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ADVANCING THE CIRCULAR ECONOMY IN UZBEKISTAN AND OTHER FOREIGN COUNTRIES: DIGITAL INNOVATION, POLICY, AND SUSTAINABLE ECONOMIC DEVELOPMENT

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Abstract

The transition to a circular economy has become a strategic priority for achieving sustainable economic development, resource efficiency, and environmental protection worldwide. Uzbekistan is increasingly recognizing the importance of circular economy principles as part of its broader agenda for green growth, digital transformation, and economic modernization. This study examines the role of digital innovation, government policy, and sustainable business practices in accelerating the adoption of circular economy models in Uzbekistan. The research explores how advanced digital technologies—including artificial intelligence (AI), the Internet of Things (IoT), blockchain, big data analytics, cloud computing, and smart manufacturing—can optimize resource utilization, reduce waste generation, improve recycling systems, and enhance industrial productivity. Furthermore, the study evaluates the existing regulatory framework, national development strategies, and institutional mechanisms that support

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circular economy initiatives while identifying key barriers such as limited technological infrastructure, insufficient investment, inadequate public awareness, and skills shortages. Based on international best practices and Uzbekistan's socio-economic context, the paper proposes policy recommendations to strengthen digital infrastructure, promote green innovation, encourage public-private partnerships, and foster sustainable business models. The findings contribute to the growing body of knowledge on circular economy implementation in emerging economies and provide practical guidance for policymakers, businesses, and researchers seeking to advance Uzbekistan's transition toward a resilient, resource-efficient, and digitally enabled sustainable economy.

Furthermore, The article examines the Circular Economy Platform (CEP) as a digital mechanism for transitioning from a linear model of production and consumption to closed-loop resource cycles. It explores the theoretical foundations of the circular economy, key circular business models, the technological architecture of the platform, and international experience from the European Union, the Netherlands, China, Canada, South Korea, and Germany.

Particular attention is paid to practical models of industrial symbiosis, ranging from the use of fruit pits and seeds in construction materials to the Canadian experience of converting food waste into compost for farmers with government subsidies. The study also analyzes the entrepreneurial upcycling model of @yanawear.uz, which transforms discounted clothing through embroidery featuring national ornaments, as an example of a circular economy startup with high added value.

The paper proposes a Circular Economy Platform (CEP) model, including its financial logic and methodological justification, an implementation roadmap, a pilot case based on the Fergana textile cluster, and a long-term development forecast for Uzbekistan. In addition, the study examines the role of the CEP as a tool for ESG compliance for exporters in the context of the introduction of the

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Carbon Border Adjustment Mechanism (CBAM) and the requirements of the EU Ecodesign Regulation.

Keywords. Circular Economy; Uzbekistan; Sustainable Economic Development; Digital Innovation; Artificial Intelligence (AI); Green Economy; Resource Efficiency; Waste Management; Recycling; Digital Transformation; Internet of Things (IoT); Big Data Analytics; Blockchain; Smart Manufacturing; Sustainable Development; Environmental Sustainability; Green Technologies; Circular Business Models; Public Policy; Industry 4.0.

Introduction

Uzbekistan is making major strides in building a circular economy—a system where waste is turned into resources, materials are reused, and economic growth happens without harming the environment. This shift is being driven by strong government leadership, new laws and institutions, digital tools, and partnerships with international organizations. A circular economy helps Uzbekistan reduce the amount of trash going to landfills, create new jobs in recycling and green industries, save money by reusing materials instead of buying new ones, and cut pollution while protecting natural resources. In late 2024, President Shavkat Mirziyoyev created a new government body called the Agency for Waste Management and Circular Economy Development, which is now in charge of collecting household and industrial waste, running recycling programs, and managing special waste like electronics, construction debris, and mining waste. The country is also introducing Extended Producer Responsibility (EPR), a system that requires companies to take responsibility for their products even after they become waste—for example, oil companies must recycle used oil and electronics makers must collect and recycle old devices. The government has set clear national targets to reach by 2030: recycle 60% of all waste, get 54% of energy from renewable sources like solar and wind, cut the number of landfills in

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half, and reduce plastic waste by 60%. To make this happen, Uzbekistan is using digital tools like the "Toza Makon" electronic billing system, which now serves more than 23 million people and makes it easier to track waste collection services and payments.¹

The country is also building 11 waste-to-energy plants with investors from China, the UAE, and South Korea—these facilities will burn trash safely to generate electricity, process up to 5.5 million tons of waste per year, and produce about 2 billion kilowatt-hours of electricity annually. At international meetings, Uzbekistan has proposed building a regional digital platform that uses artificial intelligence to track waste and recycling in real time across Central Asian countries, helping governments and businesses see exactly where materials are going and how much is being recycled. New programs are being tested to encourage people to return bottles and glass for a small deposit, and to turn food and fuel waste into useful materials like compost or biofuel. Uzbekistan is working closely with international partners including the Asian Development Bank (\$60 million for city waste management), the United Nations (help with green economy policies and emissions trading), and the European Union (support for sustainable textiles).

Recent infrastructure projects include cleaning up and closing 27 landfills in 2024 with plans to turn some into recycling centers, opening the first medical waste-to-energy plant in Tashkent in 2025, and building a large facility in Navoi to handle dangerous industrial waste. All of this fits into the national Green Economy Strategy 2019–2030, which focuses on growing the economy without increasing pollution, using resources more efficiently, and building a modern waste management system that prioritizes recycling. Despite this progress, challenges remain: current recycling rates are below 10% (much lower than in developed countries), some old technologies and weak enforcement slow

¹ <https://gov.uz/en/sanitation/news/view/88380>

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progress, and more investment and public awareness are needed. The government has declared 2025 the Year of Environmental Protection and Green Economy, showing how serious it is about this transformation. By combining new laws, digital tools, foreign investment, and public participation, Uzbekistan is laying the groundwork for an economy that grows sustainably while protecting the environment for future generations.

1.1. Research Methodology

This article represents a conceptual-analytical study that combines several methodological approaches. The research is based on the following methods.

Desk Research and Systematic Literature Review. The study analyzes publications by the OECD, World Bank, UNEP, Ellen MacArthur Foundation, and the European Environment Agency, as well as peer-reviewed articles published in journals such as Construction and Building Materials, Waste, and Resources, Conservation and Recycling during 2019–2025.

Comparative Analysis. The study examines and compares circular economy policies, programs, and platform-based solutions in six countries and regions (the European Union, the Netherlands, Canada, China, South Korea, and Germany) using a unified set of criteria: regulatory framework, government incentives, digital infrastructure, and measurable outcomes.

Industrial Symbiosis Benchmarking. Documented cases of industrial symbiosis, including Kalundborg Symbiosis, Rotterdam Circular Hotspot, and Tianjin Eco-City, are analyzed to identify the systemic factors contributing to their success and assess their applicability to the conditions of Uzbekistan.

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Analytical Modeling (Conceptual Financial Model). A three-scenario financial model for the Circular Economy Platform (CEP) is developed based on market data on secondary raw material prices and the experience of comparable platforms. All parameters are estimates, and the methodological limitations of the model are discussed in Section 8.

Analysis of Open Data and the Regulatory Framework of Uzbekistan. The study examines official statistics from the National Statistics Committee of the Republic of Uzbekistan, regulatory acts of the Cabinet of Ministers of the Republic of Uzbekistan, publicly available data from the Uzbekistan Republican Commodity Exchange (UZEX), and information from the Waste Management Agency for 2023–2025. This analysis helped identify a structural gap—the absence of an integrated system for accounting for and ensuring public visibility of industrial waste—which represents a key barrier to the development of the secondary raw materials market.

Entrepreneurial Case Analysis. The study examines the existing upcycling business model of @yanawear.uz as a primary field case based on the author's practical experience. The case demonstrates the potential reproducibility of circular business logic at the level of small and medium-sized enterprises (SMEs).

Research Limitations. The study is conceptual and analytical in nature and does not include primary field research based on a representative sample of enterprises. The financial model is an estimated calculation and requires empirical validation during the pilot implementation stage. Some statistical data on Uzbekistan available in open sources are accompanied by qualifications regarding their preliminary nature.

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2. Theoretical Foundations of the Circular Economy

The circular economy is an economic development model in which materials, products, and resources retain their usefulness and value for as long as possible. Unlike the linear economy, in which a product becomes waste after use, the circular model seeks to extend product lifecycles, restore components, return materials to production processes, and minimize resource losses.

According to the **Ellen MacArthur Foundation**, the circular economy is based on three fundamental principles:

- (1) eliminating waste and pollution at the design stage;
- (2) circulating products and materials at their highest possible value; and
- (3) regenerating natural systems. These principles form the foundation of a new industrial logic in which environmental sustainability becomes an integral component of economic efficiency.

It is important to emphasize that the circular economy is not limited to waste recycling. A higher level of circularity includes repair, reuse, product redesign, industrial symbiosis, rental and sharing models instead of ownership, product-as-a-service models, and digital product passports.

2.1. Comparison: Linear vs. Circular Models

Linear Economy	Circular Economy
Raw materials are extracted, used, and discarded.	Raw materials are continually cycled back into the economy.
Profits depend on the volume of new goods sold.	Profits are generated through services, maintenance, and reuse.
Waste is an inevitable byproduct.	Waste is treated as an economic resource.
Supply chains lack transparency.	Data and traceability drive resource management.
Environmental damage is treated as an external cost.	Ecological impacts are internalized within the business model.

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3. Circular Economy Platform: Concept and Architecture

A Circular Economy Platform (CEP) is a digital infrastructure that facilitates the accounting, exchange, processing, and reuse of resources across market participants. Operating much like an industrial marketplace, its inventory comprises physical material streams: surplus raw materials, production scrap, construction debris, textile trimmings, agro-waste, electronic waste, packaging, metals, plastics, and glass.

The primary value proposition of the platform is closing the information gap. Where one enterprise views waste as an operational expense, another sees it as cost-effective feedstocks. Without a digital coordination mechanism, these parties rarely connect. A CEP bridges this divide via resource cataloging, quality standardization, supplier rating systems, digital transactions, predictive analytics, and integration with regulatory oversight.

3.1. Functional Modules of the Platform

- **Participant Registration Module:** Profiles for manufacturers, recyclers, logistics providers, state agencies, and green investors.
- **Resource Catalog:** Material classifications, volumes, quality grades, geolocation, generation frequencies, and storage requirements.
- **Matching Engine:** Automated algorithmic pairing of buyers and recyclers based on material type, logistics proximity, pricing, and technical specifications.
- **Logistics Module:** Dynamic route optimization, cargo consolidation, delivery cost estimation, and carbon footprint tracking.
- **Analytics Module:** Predictive forecasting of volumes, pricing trends, demand shifts, raw material savings, and aggregate ESG impacts.
- **Reporting Module:** Generation of ESG reports, Digital Product Passports (DPPs), and compliance filings for regulatory bodies.
- **Financial Module:** Fee structures, SaaS subscriptions, secure escrow transactions, deal insurance, and green financing integrations.

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3.2. Proposed CEP Model for Uzbekistan

Model Component	Description
Objective	Build a digital marketplace for secondary resources and reduce material waste across key domestic industries.
Participants	Industrial enterprises, recyclers, logistics providers, construction firms, farmers, upcycling startups, state bodies, and investors.
Pilot I	Textiles and construction in Tashkent, the Fergana Valley, and designated industrial zones.
Pilot II	Agri-food sector: juice processing plants -> secondary raw materials (fruit pits, pomace) -> construction materials and biofertilizers.
Revenue Streams	2%–5% transaction commissions, SaaS subscriptions, premium analytics, ESG certification services, and integrated logistics fees.
Key KPIs	Tons of materials circulated, transaction volume (USD), waste diversion rate (%), net CO2 abatement, and active user base.
Long-Term Vision	A national resource-efficiency platform serving as Central Asia's regional circular economy hub by 2040.

4. Circular Economy Business Models

The OECD categorizes circular business models into five core types: circular supply, resource recovery, product life extension, sharing models, and product-service systems. In a platform ecosystem, these archetypes integrate into a single environment where participants deploy value-creation strategies suited to their operations. For a CEP, a hybrid model is optimal—combining transaction commissions with business subscriptions, analytical reporting, ESG certifications, and logistics routing.

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Model	Core Concept	Application in Uzbekistan
Circular Supply	Replacing virgin inputs with bio-based or fully recyclable alternatives.	Recycled cotton fiber, secondary polymers, organic biofertilizers.
Resource Recovery	Extracting usable materials and energy from waste/byproducts.	Fabric trimmings, PET flake, scrap metal, crushed concrete waste.
Product Life Extension	Prolonging usage cycles through repair, remanufacturing, and resale.	Upcycling deadstock apparel with embroidery (@yanawear.uz model).
Sharing Model	Shared access to underutilized assets over individual ownership.	Shared rentals for agricultural and construction machinery; shared warehousing.
Product-Service System	Delivering performance/utility via service contracts over asset sales.	Equipment-as-a-Service, machine leasing, performance contracts.

4.1. Case Study: Upcycling as a Circular Business Model — @yanawear.uz

A practical implementation of the Product Life Extension model within the fashion sector is demonstrated by the entrepreneurial venture @yanawear.uz. The operational premise involves acquiring unsold, seasonal deadstock apparel and transforming it into unique, high-margin garments through traditional Uzbek hand-embroidery.

This model achieves multiple strategic outcomes: it diverts unsold apparel inventory from landfills, creates culturally distinctive consumer goods, unlocks export opportunities via authentic branding, and captures healthy margins without the capital expense of manufacturing virgin fabrics.

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The global upcycled fashion market was valued at \$8.5 billion in 2024 and is projected to reach \$20.6 billion by 2034, expanding at a CAGR of 9.2% (Precedence Research, 2025). Major industry players—such as Chanel (via its L'Atelier des Matières deadstock initiative) and Germany's Re-Fresh Global—are investing heavily in circularity. According to WRAP (UK, 2024), repair, resale, rental, and upcycling models are fundamental to scaling circularity within textiles.

The @yanawear.uz model aligns with these global trends while leveraging cultural heritage as a market differentiator. Within a CEP, such startups act as 'anchor demand drivers': they provide steady demand for surplus inventory, generate predictable waste-diverting processing flows, and validate the business case for other textile manufacturers.

5. Industrial Symbiosis: Inter-Enterprise Collaboration Models

Industrial Symbiosis (IS) is an operational framework where the byproducts or waste of one enterprise serve as primary raw materials for another. More than simple recycling, it is a structural integration of manufacturing loops focused on maximizing resource utilization and eliminating landfill disposal. IS represents one of the most commercially attractive pillars of the CEP, generating direct cost reductions and new revenue for all participating parties.

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Sector / Byproduct	Secondary Application	Economic & Environmental Impact
Cherry and apricot pits (Juice processing)	Lightweight organic aggregate for non-structural concrete products (up to 25% by volume).	Lighter structural weight, up to 20% lower embodied CO ₂ , new revenue stream for processors.
Food waste (Restaurants, wholesale markets)	Industrial composting and organic biofertilizers for agricultural use (Canadian model).	Reduced landfill volumes, new municipal revenue, state subsidy eligibility, soil regeneration.
Textile offcuts and deadstock apparel	High-value upcycling incorporating national embroidery.	Reduced textile waste, export growth, high value-add cultural branding.
Coal fly ash and slag (Thermal power plants)	Clinker replacement in cement manufacturing (Supplementary Cementitious Materials — SCMs).	15%–30% lower cement production costs, reduced industrial emissions.
Agricultural residues (Straw, seed meal/cake)	Biogas production, composting, and solid heating pellets.	Enhanced farm energy independence, significant reduction in methane emissions.

5.1. Fruit Pits as Aggregate in Concrete Formulations

A compelling opportunity for industrial symbiosis in Uzbekistan lies within commercial fruit and juice processing plants. Annually, these operations generate thousands of tons of stone fruit pits (cherry, apricot, peach, plum)—materials traditionally discarded in landfills or incinerated.

Empirical studies confirm that processed fruit pits can serve as sustainable, lightweight organic aggregates in cementitious composites. Research by Zwicky (Construction and Building Materials, ScienceDirect, 2022) revealed that substituting traditional gravel with cherry and grape seeds at up to 25%

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replacement levels provides sufficient compressive strength for non-structural, lightweight construction applications (such as partition panels, thermal insulation blocks, and architectural elements) while lowering aggregate dead load. (Structural applications require further engineering validation). Similar findings were published by D'Eusanio et al. (Waste, 2023) for apricot, peach, and plum shells, recommending them as sustainable aggregates for acoustic, thermal, and non-load-bearing applications. A review in PMC (2025) affirmed that properly conditioned agricultural byproducts—including palm kernel shells, coconut shells, date stones, and stone fruit pits—meet relevant building material specifications while reducing concrete manufacturing carbon emissions by up to 20%.

Deployment Scheme for Uzbekistan: Juice Processing Facility (Pit Supplier) -> CEP Platform (Logistics, Grading, Matching) -> Concrete/Precast Manufacturer (Aggregate Offtaker) -> Reduced Concrete Production Costs + Additional Plant Revenue + Waste Diverted from Landfills.

5.2. Food Waste -> Compost -> Agricultural Inputs: The Canadian Experience

Canada is an established innovator in developing closed-loop food systems via public-private partnerships (PPPs):

ReFeed Canada & 'Circular Nutrition' (est. 2020): Diverts commercial food surpluses by grading edible fruits and vegetables for food banks or dehydrating them into shelf-stable foods. Inedible portions are converted into livestock feed, while remaining organic residues are fed to commercial vermiculture farms to yield organic soil bio-amendments. In its inaugural operating year, ReFeed

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diverted 2.7 million kg of organic waste from regional landfills (Smart Prosperity Institute, 2021).

Cowessess First Nation Project (Saskatchewan, Canada): Partnering with biotech firm B-Nature Biotech, this initiative secured \$855,000 in funding from PrairiesCan in 2026. The funds support an accelerated industrial composting installation that transforms community food waste into nutrient-dense compost for greenhouses and agricultural soils, with operations slated for 2027 (EastFruit, March 2026).

Key Takeaways for Uzbekistan: The public sector provides targeted grant capital, private logistics firms manage aggregation and processing, and agricultural producers secure lower-cost organic fertilizers. This operational framework can be replicated across regional markets in Tashkent, Samarkand, and Fergana.

Under the Canadian Agricultural Partnership, matching funds assist farms implementing anaerobic digestion and advanced composting. Data from the Organic Agriculture Centre of Canada (2025) indicates that an Alberta greenhouse operator saved \$40,000 annually by converting crop residues into onsite biofuel, while a regional dairy operation secured an extra \$25,000 per year by using an anaerobic digester to produce power and livestock bedding from animal manure.

6. International Circular Economy Implementation

Global precedents indicate that circular transformation accelerates when three elements align: public policy frameworks, economic incentives, and shared digital infrastructure.

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Country / Region	Core Policy Mechanism	Representative Program	Strategic Insight for Uzbekistan
European Union	ESG mandates, Ecodesign standards, Digital Product Passports (DPPs).	Circular Economy Action Plan; EU Ecodesign Regulation.	Institutionalize secondary material standards and supply chain transparency.
Netherlands	Construction-sector industrial symbiosis; 2050 circularity roadmap.	RCA Industrial Symbiosis Platform.	Sector-specific circular roadmaps; scaling recycled concrete aggregates (RCA).
Canada	Food waste upcycling to compost/fertilizers backed by state subsidies.	ReFeed Circular Nutrition; Cowessess First Nation Composting (\$855K grant).	PPP structure: private logistics/processing, government capex subsidies, low-cost farmer inputs.
China	Eco-industrial parks, cross-industry symbiosis, nationwide EPR.	Tianjin Eco-City; Circular Economy Promotion Law.	Embed CEP platforms directly inside industrial zones and regional textile clusters.
South Korea	Digitalized lifecycle tracking, e-waste processing, statutory EPR.	Extended Producer Responsibility Act; Smart Waste Management System.	End-to-end e-waste tracking; statutory recycling quotas for electronic importers.
Germany	Automated textile upcycling and biotech conversion plants.	Re-Fresh Global (waste -> bioethanol, nanocellulose, non-wovens).	High-tech textile conversion hubs for the Fergana textile industrial cluster.

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6.1. The Netherlands: Construction Industrial Symbiosis & Recycled Aggregates

The Netherlands is a leader in construction-sector circularity. A University of Twente study (ScienceDirect, 2021) regarding Recycled Concrete Aggregates (RCA) revealed that digital platforms and structured symbiosis enable supply chain participants to negotiate input transactions dynamically in real time. Targeted state fiscal incentives substantially increase project margins. The country maintains a binding national target to achieve a 100% circular economy by 2050.

6.2. Germany: Next-Generation Textile Upcycling Hubs

German firm Re-Fresh Global has pioneered 'smart micro-factories' for textile upcycling. Collected post-consumer garments are sorted by optical systems according to color and fiber composition. A patented biotechnology process converts these low-grade textiles into three high-value industrial inputs: bioethanol, nanocellulose, and non-woven fibers for use across the automotive, construction, and apparel sectors (WEF, 2024).

6.3. CBAM, EU ESG Regulations, and Material Traceability

Beginning in 2026, the European Union's Carbon Border Adjustment Mechanism (CBAM) enters full application, introducing carbon border tariffs on carbon-intensive industrial imports. Concurrently, the EU Ecodesign for Sustainable Products Regulation (2024) mandates transparent material origin tracking and strict ESG compliance across supply chains. For Uzbek textile exporters serving European brands (such as LC Waikiki and Inditex), this creates immediate compliance demands: producers must verify fiber provenance, report scrap generation volumes, and provide certified disposal records.

In this operating environment, the CEP functions as a compliance and export-enablement platform. Features like digital accounting of secondary resource

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streams, automated ESG reporting aligned with ESRS (European Sustainability Reporting Standards), and Digital Product Passports (DPPs) directly lower cross-border regulatory risks for Uzbek exporters. WTO and UNCTAD assessments confirm that suppliers in emerging markets with verified traceability secure preferred supplier status with European retail groups. The CEP addresses both domestic resource efficiency and international market access.

7. CEP Application in Uzbekistan

Uzbekistan possesses the industrial scale needed for a viable CEP. According to the National Statistics Committee, as of July 1, 2025, the country hosts 59,010 industrial enterprises, 27,908 construction firms, and roughly 31,297 commercial agricultural entities. Industrial activity is concentrated regionally: 17.9% of enterprises are in Tashkent City, 10.6% in the Fergana Region, 10.3% in the Tashkent Region, 8.4% in Samarkand, and 8.1% in Andijan. In the textile sector, 66 large enterprises produce directly for major multinational retail brands, representing an annual output capacity exceeding 850,000 metric tons. According to Reuters (2024), Uzbekistan has committed \$1.3 billion to waste-to-energy initiatives designed to process 4.7 million tons of municipal solid waste (MSW) annually and generate 2.1 billion kWh of electricity by 2027. Maximizing these capital projects requires establishing supporting data systems, primary sorting networks, and secondary trading channels.

7.1. Key Sectoral Applications for Uzbekistan

Textiles: Direct B2B matching for fabric offcuts and deadstock; upcycling channels (@yanawear.uz); fiber garnetting and re-spinning into recycled yarn.

Construction: Cataloging of demolition concrete rubble, structural steel offcuts, and timber scrap for recovery, reducing landfill and procurement expenses.

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Agri-Food Processing: Channeling fruit pits from canneries into lightweight concrete aggregate; diverting organic food scrap into subsidized regional composting facilities.

Electronics (E-Waste): Regulated take-back channels, component disassembly, and precious metal recovery to divert toxic materials from municipal dumps.

Plastics & Packaging: Standardized quality grading and open B2B trading for secondary polymers (PET, HDPE, PP).

7.2. Current Corporate Waste Accounting: Market Assessment

Despite substantial industrial activity, Uzbekistan lacks a unified digital marketplace for industrial byproducts and secondary raw materials. Industrial enterprises currently handle waste through four fragmented channels:

Accounting / Sales Channel	Current Operating Model	Identified Systemic Deficit
Internal Enterprise Accounting	Reusable scrap is accounted for internally as production byproducts (semi-finished scrap that has lost primary specifications).	Data remains locked in local ERP systems; zero public visibility for secondary raw material buyers.
UZEX Commodity Exchange	Since June 1, 2024, secondary materials from municipal solid waste must be sold via UZEX (13 regional branches, 800+ brokerages) across two daily sessions.	Operates purely as a trading engine, not a resource registry. Industrial manufacturing waste is not listed automatically; lacks quality specs.
Agency for Waste Management (Est. 2024)	Regulated under Cabinet of Ministers Resolution No. 648 (Oct 16, 2025). Established 200 sanitation and 290 processing facilities; deployed 1,200 specialized vehicles.	The Agency is still scaling operations; an integrated digital registry for enterprise-level industrial waste is not yet online.
Informal Brokers & Intermediaries	Most textile trimmings, construction debris, and agricultural scrap are sold informally through unlisted middlemen.	Opaque cash-based pricing, untracked volumes, inconsistent quality grades, and zero official transaction records.

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The vast majority of the country's ~59,000 industrial and ~28,000 construction enterprises have no public mechanism for listing secondary materials. Scrap fabric from Fergana mills and concrete debris from Tashkent building sites represent unmonetized resource flows operating outside formal markets.

The scale of this untapped potential is clear: Uzbekistan generates roughly 14 million metric tons of municipal solid waste annually, with current recycling rates hovering around 5% (Ministry of Ecology, August 2025). Approximately 25% of this volume comprises paper, plastics, rubber, glass, and textiles; author estimates suggest a structured secondary commodity market could recover over 1 trillion UZS in residual raw material value annually. Crucially, this figure excludes the substantial volumes of industrial and construction scrap, which remain largely unmonitored. Deploying a CEP prioritizes connecting existing waste streams with ready industrial buyers over building new disposal capacity.

7.3. Pilot Scenario: The Fergana Valley Textile Cluster

The Fergana Valley textile cluster—home to more than 13 major vertically integrated textile enterprises—provides an ideal environment for a pilot deployment.

Step 1 — Resource Listing: A spinning-weaving mill in Fergana registers on the platform, listing 12–15 metric tons per month of non-standard yarn trimmings and cut offcuts previously disposed of at a net cost.

Step 2 — AI Matching: The matching engine pairs the listing with two buyers: (a) a design workshop (@yanawear.uz) sourcing inputs for embroidered apparel, and (b) a building materials plant using processed cotton fiber in thermal insulation panels.

Step 3 — Contracting & Logistics: The purchase order is executed through the platform's escrow module. The freight module pools shipments across neighboring mills, lowering transport costs by 30%–40%. The platform collects a 3% transaction fee.

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Step 4 — Value Addition & Export: The design atelier produces an embroidered collection sold internationally with a digital material passport verifying the recycled origin of the fabrics, securing sales from ESG-conscious EU buyers.

Step 5 — ESG Verification: The platform generates verified ESG metrics for the textile mill: total waste diverted, calculated CO2 emissions avoided, and net disposal savings. The mill passes these records to its international retail partners to verify supply-chain sustainability compliance.

8. Financial Model and ROI Projections

The financial model accounts for platform revenues alongside broader economic impacts: reduced virgin material imports, lower waste management costs, and green job creation. Estimates rely on an analytical model using average secondary raw material pricing across emerging markets (OECD, 2023; World Bank, 2024). The baseline assumption (\$70/metric ton) reflects prevailing price bands for recycled cotton fiber and secondary polymers in Central Asia. Modeled throughput volumes (250,000 to 3,000,000 metric tons) are benchmarked against similar platforms in the Netherlands, Turkey, and China across launch, expansion, and mature phases. The 2%–5% transaction fee reflects median industrial B2B marketplace standards (KPMG, 2022).

Key Performance Metric	Conservative Case	Baseline Case	Optimistic Case
Annual Traded Volume (Tons)	250,000	1,000,000	3,000,000
Average Material Value (USD/Ton)	\$50	\$70	\$90
Gross Marketplace Volume (GMV/Year)	\$12.5M	\$70.0M	\$270.0M
Average Platform Fee (%)	2.0%	3.0%	4.0%
Annual Commission Revenue	\$250K	\$2.1M	\$10.8M
Ancillary Revenue (SaaS, Data, ESG)	\$100K–\$300K	\$800K–\$1.5M	\$3.0M–\$5.0M
Estimated Payback Period	4–5 years	2–3 years	1.5–2 years

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9. Strategic Development Roadmap: 2026–2050

Horizon	Core Strategic Initiatives	Target Milestones & Deliverables
2026–2030	Launch sectoral pilot platforms across textiles, construction, plastics, and e-waste; formalize secondary resource grading standards.	Functioning secondary resource exchanges, corporate waste transparency, and standardized enterprise ESG reporting.
2030–2040	Scale coverage across all regional Free Economic Zones (FEZs); integrate with state customs and tax databases; implement mandatory EPR.	Substantial reductions in industrial landfilling, rapid expansion of private recyclers, and widespread green job creation.
2040–2050	Transition into the National Resource Efficiency Platform; integrate Digital Product Passports and enterprise carbon accounting.	Uzbekistan established as the premier circular economy and green manufacturing hub in Central Asia.

10. Risk Management Framework

Risk Factor	Operational Manifestation	Mitigation Strategy
Low Corporate Digital Adoption	Factories lack systematic digital scrap accounting.	Simplified mobile interfaces, guided accounting templates, and onboarding workshops.
Counterparty Mistrust	Uncertainty over scrap material quality and grading.	Supplier rating systems, verified lab testing, and escrow payment processing.
Logistical Friction	High per-ton shipping costs on low-volume scrap batches.	Regional shipment pooling, cargo consolidation, and localized logistics hubs.

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Cross-Contamination of Inputs	Mixed, unseparated waste reduces feedstock value.	Mandatory source-separation protocols and clear feedstock acceptance standards.
Regulatory Ambiguity	Inconsistent definitions for industrial secondary raw materials.	Standardized commodity codes, nationwide EPR frameworks, and digital waste registries.
Recycler Capital Constraints	Recyclers lack capital to upgrade processing equipment.	Preferential green loans, green bonds, R&D grants, and state-backed PPP initiatives.

11. Recommendations and Phased Roadmap

Rolling out the CEP effectively requires a phased approach: launching targeted pilots in sectors with high waste density and clear secondary demand before scaling nationally.

Phase	Timeline	Core Focus Areas	Targeted Deliverables & KPIs
1. Preparation	Months 0–3	Sector selection, pilot zone identification, working group formation, legal structuring.	2 target sectors onboarded; 30–50 industrial enterprise partners.
2. MVP Rollout	Months 3–9	Basic catalog deployment, trade clearing engine, automated matching, logistics module.	1,000+ metric tons of secondary resources cleared through the platform.
3. Pilot Expansion	Months 9–18	Onboarding dedicated recyclers, automated ESG reporting, material quality standards.	Demonstrable cost savings for participants; measurable recurring transaction volumes.

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4. Broad Scaling	Months 18–36	Expansion to all regional industrial zones, state data integration, SaaS subscriptions.	100+ active enterprise clients; 100,000+ metric tons traded annually.
5. National Platform	Years 3–5	Universal Digital Product Passports, EPR integration, zero-carbon export verification.	Millions of tons traded annually; self-sustaining platform profitability.

11.1. Policy Recommendations for the Public Sector

Formulate clear national standards and technical certifications for secondary materials across the textile, construction, plastics, and agricultural sectors.

Enact Extended Producer Responsibility (EPR) regulations for consumer packaging, automotive components, and commercial electronics.

Introduce tax incentives and accelerated depreciation for companies using certified secondary raw materials.

Allocate matching grant funding for regional industrial symbiosis projects, adopting proven international co-investment models.

Mandate digital waste tracking for large enterprises and connect state reporting systems directly to the CEP.

11.2. Strategic Recommendations for Industry

Industrial Manufacturers: Audit all byproduct flows and list scrap materials on the platform to monetize waste streams.

Construction Companies: Test and incorporate verified secondary aggregates and agricultural byproducts into non-load-bearing concrete production.

Agri-Food Processors: Establish supply partnerships with building material firms and compost producers to valorize organic residues and fruit pits.

Fashion Brands & Designers: Expand upcycling operations following the @yanawear.uz model, using cultural branding to build high-margin exports.

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Institutional Investors: Utilize green bonds and PPP models to finance secondary resource processing, sorting, and logistics infrastructure.

Conclusion

A Circular Economy Platform is more than an environmental initiative; it is a foundational digital infrastructure for resource management. For Uzbekistan, a CEP provides a pathway to cut industrial waste, expand recycling capacity, reduce input costs for manufacturers, attract green capital, and increase macroeconomic resilience.

International experience—from Canadian compost co-funding to Dutch construction symbiosis, German automated textile recovery, and South Korean smart e-waste management—shows that circular models are commercially sound. Successful implementation requires aligning public policy, digital platforms, and private enterprise.

Circular frameworks also unlock opportunities for modern entrepreneurs. Ventures like @yanawear.uz prove that secondary inputs can support viable businesses that combine cultural heritage, high profit margins, and export potential. Discarded fruit pits can become aggregate for construction, urban food waste can regenerate agricultural soils, and unsold apparel can be transformed into premium cultural exports.

Uzbekistan has the industrial foundation to establish itself as Central Asia's hub for circular economic development. Realizing this potential starts with immediate steps: launching targeted pilot projects, establishing clear secondary material standards, and fostering collaboration across government, industry, and academia.

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