al., 2022), they frequently rely on more accessible technologies to support sustainability and circular practices already embedded within their production systems. In many cases, digital technologies do not drive circularity directly but rather reinforce existing practices rooted in artisanal knowledge, local production traditions, and resource-conscious production logics.

2.3 Circular and sustainable business model

BM framework is commonly used to support organizational change (Osterwalder and Pigneur, 2002, Teece 2010, Richardson, 2008). While the concept has traditionally focused on economic value (Chesbrough and

Rosenbloom, 2002), it has progressively evolved to include environmental and social impacts (Schaltegger et al., 2012), drawing inspiration from the principles of sustainable development, giving rise to the notion of SBM. SBMs integrate BM value perspective and the economic goals with stakeholder needs alongside the environmental and social objectives of the firm (Evans et al., 2017; Stubbs and Cocklin, 2008) and aim to minimize negative impacts of firms' actions while maximizing positive outcomes for both the environment and society (Bocken et al., 2014; Geissdoerfer et al., 2018). Among the frameworks proposed in the literature, the SBM archetypes developed by Bocken et al. (2014) provide a useful analytical lens to identify sustainability-oriented practices within firms' BMs. Following Boons & Lüdeke-Freund (2013), these archetypes can be grouped into three analytical dimensions to facilitate the interpretation of sustainability practices (as shown in Figure 2): technological (energy and material efficiency; value from waste; substitution with renewables and natural processes); social (deliver functionality rather than ownership; adopt a stewardship role; encourage sufficiency); organizational (repurpose the business for society/environment, develop scalable solutions, enabling the replication and diffusion of sustainable innovations). The implementation of these archetypes may take different forms depending on the organizational context. In MSEs, sustainability practices often emerge through informal processes and strong connections with local traditions and territorial networks (Johnson, M.P. & Schaltegger, S. 2016).

CE emerged as a new way to operationalize sustainability by seeking to overcome the traditional linear "take-make-dispose" (Centobelli et al., 2020) model by promoting efficient resource use and the regeneration of materials (Ghisellini et al., 2016). The integration of CE can be observed and guided by a CBM (Geissdoerfer et al., 2018; Bocken et al., 2016) that can be interpreted as a specific configuration of SBM focused on the CE strategies of closing, slowing, and narrowing resource loops to minimize waste and reduce the use of virgin resources. CBMs combine environmental strategies with value creation logics (Nußholz, 2017), extending product lifecycles and closing material loops. Within this perspective, Bocken et al., (2016) identify the three core strategies underpinning CBMs: narrowing (resource efficiency), slowing (product life extension) and closing (recycling and regeneration) loops that serves as the operational foundation to translate CE into their CBMs.

These strategies may support the development of more sustainable production and consumption systems. However, a potential tension in the literature arises. Archetypes and CBM strategies have been developed with reference to large firms, and this justify their analysis in MSEs (Johnson & Schaltegger, 2016;

Franco, 2017). In such a context, sustainable transition follows an informal path based on firms' culture and territorially embedded norms.

2.4 Integrating circular economy, digital technologies and circular business models in MSEs

The transition towards more sustainable production systems increasingly requires the integration of CE principles, digital technologies, and CBM, as described separately in the previous sections. Using a holistic logic, it is possible to identify the relationship between these three elements and to describe the role of the context. CE strategies (narrowing, slowing and closing loops) provide the operational logic (Bocken et al., 2016). Digital technologies act as facilitators since they may support these processes by improving information management, enhancing traceability, facilitating communication among supply chain actors, and enabling more efficient resource monitoring and production planning (Wiegand and Wynn, 2024). Finally, CBM represents the framework to plan the implementation of circular practices in value creation, and capture (Geissdoerfer et al., 2018). However, the adoption of digital technologies and CE practices does not occur uniformly across firms, but depends on organisational and contextual characteristics. While larger firms often develop CBMs through formalised strategies supported by significant technological investments, artisanal MSEs are more likely to pursue circular transitions through informal organisational processes, accumulated knowledge, and territorially embedded values and relationships. For this reason, it is worthy analysing how circular transitions develop in traditional production systems and in MSEs.

Figure 1 - Integrative framework: the mediated development of CBMs through the interplay of digital enablers and CE strategies within the context of artisanal MSEs

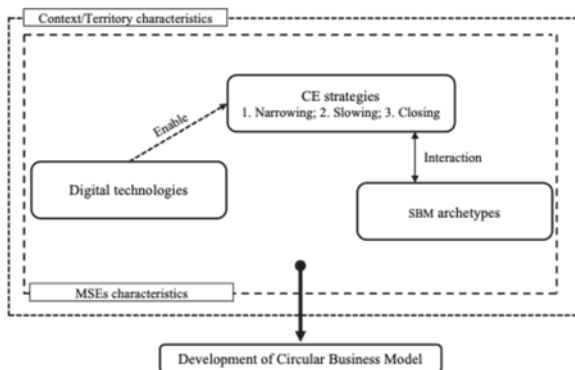


Figure 1 illustrates the integrative framework of the study, showcasing how the development of CBMs is not a standalone process, but is embedded within the specific characteristics of the territory and the MSEs. The framework highlights the enabling role of digital technologies in supporting CE strategies and their interaction with SBM archetypes.

3. Methodology

3.1 *The context of the study*

The textile and fashion sector is highly heterogeneous and, according to the Ateco 2007 classification, includes textile manufacturing industries (division 13), as well as the production of apparel (division 14) and leather goods (division 15). In Sardinia, the sector comprises 842 firms (source: *Telemaco*).

Despite its long-standing artisanal tradition, the Sardinian textile sector plays only a marginal role at the national level. The entrepreneurial structure is predominantly composed of MSEs, with 97% of firms employing fewer than ten workers, and the sector overall generating relatively limited turnover. The sector is distinguished by its strong artisanal character, particularly in the production of carpets, which represent a symbol of Sardinian craftsmanship and excellence. This context makes the Sardinian textile sector a particularly relevant case study for exploring how MSEs can integrate tradition, digital innovation, and CE into BMs to address sustainability challenges.

3.2 *Case study analysis and the cases selection*

To explore the level of circularity among MSEs in the Sardinian textile sector, this study adopts a multiple-case study approach, which is particularly suitable for exploring complex organizational phenomena within their real-life context (Yin, 2018). Data collection, involving four companies, was conducted between January and March 2025, combining semi-structured interviews with company owners or production managers and the analysis of secondary sources (websites, articles, and official documents). For three companies (A, B, and D), site visits were carried out at their production facilities. Each visit lasted approximately two hours, during which three members of the research team conducted the interviews in person. For company C, due to the inability to conduct a site visit, two members of the

research team conducted a telephone interview lasting approximately 45 minutes. The four firms were selected through purposive sampling (source *Telemaco* database) to identify information-rich cases capable of providing insights into circular practices and digitalization processes within the Sardinian textile sector (Patton, 2002). In particular, the selected firms differ in terms of production structure, degree of industrialization, market positioning, and approaches to sustainability, thus allowing for analytical comparison across heterogeneous organizational contexts. The cases were also selected based on their relevance within the regional textile sector, the availability of secondary data, and the willingness of firms to participate in the research (Seawright & Gerring, 2008). To enhance the reliability of the analysis, the study adopted a triangulation approach combining primary and secondary data (Eisenhardt & Graebner, 2007). The integration of multiple sources (interviews, direct observations, and various corporate and press documents) enabled the cross-validation of information, mitigating potential biases and ensuring a comprehensive understanding of the firms’ practices (see Table 1).

Table 1 - Data sources and triangulation across the analyzed cases

Case	Primary Sources (Interviews)	Secondary Sources	Physical/Direct Evidence	Triangulation Objective
A	In-person (Owner) 120 min.	Website, Official docs, Press articles	Site visit (Production facility)	Cross-verify sustainability claimswith observed production processes.
B	In-person (Prod. Manager) 120 min.	Website, Official docs, Social media	Site visit (Production facility)	Match internal docs with managerial discourse on circularity.
C	Telephone (Owner) 45 min.	Website, Official docs, Press articles, Social media	-	Compensate for lack of site visit with extensive secondary data analysis.
D	In-person (Owner), 120 min.	Website, Social media, Press articles	Site visit (Production facility)	Validate digital technology adoption through direct observation.

The semi-structured interviews, transcribed using Transkriptor software, were designed to explore four main areas related to the objectives of the study. First, the interviews investigated the general characteristics of the firms and their BMs, including organisational structure, value proposition, relationships with suppliers and customers, and the main production and distribution processes. Second, attention was devoted to sustainability and CE practices, with reference to environmental initiatives, waste management, reuse and recycling activities, and relationships with stakeholders. Third, the interviews explored the main difficulties related to

the implementation of CE practices. Finally, the interviews examined the role of digital technologies and the influence of regulatory dynamics in supporting circular transitions within the analysed firms.

The interviews were guided by a structured questionnaire that ensured the collection of consistent and comparable data across all cases. Variation in interview duration is attributable to differences in the administration setting, as in-person interviews tended to be longer than telephone interviews. The structure of the interviews allowed respondents to elaborate on firm-specific practices and organisational dynamics while ensuring consistency and comparability across cases.

3.3 Data Analysis and Coding Procedures

The collected information was initially coded into first-order empirical categories closely reflecting the language of the cases (e.g., repair activities, reuse of production scraps ecc.). These categories, combining deductive coding with inductive insights, were then grouped into second-order themes aligned with the analytical framework, namely CE strategies (narrowing, slowing, closing loops), SBM-archetypes, and digital enabling mechanisms. Subsequently, a cross-case comparison was conducted to identify recurring patterns related to circular strategies and the role of digital technologies across the analysed firms. To further clarify the analytical transition from empirical data to theoretical themes, Table 2 illustrates three examples of the coding, showing the transition from the raw data to the final aggregate themes.

Table 2 - Exemplification of the coding and theme development process

Raw Data Extract (Empirical Material)	First-order Code	Second-order Category	Aggregate Theme
<i>“We follow the entire wool collection chain of the shepherds [...] the wool arrives from Sardinia in some cases.” (Case A)</i>	Local raw material sourcing	Supply Chain Territorialization	CBM: Sustainable Sourcing
<i>“If this wears out, we take the needle and redo all the plots [...] it’s an emotional question.” (Case B)</i>	Manual repair and restoration	Product Longevity	CE (Slowing the loop)

<i>“Blockchain would be perfect, but we’re still a long way off.” (Case A); “We should be able to certify the entire process! This is our aspiration (Case B)”</i>	Digital tracking of raw materials	Transparency & Certification	Digital Enabling
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To enhance the reliability of the analysis, coding results were discussed among the research team, and discrepancies were resolved through iterative comparison. This process contributed to improving interpretive consistency and reducing individual researcher bias. Table 3 summarizes the cases’ characteristics.

Table 3 - Firms analysed

	Case A	Case B	Case C	Case D
Label	Luxury handcrafted carpets	Tradition and industrial production	Women's cooperative	Integrated wool supply chain
Founded	1981	1978	1971	1964
Ownership	Family-owned	Family-owned	Cooperative	Family-owned
Employees	11	10	15	10
Turnover (2023)	€500k-€1M	€100k-€500k	€100k-€500k	€500k-€1M
Products	Handmade carpets	Carpets	Carpets, home textiles	Industrial carpets, furnishing textiles
Key feature	Sardinian wool, cotton, silk; luxury segment	Traditional craft + modern equipment; tourist showrooms	Oldest textile org. in Sardinia; all-female; <i>pibiones</i> technique	Only fully integrated supply chain (wool collection to weaving)

4. Results

This section presents the empirical evidence collected during the interviews. For each firm we report, in line with the literature and with the integrative framework (Figure 1) firms’ CE and sustainability practices and their relations with their SBM, digital technology adopted, and the role of internal and external contextual factors shaping these practices. In the following sub-sections, *italics* highlight direct quotations from the

interviews. To allow a cross-case interpretation, Table 3 summarizes the evidence collected that will be discussed in section 5.

4.1 Case A – Luxury Handcrafted Carpets

Company A operates in the upper-middle segment of the artistic textile market, with 90–95% of its turnover generated through exports to Australia, the United States, and Asia. Its value proposition is based on products developed in collaboration with designers, primarily using Sardinian wool.

As the firm's owner said: *“our supply chain is largely controlled internally, from wool collection to spinning. That's why we created a proprietary label certifying the origin and natural quality of the wool used to reduce the use of chemically treated materials”*. The high level of artisanal craftsmanship ensures the durability of the products, which can also be repaired to extend their useful life. The production process generates limited waste, most of which is reused for padding, prototypes, or as material for practical activities during training courses for weavers. Residual waste is handled by specialized waste management companies. Digital innovation is reflected in the introduction of software embedded in machinery for the interpretation of design patterns, as well as in the construction of a new self-sufficient energy facility equipped with advanced technologies, water recovery systems, and photovoltaic panels. In addition, the company launched a project *“aimed at assessing the sustainability of Sardinian carpets by involving the entire supply chain, from the origin of the wool to processing activities, and the traceability of materials”*. However, the company suspended the project *“due to the absence of a certifying body capable of validating the information to be recorded on a blockchain system”*.

4.2 Case B – Artisanal and Industrial Quality Carpets

Company B operates primarily in the domestic market (95% of its turnover), with three showrooms located in tourist areas. *“We collaborate with designers and furniture brands, combining traditional craftsmanship with industrial production processes and mainly using natural materials, favoring Sardinian wool wherever possible.”* In this sense, the interviewee highlighted certain constraints related to the use of natural materials. In particular, *“for furnishing supplies destined for the hospitality sector, regulations require the use of synthetic fire-retardant yarns, thereby limiting the use of more sustainable materials”*. Similarly, the adoption of natural dyes is constrained by the limited availability of specialized suppliers.

Nevertheless, the company enhances the value of natural raw materials through artisanal production processes that generate minimal waste. It also provides repair services for carpets that hold significant sentimental value for customers. In addition, the company has installed solar panels to cover part of its energy requirements. The firm has also expressed interest in implementing blockchain technology: *“Our goal is to implement a digital label that generates a unique certificate for every piece; we see this as an essential step to truly validate and enhance the intrinsic value of our handcrafted products”*. However, the lack of specific technical expertise has delayed the implementation of this initiative.

4.3 Case C – Cooperative Producing Sardinian Carpets

Case C is a historic all-female cooperative producing handcrafted carpets destined for private customers, retailers, and occasionally luxury hospitality facilities. The cooperative operates primarily in the domestic market, benefiting from local tourism demand. The company uses natural materials – such as wool, linen, and cotton – sourced from regional suppliers. Indeed, *“Using local wool isn't just about quality; it's about supporting our economy and ensuring that the Sardinian textile tradition remains a living ecosystem”*

As in the previous cases, the artisanal production process results in limited waste, which is reused for small objects, educational or artistic projects (e.g., rag rugs), and similar initiatives. The cooperative also provides carpet repair services. As stated, *“when a customer brings in an item for repair, we don't just repair a product; we restore a tradition.”* The organization's sustainable orientation is further reflected in the use of eco-friendly packaging and the installation of photovoltaic panels.

4.4 Case D – From Wool to Carpet

Company D integrates the entire wool supply chain and is characterized by a more industrial production structure. The firm operates a facility that encompasses all stages of wool processing, excluding chemical dyeing and sells wool at different stages of processing, including exports to international markets such as India. Concentrating all processing stages within a single facility *“allows us to reduce logistics costs, promote a local circular production model, and minimize environmental impacts, particularly through the recovery of washing water”*. The company operates a water treatment plant and two sedimentation tanks for this purpose. The recovery of wool is central to their mission, as one manager explained: *“Our goal is zero waste across the entire process. Collecting*

surplus wool from farmers is the first step in a responsible chain. Then, within these walls, we ensure that spinning waste is entirely reintegrated into production, while weaving waste is sold for recycling". Consider that in the past, even colored textile waste was transformed into non-woven materials used for road paving". The final products are designed to be durable and repairable. The company has also established collaborations with other industry operators and universities and has filed patents for alternative uses of wool.

The cross-case analysis shows some commonalities and divergence. Firms use and rely on local woods, aims at reducing waste, focus on repair and invested in renewable energy. Two main differences arise: the production structure that is mainly artisanal for case A, B and C while is industrial oriented for case D, and the degree of digitalization that is higher in case A and B when compared to the other. Table 4 allows a comparison of the findings about CE strategies, sustainability practice, productive process and digital technology adopted across the four cases and informs the discussions developed in the next session.

Table 4 - Comparative sustainability and digitalization patterns across the analyzed firms

Dimension	Case A	Case B	Case C	Case D
Production structure	Hybrid artisanal-industrial	Hybrid industrial-artisanal	Predominantly artisanal	Vertically integrated industrial
Sustainability orientation	Territorial identity and natural wool valorisation	Energy efficiency and durability	Cultural preservation and artisanal production	Circular wool valorisation and process integration
Main CE strategies	Slowing, narrowing	Slowing, narrowing	Slowing	Narrowing, closing
Circular practices	Repair, waste reuse, natural materials	Low-waste production, repair	Textile reuse, repair	Water recovery, recycling, insulating panels
SBM archetypes	Renewables, sufficiency, stewardship	Renewables, sufficiency	Sufficiency	Renewables, stewardship
Digital technologies	Digital looms, social media, blockchain interest	Digital looms, social media	Social media	IoT monitoring, social media
Main barriers	Fragmented supply chain	Limited recycling integration	Limited technological capabilities	Scaling circular practices

5. Discussion

Building on the integrative framework outlined in Section 2.4 (Figure 1), this section interprets the cross-case evidence summarized in Table 3. The findings firstly suggest that sustainability practices in the analyzed firms often emerge through traditional production processes and artisanal knowledge rather than through formalized sustainability strategies. This means that sustainability transitions in artisanal sectors may follow bottom-up pathways rooted in tradition, rather than top-down strategic sustainability initiatives typically observed in large firms (Johnson & Schaltegger, 2016). As shown in Table 3, several common sustainability-oriented patterns across the analysed firms emerge, despite differences in production structure and organisational configuration. A first shared characteristic by artisanal oriented firms (A, B, C) concerns the presence of “slow production” models rooted in artisanal traditions, product durability, and local manufacturing practices (Schnatmann et al., 2023). In contrast with the logic of fast fashion, the analysed firms emphasise longevity, quality, and the preservation of cultural value (Abbate et al., 2023). An emblematic example is represented by the Sardinian carpet, whose durability allows product lifecycles that may extend for several decades or even centuries, also supported by repair practices offered by producers. Across the four cases, sustainability is therefore associated not only with environmental performance but also with the production of long-lasting and culturally embedded products. This orientation is consistent with the slowing strategy identified within CE literature (Bocken et al., 2016), as firms prioritise durability and repairability over rapid product replacement.

The cases reveal the role of cultural values and territorial embeddedness which, together with environmental motivations, drive the adoption of slowing strategies, thereby broadening attention beyond the eco-efficiency rationale that typically motivates larger textile firms (Abbate et al., 2023).

Another recurring element concerns the widespread use of natural and locally sourced materials, particularly wool. In all firms, the origin and quality of raw materials are strongly connected to territorial identity and are frequently emphasised through product labelling, communication practices, and relationships with local suppliers and shepherds (Ferasso et al., 2024). The use of untreated or naturally coloured wool further contributes to product durability and recyclability while simultaneously reinforcing brand differentiation and the perceived authenticity of the final product.

Despite these commonalities, firms differ significantly in terms of production structure, degree of industrialisation, and management of

production processes. The comparison reveals the coexistence of heterogeneous organisational configurations ranging from highly artisanal production models to more industrialised and vertically integrated systems.

The analysis also unveils the role of production models: the global of partial orientation toward artisanal production, especially in a territory where the strong cultural heritage gives to those productions artistic relevance, seems to orient firms to a specific set of SMB practices.

Cases A, B, and C maintain a strong artisanal orientation characterised by manual weaving practices, limited production volumes, and a close connection between production activities and local craftsmanship traditions. In these firms, sustainability is strongly embedded within tacit knowledge, artisanal routines, and product customisation. However, the analysis also shows that artisanal production does not necessarily exclude the selective adoption of industrial technologies. Cases A and B, for instance, combine traditional production logic with the use of automatic or semi-automatic looms to improve production efficiency and increase output volumes while preserving product quality and durability. By contrast, Case D represents a more industrialised configuration characterised by vertical integration across the wool supply chain. Unlike the other firms, Company D directly manages multiple stages of wool processing, including washing, spinning, and waste recovery activities.

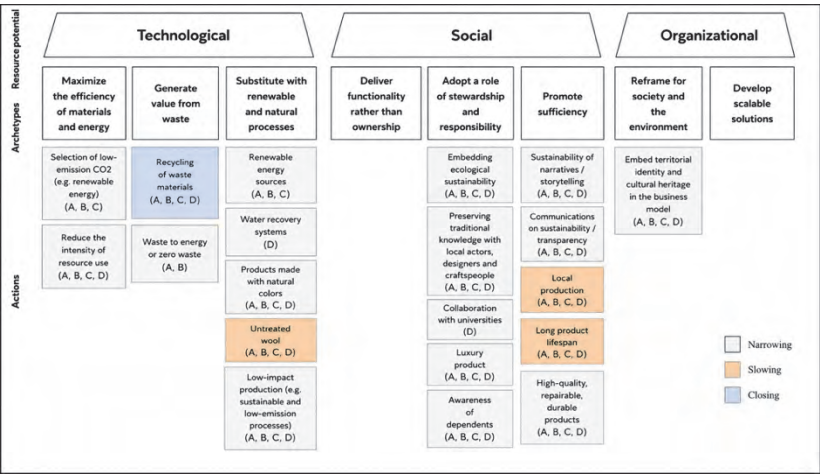
This organisational structure enables greater control over resource flows and facilitates the implementation of more structured circular practices, particularly for water recovery systems, waste valorisation, and logistics optimisation. The practices described above reveal several sustainability-oriented approaches embedded in the firms' BMs. With reference to the first objective of this study, these practices can be interpreted through the SBM archetypes proposed by Bocken et al. (2014) and the CE strategies of narrowing, slowing, and closing resource loops (Bocken et al., 2016).

As shown in Figure 2, the firms' actions mainly revolve around three archetypes (maximise the efficiency of materials and energy, generate value from waste and substitute with renewable and natural processes), two out of three social archetypes (adopt a role of stewardship and responsibility and promote sufficiency), and the organizational archetype "reframe for society and the environment" (Bocken et al., 2014); repair and durability practices, in particular, refer to long product lifespan and high-quality, repairable products.

From a CE perspective, the analysis reveals different levels of maturity in the implementation of narrowing, slowing, and closing strategies across the analysed firms. Among these, narrowing resource loops appears to be the

most consolidated approach. As illustrated in Figure 2, narrowing practices are not limited to technological initiatives aimed at improving resource efficiency, but also extend to social and organisational dimensions through activities related to environmental awareness, stakeholder communication, territorial embeddedness, and the preservation of local cultural heritage. Across all cases, firms pursue resource efficiency through low-waste production processes, limited material losses, and investments in renewable energy systems. Both artisanal and more industrialised production models exhibit relatively high levels of production efficiency, particularly in relation to weaving activities, where waste generation remains limited. Cases B and D, in particular, combine process optimisation with semi-automated production systems and renewable energy adoption, while Case D additionally implements water recovery systems aimed at reducing environmental impacts during wool washing activities. Although less pervasive than narrowing practices, the slowing strategy emerges as the most distinctive characteristic and appears deeply embedded not only in the production logic, but also in the social identity of the firms.

Figure 2 – Cross-case interpretation of circular actions and SBM archetypes (source: our elaboration based on Bocken et al., 2014, 2016, Boons & Lüdeke-Freund, 2013)



Product durability, repairability, and the use of natural materials represent common elements across all cases and contribute to extending product lifecycles. Carpets are frequently conceived as durable products with symbolic and cultural value capable of being preserved and transmitted

across generations. Repair activities, although often managed informally, reinforce this orientation towards longevity and reflect a production culture centred on quality, maintenance, and long-term use rather than rapid replacement. Repair emerges explicitly in firms' interview as a key strategy strictly connected with carpets' tradition (Case C) while wool's recovery is a key part of Case D mission in line with their higher industrial and integrated productive system. By contrast, closing resource loops remains less developed, more fragmented across the analysed firms and confined to the technological dimension. Although several reuse and recycling initiatives are present, these practices rarely assume a fully systemic configuration. The firms adopt different approaches to material recovery. Case A reuses textile scraps for prototypes, promotional products, and secondary applications, while Case D exhibits a more structured approach by transforming wool by-products into insulating panels and redirecting weaving waste towards recycling activities. Nevertheless, these practices remain partially isolated and are not yet integrated into broader circular supply chain systems. This fragmentation is consistent with the barriers to closing loops documented for the fashion and textile sector (Abdelmeguid et al., 2022), which the present cases show to be amplified by the limited scale and relational reach of MSEs. Indeed, the small scale limits the capability of firms to build and maintain relationship through all the supply chain and this issue is amplified by the low density of firms in the territory.

The evidence therefore suggests that artisanal MSEs tend to prioritise slowing and narrowing strategies, which are more compatible with territorially embedded production systems and artisanal manufacturing routines, while more advanced closing strategies appear constrained by limited scale, fragmented supply chains, and reduced organisational and relational capabilities. This confirms that the transition towards fully integrated CBMs remains gradual and uneven within traditional production sectors.

With reference to the second objective of this study, the analysis also reveals that the adoption of digital technologies within the analysed firms remains selective, incremental, and strongly conditioned by organisational structure, managerial orientation, and relational capabilities. Rather than driving radical BM transformations, digital technologies mainly support specific operational and communication activities related to product design, production efficiency, energy monitoring, and customer interaction. Cases A and B appear more advanced in the adoption of digital technologies, particularly through the introduction of digitally enabled looms used for carpet modelling and production customisation. These technologies improve

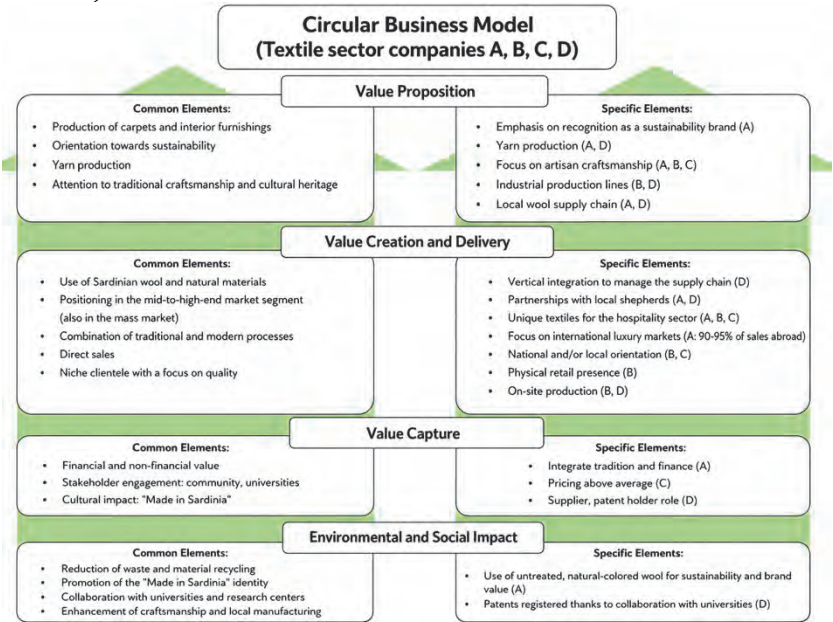
production flexibility and efficiency while remaining compatible with the artisanal identity of the firms. At the same time, all firms make use of social media platforms to support product promotion, communication, and customer engagement, although these tools are rarely integrated into broader sustainability or CE strategies (see Table 2). More advanced digital solutions, particularly blockchain-based traceability systems, remain largely at an exploratory stage. Companies A and B expressed interest in implementing blockchain technologies to strengthen supply chain transparency and communicate sustainability-related information associated with raw materials and production processes. However, no fully operational blockchain systems were identified across the analysed firms. This finding suggests that digital technologies currently play an enabling rather than transformative role within artisanal MSEs, thus partially limiting at this size, the enabling potential attributed to digital technologies in the circular-economy literature (Wiegand & Wynn, 2024), since in MSEs digitalization is limited to isolated areas and does not concur to automatize or change productive processes. Their contribution mainly concerns the support of selected sustainability-oriented activities rather than the systemic reconfiguration of BMs or supply chains. As a consequence, sustainability and CE transitions tend to remain fragmented and partially dependent on external influence. In several cases, firms appear to adopt a cautious “waiting game” approach, postponing more substantial investments in advanced circular or digital systems until clearer regulatory frameworks, stronger customer demand, or broader supply chain transformations emerge (Franco, 2017).

Beyond technological adoption, the analysis further highlights the predominance of informal governance mechanisms in supporting sustainability-oriented practices. None of the analysed firms employs formal sustainability control systems or structured sustainability reporting tools. Instead, sustainability appears to be embedded within owner-manager values rooted in territorial identity (Cases A and D), family and cooperative oversight (Cases B and C), tacit artisanal routines, and territorially embedded cultural norms (A, B, C and D) that shape perceptions of product quality, durability, and responsible production. Sustainability governance, therefore, relies predominantly on informal controls and socially embedded organisational practices rather than formalised performance measurement systems. This configuration, in which cultural and internal controls substitute for the formal planning and controls that dominate larger firms, is consistent with the management control package described by Malmi and Brown (2008).

The analysis also made it possible to identify a shared SBM configuration (where the three BM dimensions are integrated with environmental and social impacts) across the analysed firms, despite differences in production structure and levels of industrialisation (Figure 3). This shared configuration is characterised by a value proposition centred on durable and culturally embedded products, value creation processes rooted in artisanal knowledge and local supply networks, and value capture mechanisms linked to territorial identity, product quality, and the reduction of production waste.

Building on these findings it is possible to develop the theoretical contribution of this paper. The cases shows that MSEs transition to CBM or SBM is not as a deliberate and planned process (Mintzberg & Waters, 1985) rooted in digital technologies as for larger firms, but it relies on informal coordinating mechanism, and it is strongly influenced by organizational culture and territorial values.

Figure 3 – Cross-case interpretation of Circular Business Model (Source: our elaboration)



5.1 Conclusions, implications, limits and future developments

This study contributes to the literature by showing how CE transitions within artisanal MSEs may emerge through bottom-up processes rooted in

artisanal knowledge, local culture, and informal organisational routines rather than through formalised strategies alone. The findings reveal that circular practices are deeply intertwined with territorially embedded production systems and that firms combine traditional production logics with selective forms of technological and organisational innovation, generating hybrid configurations that attempt to reconcile cultural preservation, production efficiency, and sustainability objectives. Within this context, digital technologies mainly play an enabling role, supporting selected operational and communication activities without radically transforming existing BMs or replacing the relational and cultural foundations upon which these production systems are built.

From a managerial perspective, the findings suggest that sustainability transitions within artisanal MSEs require governance approaches that differ significantly from those typically adopted by large firms. In the analysed cases, sustainability is supported less by formal sustainability management systems and more by informal controls, owner-manager values, tacit knowledge, and territorially embedded relationships. This implies that managers operating in traditional production sectors should integrate circular initiatives with local production cultures and existing organisational routines rather than relying exclusively on standardised frameworks.

At the same time, selective and incremental forms of digitalisation appear more compatible with the organisational characteristics of artisanal MSEs than large-scale digital transformation strategies. Technologies such as digital production tools, monitoring systems, and social media platforms appear particularly valuable when they reinforce product traceability, communication, and production efficiency without undermining artisanal identity and production flexibility.

The findings also underline the importance of collaborative networks and supply chain relationships in supporting the implementation of more advanced circular practices, particularly in contexts characterised by limited organisational resources.

In light of these considerations, the study presents several limitations. From a methodological perspective, the research is based on a limited number of exploratory case studies conducted within a specific regional and sectoral context, which reduces the generalisability of the findings beyond similar craft-based settings. In addition, the qualitative nature of the analysis does not allow the measurement of sustainability performance or the quantitative assessment of CE impacts. From a theoretical perspective, the study mainly focuses on the interaction between SBM archetypes, CE

strategies, and digital technologies, while sustainability performance measurement tools remain outside the scope of the analysis.

Future research could expand the sample to include additional firms operating in the textile sector and other traditional manufacturing industries characterised by strong territorial embeddedness. Comparative and longitudinal studies may also contribute to understanding how sustainability transitions evolve over time and how formal and informal governance mechanisms interact in supporting CE and digitalisation processes within MSEs. Future studies could further explore the role of digital technologies in supporting the transition towards more integrated CBMs and assess sustainability practices in relation to emerging best practices within traditional production sectors.

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