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INDUSTRY–ACADEMIA KNOWLEDGE TRANSFER AS AN ENABLING MECHANISM FOR CIRCULAR TRANSFORMATION IN THE MOLDOVAN FASHION SECTOR

Purpose. *This paper develops a sector-specific conceptual framework for industry–academia knowledge transfer capable of supporting the circular transformation of the Moldovan textile and apparel sector. It examines how a university can act not only as an education provider, but also as an innovation intermediary, competence developer, data steward and coordinator of applied experimentation for enterprises operating in a resource-constrained, export-oriented environment.*

Keywords. *circular fashion, knowledge transfer, industry–academia collaboration, circular-design competences, living labs, textile-waste mapping, Republic of Moldova.*

Objectives. The objectives are: (1) to clarify the role of the Technical University of Moldova (UTM) within a proposed circular-innovation ecosystem; (2) to define a practicable university-supported approach to pre-consumer textile-waste mapping; (3) to identify circular-design, digital and entrepreneurial competences that should be strengthened in fashion education; and (4) to formulate a governance and transfer cycle connecting research, teaching and industrial experimentation.

Methodology. The study uses qualitative integrative review, sectoral document analysis and conceptual modelling. It combines previous TUM research on circular-fashion and entrepreneurial competences [1–4], sectoral evidence on the Moldovan light-industry ecosystem [5], and recent research on circular-economy education, collaboration and innovation intermediation [6–10]. Current European skills and product-data initiatives and the 2026 Moldovan draft regulation on textile products and textile waste are used to test the framework against the present policy context [11–14]. The paper proposes an institutional model; it does not empirically measure its environmental or economic impact. Expected effects are therefore formulated as propositions for subsequent pilot validation.

Research results. Circular transformation in textiles is increasingly understood as a coordination and capability problem rather than a recycling problem alone. Recent research emphasises that knowledge-sharing routines, aligned goals and intermediary actors are essential for building circular textile ecosystems [7, 9]. At the same time, the European TCLF Skills Alliance identifies persistent mismatches between education and industrial needs and places green and digital upskilling at the centre of the sector's transition [11]. For Moldova, these challenges are reinforced by the export orientation of the sector, limited internal R&D capacity in many firms and the need to prepare for more demanding traceability, waste-management and product-data requirements [5, 12, 13].

1. From bilateral cooperation to a circular knowledge-transfer ecosystem

A circular transition requires a permanent interface between education, research and industry rather than occasional consultation. Knowledge transfer should be reciprocal: universities translate research and regulatory developments into usable methods, while enterprises bring production constraints, data and unresolved problems into teaching and research. This reciprocal logic is consistent with contemporary work on circular-textile intermediation, which distinguishes brokering, configuring, facilitating and capacitating, and structural negotiating as complementary functions in ecosystem development [9].

Within the proposed Moldovan model, TUM would act as an intermediary rather than as an assumed 'neutral' authority. Its role would be to convene APIUS, participating enterprises and relevant public institutions around defined problems, methods and pilot projects. Credibility would depend on transparent governance: data-sharing agreements, confidentiality rules, ownership of results, intellectual-property provisions, responsibilities for validation and agreed indicators of success. This is important because living-lab research shows that sustained collaboration depends not only on technical expertise but also on coordination, stakeholder commitment, suitable methods and institutional support [8].

2. University-supported textile-data observatory

A practical first step is a pilot observatory for pre-consumer textile flows rather than an immediate claim to create a complete national register. Existing sectoral mapping identifies circularity and resource efficiency as strategic issues, but investment decisions remain constrained by incomplete information on the composition, location, ownership and destination of textile residues [5]. A university-supported observatory could standardise the minimum data fields collected across participating factories and generate an aggregated evidence base for research, industrial symbiosis and future policy implementation.

Factory audits should record mass, fibre composition, colour, contamination, production frequency, ownership or contractual status, current treatment route and potential recovery pathway. Data quality should be checked through documented sampling and material-identification procedures. Commercially sensitive information should remain company-controlled, with only agreed aggregated data used for sectoral analysis. This distinction is important: a research database is not a regulatory register, and student participation cannot substitute for professional verification where legal reporting is required.

The relevance of such data infrastructure is increasing. Moldova's draft Regulation on the management of textile products and textile waste was subject to renewed public consultation in July 2026 and is designed to introduce extended producer responsibility mechanisms [12]. At EU level, sector-specific Digital Product Passport requirements for textiles are planned under the Ecodesign for Sustainable Products framework for 2027 [11]. Although production-waste mapping and product passports are different instruments, both increase the strategic value of reliable, structured and interoperable material data.

3. Circular-fashion competences as preventive innovation

Curriculum transformation is the second transfer mechanism. Previous UTM research found a comparatively high level of general sustainability awareness among students, but awareness must be converted into operational competence [2]. Recent research on fashion-design education similarly shows that circular-economy principles require deliberate integration into curricula and design practice rather than treatment as an isolated sustainability topic [6].

Five competence areas are particularly relevant. First, material selection should balance durability, performance and realistic recovery routes; mono-material design may be advantageous where functionally appropriate, but it should not be treated as a universal rule. Secondly, design for longevity, repair and disassembly should be integrated into construction decisions [15, 16]. Thirdly, low-waste pattern development and marker optimisation should be taught together with material-efficiency metrics. Fourthly, three-dimensional prototyping can reduce physical sampling when embedded in a disciplined development workflow, although digitalisation should not be presented as impact-free by default. Fifthly, students need data literacy: basic life-cycle thinking, material-flow analysis, traceability and the ability to structure product and material information for emerging digital systems.

These priorities align with the current European skills agenda. The TCLF Skills Alliance brings together industry, education providers, research organisations and public authorities and aims to support upskilling and reskilling

across the ecosystem, including green and digital competences [11]. Completed European initiatives such as ADDTEX also demonstrate the value of co-created training, industry–education hubs and applied learning formats for the textile sector [14]. Student projects can therefore function as supervised, low-risk innovation pilots, but they should complement rather than replace enterprise R&D and professional engineering.

Table 1 – **Proposed knowledge-transfer framework for circular fashion**

Pillar	University mechanism	Industrial interface	Measurable output
Data & traceability	Standardised waste audits; data stewardship	Pilot factories; APIUS	Validated dataset; coverage and data-quality indicators
Design & skills	Circular-design studios; digital prototyping	Industrial briefs; technical mentors	Tested concepts; documented competence gains
Business & experimentation	Living-lab challenges; mentoring	Local brands; SMEs; exporters	Pilot business cases; implementation decisions
Transfer & scaling	Workshops; toolkits; train-the-trainer	APIUS; public bodies; sector networks	Adoption, replication and repeat participation
Governance	Data/IP rules; ethics; KPI review	All participating partners	Trusted and repeatable collaboration

4. From competences to implementation: a living-lab model

Technical knowledge creates sectoral value only when it can be translated into organisational practice. Entrepreneurial education is therefore relevant not because every student should establish a company, but because implementation requires opportunity recognition, costing, stakeholder negotiation, experimentation and risk assessment [1–4]. TUM's existing entrepreneurship-oriented activities can be adapted to circular-fashion challenges such as repair services, take-back models, traceability prototypes or business cases for the reuse of cutting remnants.

A living-lab format strengthens this approach by placing students, researchers and firms around a real problem and a measurable pilot. Recent higher-education research identifies co-creation, stakeholder networks, coordination and evaluation as central conditions for effective sustainability living labs [8]. A short 'learn–test–measure–transfer' cycle is therefore preferable to isolated seminars: a method is introduced, applied to a defined industrial case, assessed against agreed indicators and then either revised, discontinued or prepared for wider transfer.

International cooperation should support this cycle rather than remain a separate mobility activity. The current European textile skills ecosystem and projects such as ADDTEX provide reusable training resources and examples of industry–education co-creation [11, 14]. For Moldova, the practical objective is to

adapt such resources to local production structures, language, firm size and regulatory conditions.

On this basis, the paper proposes a Circular Fashion Knowledge Transfer Lab within the Faculty of Design at TUM. The Lab is conceived as a lightweight coordination platform, not a separate research institute. Its functions would be to maintain the pilot textile-data observatory, coordinate applied student and staff projects, support circular-design and digital pilots, organise enterprise challenges and translate international knowledge into tested local guidance. Its viability would require an identified coordinator, partner commitments and a small operating budget; without these conditions, the risk is that knowledge transfer remains dependent on short-term projects.

5. Transfer cycle and evaluation

The proposed model follows a six-stage cycle: industrial problem identification; joint definition of data and success criteria; academic analysis and co-design; prototype or educational intervention; industrial testing; and feedback into both company practice and university curricula. This sequence converts collaboration from a one-way dissemination process into an iterative learning system. Recent textile-sector research supports this emphasis on structured collaboration and knowledge-sharing routines as central enablers of circular implementation [7, 9].

Evaluation should distinguish activity from impact. Useful indicators include the number and diversity of participating firms, data completeness and validation rates, the share of student projects converted into industrial pilots, time from problem definition to tested solution, repeat participation by enterprises, curriculum changes generated by industrial feedback and documented adoption of proposed practices. Environmental or economic benefits should be claimed only where they are directly measured—for example, verified waste reduction, material recovery, avoided sampling, reduced processing time or quantified business performance.

Conclusion. The study proposes that industry–academia knowledge transfer can support circular transformation in Moldova when it is organised as a governed, reciprocal and measurable intermediary system rather than as a sequence of isolated educational activities. TUM can contribute through four connected functions: generation of sector-relevant evidence; development of circular-design and data competences; applied experimentation through living-lab methods; and structured transfer to enterprises and curricula. The model is compatible with the current European emphasis on green and digital skills, traceability and cross-sector collaboration, and it responds to Moldova’s emerging textile-waste regulatory

context [11–13]. Its principal limitation is that it remains a conceptual framework. The next research stage should therefore test it through a small number of formal pilot partnerships with APIUS member companies, using baseline data, predefined indicators and post-pilot evaluation of adoption, costs and measurable resource effects.

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