

## Review Article

# Circular economy as a strategy for economic diversification in Libya

Omar Musbah Awedat Amir <sup>1\*</sup>, Ahmed Jamah Ahmed Alnagrat<sup>2</sup>

<sup>1</sup> Department of Administrative & Financial Sciences, Higher Institute of Science & Technology, Wadi al-Shati, Fezzan, Libya.

<sup>2</sup> Department of Computer Science & Information Technology, Higher Institute of Science & Technology, Wadi al-Shati, Fezzan, Libya.

\* Corresponding author's e-mail: jamah1580538@gmail.com, omeramer665@gmail.com

## ABSTRACT

Libya faces a persistent diversification challenge because national income, public finance, employment opportunities, and external balances remain strongly linked to hydrocarbon activity. This article examines the circular economy as a practical strategy for broadening Libya's non-oil productive base through resource efficiency, waste valorization, repair, reuse, recycling, and circular industrial services. The research problem is that diversification debates in Libya often emphasize broad sectoral expansion while paying limited attention to material flows, municipal waste, construction residues, plastics, agricultural by-products, and idle assets as sources of economic value. The study applies a review article and conceptual policy analysis method based on recent international literature, Libya-focused policy reports, and a structured sector-readiness assessment. The results identify six priority pathways: construction material recovery, municipal waste valorization, plastic recycling, agri-food residue utilization, repair and remanufacturing services, and water reuse. Construction materials and municipal waste show the highest combined potential because they connect large material flows with local enterprise creation and reduced import dependence. The discussion argues that circular diversification in Libya requires coordinated governance, reliable data, municipal pilots, green procurement, finance for small and medium-sized enterprises, and standards for secondary materials. The study concludes that circular economy policies can strengthen diversification only when they are treated as economic development instruments, not merely environmental interventions.

**Keywords:** *circular business models, circular economy, economic diversification, Libya, resource efficiency, sustainable development*

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## INTRODUCTION

Economic diversification is a strategic issue for Libya because the national economy remains highly exposed to oil-sector volatility, public-sector spending cycles, institutional fragmentation, and limited private-sector depth. Recent international assessments emphasize that Libya's outlook continues to be dominated by the hydrocarbon sector and that reforms are needed to diversify the economy away from oil while strengthening fiscal sustainability and private-sector activity (International Monetary Fund, 2025; Alhmoud et al., 2025). In such a context, diversification cannot be understood only as adding new sectors; it also requires a different model of value creation that converts losses, unused resources, and inefficient material flows into productive activities.

The circular economy provides a relevant lens for this challenge. Unlike the linear model of extracting, producing, consuming, and discarding, circular economy approaches seek to retain the value of materials, products, assets, and infrastructure for as long as possible through reduction, reuse, repair, refurbishment, remanufacturing, recycling, and recovery. Global evidence shows that the circular economy is increasingly framed as a development and competitiveness agenda rather than a narrow waste-management issue. The Circularity Gap Report 2024 observes that the global circularity rate decreased from 9.1 percent in 2018 to 7.2 percent in 2023, indicating that policy interest has grown faster than practical implementation (Circle Economy Foundation, 2024). This gap between discourse and implementation is especially relevant to developing and resource-rich economies.

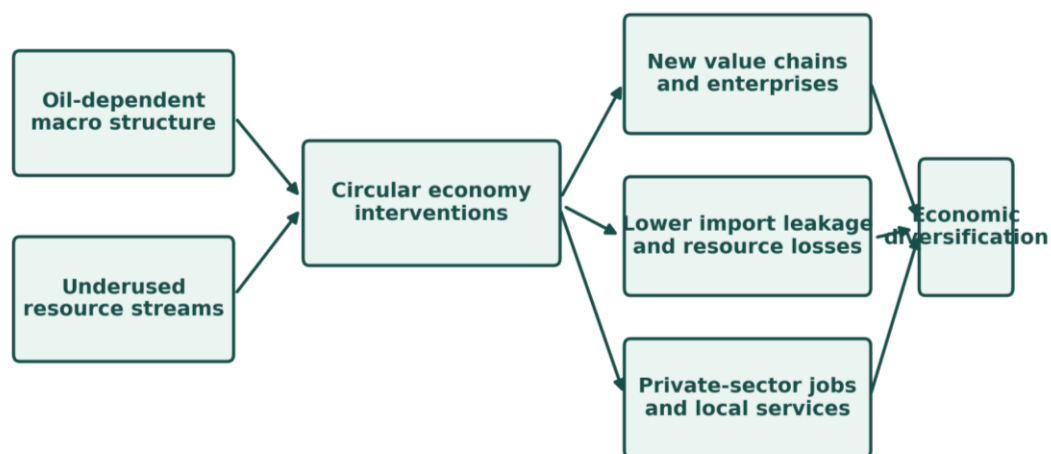
Libya has several resource streams that can support circular diversification. Municipal solid waste, plastics, construction and demolition residues, organic waste, used equipment, water resources, and energy assets are often treated as burdens rather than inputs for local value chains. At the same time, Libya has a need for employment, local services, industrial repair capabilities, municipal upgrading, and reduced import dependence. Circular economy policies can connect these needs by stimulating local recycling enterprises, repair businesses, secondary-material markets, renewable-energy services, composting, construction-material recovery, and public procurement for circular products.

The research problem addressed in this article is that the circular economy is often introduced in Libya mainly as an environmental or municipal service agenda, while its role in economic diversification remains underdeveloped. Existing discussions of diversification tend to focus on agriculture, tourism, renewable energy, logistics, and private-sector reform, but they rarely integrate material-flow analysis, reverse logistics, secondary markets, and circular business models into a coherent national strategy. This creates a policy gap: Libya may invest in waste collection or isolated recycling projects without building the wider economic ecosystem needed to create value, jobs, and industrial capabilities.

The objective of this study is to develop an analytical framework for using the circular economy as a strategy for economic diversification in Libya. The article asks four research questions. First, which circular economy pathways have the strongest potential to support diversification in Libya? Second, what economic mechanisms connect circular practices to non-oil value creation? Third, what institutional and market barriers limit implementation? Fourth, what policy roadmap can support a gradual transition from isolated environmental



projects to a circular diversification strategy? The contribution of the article is the integration of circular economy literature, Libya’s diversification challenge, and a structured sector-readiness assessment into a practical policy framework for implementation.



proposition: circular systems can convert waste, idle assets, and material losses into non-oil economic act

**Figure 1.** Conceptual framework linking circular economy interventions to economic diversification in Libya

## LITERATURE REVIEW

### 2.1 Circular economy as an economic development model

The circular economy has evolved from a waste-management concept into a broader systems approach for transforming production, consumption, and value chains. Contemporary literature emphasizes that circularity is not limited to recycling; it also includes higher-value strategies such as product-life extension, repair, refurbishment, sharing models, product-service systems, and industrial symbiosis (Ellen MacArthur Foundation, 2021; Rashid, 2025). This distinction is important because recycling alone often captures only a small portion of economic value, while reuse, repair, and remanufacturing can preserve labor, embedded energy, technical knowledge, and capital value.

International evidence also shows that circular transitions require policy coordination. The United Nations Environment Programme (2024) argues that business-as-usual waste trajectories impose large economic, social, and environmental costs, while circular waste prevention and management can generate net gains through avoided externalities and new economic activities. Similarly, the GACERE (2024) frames solid waste as a material-flow issue linked to industrial policy, resource efficiency, and value-chain upgrading. These findings suggest that circular economy policies are most effective when waste, industry, finance, procurement, and innovation policies are treated as connected systems.

The economics of circularity is especially relevant to developing economies. Systematic reviews of circular business models in developing countries show that adoption is often constrained by finance, weak regulation, insufficient infrastructure, limited technical



capabilities, and uncertain markets for secondary materials (Ndoka, 2025; Redaputri, 2024). However, these barriers also reveal development opportunities. Local repair systems, micro-enterprises, informal recyclers, and small manufacturing workshops can become part of circular value chains if they are formalized, trained, financed, and connected to quality standards.

## 2.2 Economic diversification and the circular economy in oil-dependent economies

Resource-dependent economies face a specific diversification problem because public spending, external balances, and business cycles are often linked to commodity revenues. Diversification literature argues that oil-dependent countries need to expand tradable and non-tradable non-oil sectors, improve the business environment, develop human capital, and reduce fiscal dependence on hydrocarbon receipts (International Monetary Fund, 2025; Alhmoud et al., 2025). Circular economy strategies can support this goal because they create non-oil activities from local material flows rather than relying solely on imported inputs or large-scale industrialization.

Circular diversification differs from conventional diversification in three ways. First, it begins with resource inefficiencies that already exist in the domestic economy, such as material leakage, landfill dependence, food losses, low repair rates, and inefficient energy and water use. Second, it favors distributed local enterprise creation because collection, sorting, repair, maintenance, and recycling services usually require city-level and regional actors. Third, it can reduce import leakage by replacing some virgin materials, imported spare parts, and new products with secondary inputs and repaired assets. These mechanisms are highly relevant to Libya, where non-oil private-sector development remains constrained by weak financial intermediation and the dominance of public-sector and hydrocarbon-linked activity (World Bank, 2025).

The global literature on reverse logistics also supports this perspective. Bibliometric studies show that reverse logistics and sustainability research increasingly focuses on recycling, closed-loop supply chains, waste reduction, and decision-making systems (Amri, Lamsali, & Rajemi, 2025; Salas-Navarro et al., 2024). For Libya, this implies that circular diversification cannot rely only on end-of-pipe recycling facilities; it needs reverse logistics systems that connect households, municipalities, construction sites, workshops, sorting facilities, manufacturers, and public procurement agencies.

## 2.2 Libya-specific circular economy opportunities and research gaps

Libya-focused evidence indicates that municipal solid waste management remains a critical challenge and an entry point for circular economy policy. A recent systematic review on municipal solid waste in Libya identifies rapid urbanization, inadequate infrastructure, reliance on unsustainable disposal methods, weak treatment capacity, and implementation gaps as major obstacles (Maafa & Badi, 2026). These findings suggest that Libya has not yet converted municipal waste management into a stable circular value chain. However, the same evidence also points to opportunities in waste-to-energy, composting, recycling, and municipal data systems.



Additional Libya-focused development initiatives highlight the growing relevance of circular economy and green transition agendas. A United Nations project on plastic waste in Libya describes solid waste as a major municipal issue and frames plastic recycling as a driver of value creation and diversification (United Nations Office for Project Services, 2024). The United Nations Development Programme has also supported renewable-energy capacity building in Libya as part of a transition from hydrocarbon dependence to cleaner energy systems (United Nations Development Programme, 2024). These initiatives are not sufficient on their own, but they show that circular and green economy topics are becoming part of Libya’s development agenda.

The gap in the literature is not the absence of circular economy concepts, but the lack of a diversification-oriented framework for Libya. Much of the available work focuses on waste problems, renewable energy potential, or general sustainability. Fewer studies connect circular economy pathways to macroeconomic diversification, private-sector development, non-oil value added, local employment, and import substitution. This article addresses that gap by developing a sector-readiness framework and a policy roadmap that link circular systems directly to Libya’s economic diversification challenge.

**Table I.** Analytical synthesis of literature themes relevant to circular diversification in Libya

Theme	Key insight	Relevance to Libya	Representative sources
Circular economy theory	Circularity should prioritize value retention, repair, reuse, refurbishment, and system redesign, not only recycling.	Broadens Libya’s diversification debate from waste disposal to non-oil value creation.	Ellen MacArthur Foundation (2021); Rashid (2025)
Waste and resource efficiency	Waste prevention and circular management can reduce economic and environmental losses.	Supports municipal reform and local circular enterprise creation.	United Nations Environment Programme (2024); UNIDO (2024)
Developing-country barriers	Finance, regulation, infrastructure, capabilities, and markets constrain circular business models.	Explains why Libya needs staged implementation and public-sector coordination.	Ndoka (2025); Redaputri (2024)
Reverse logistics	Closed-loop value chains depend on collection, sorting, return logistics, and decision systems.	Highlights the need for municipal and private-sector reverse logistics in Libya.	Amri et al. (2025); Salas-Navarro et al. (2024)
Libya-specific waste evidence	Municipal solid waste management faces infrastructure, governance, and treatment gaps.	Identifies waste management as a priority entry point for circular diversification.	Maafa and Badi (2026); UNOPS (2024)



## METHOD

This study uses a review article and conceptual policy analysis design. The approach is appropriate because the purpose is not to estimate a single causal coefficient, but to synthesize recent evidence and develop a practical framework that connects circular economy pathways to economic diversification in Libya. The method combines three components: an integrative literature review, a Libya-context diagnostic, and a structured sector-readiness assessment.

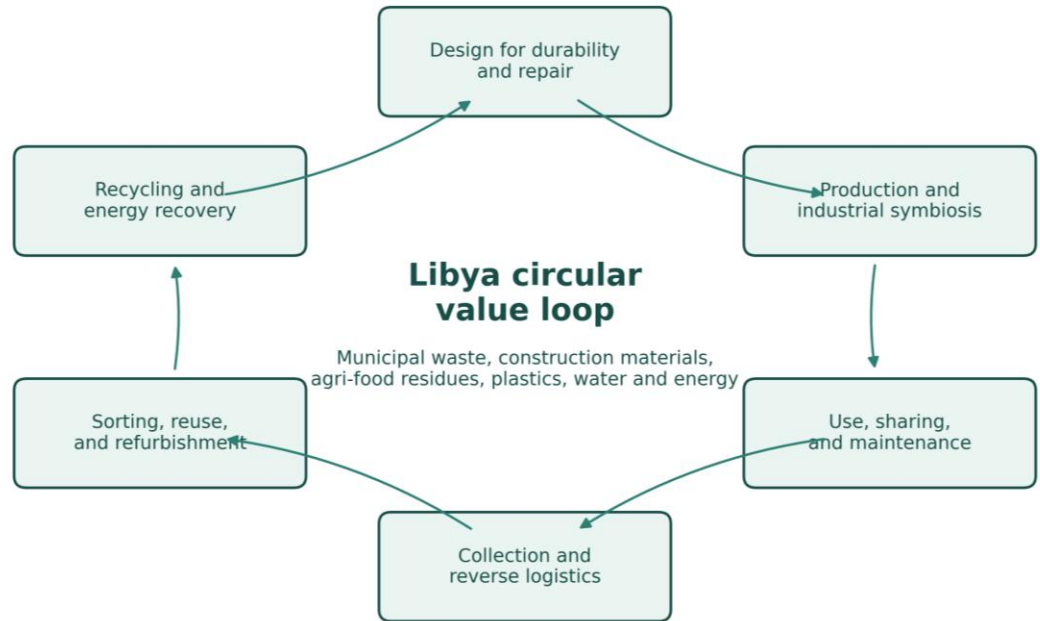
The literature review covered recent peer-reviewed and institutional sources on circular economy, reverse logistics, circular business models, resource efficiency, municipal waste, construction waste, and economic diversification. Priority was given to publications from 2021 to 2026, while older sources were retained only when they provided foundational concepts or authoritative policy evidence. The review included journal articles, systematic reviews, bibliometric studies, international reports, and Libya-focused development sources. Institutional sources were used for macroeconomic context because official and international economic assessments provide the most reliable information on Libya's oil dependence, fiscal exposure, and private-sector constraints.

The Libya-context diagnostic examined the relationship between circular economy opportunities and the national diversification problem. The diagnostic considered six criteria: size of the material stream, feasibility of local value creation, potential for small and medium-sized enterprises, contribution to import substitution, infrastructure readiness, and policy urgency. Each sector was assessed on a five-point scale. The scoring is not presented as official statistical measurement; it is an analytical prioritization tool based on evidence synthesis and expert-policy logic. A score of one indicates low readiness or impact, while a score of five indicates high readiness or impact.

The study then developed a circular diversification framework and policy roadmap. The framework identifies how circular interventions can generate non-oil economic activity through waste valorization, secondary-material markets, repair and maintenance services, local production of substitutes, and public procurement. The roadmap translates the findings into staged actions for 2026 to 2035. These actions include baseline data development, municipal pilots, standards for secondary materials, green public procurement, finance for circular enterprises, skills development, and national monitoring indicators.

The results are evaluated using qualitative synthesis and structured scoring rather than econometric estimation. This is appropriate because Libya lacks consistent public material-flow accounts, municipal waste composition datasets, and firm-level circular economy surveys. The article, therefore, treats data limitations as a methodological issue and proposes future research pathways for empirical validation.





**Figure 2.** Circular value loop proposed for Libya’s resource streams

**Table 2.** Methodological structure of the review and policy analysis

Stage	Procedure	Output
Evidence identification	Review of recent circular economy, reverse logistics, Libya economy, municipal waste, and development sources.	Evidence base for the conceptual framework.
Context diagnosis	Assessment of Libya’s oil dependence, private-sector constraints, municipal waste challenges, and resource streams.	Problem statement and sector selection.
Sector scoring	Evaluation of six pathways using readiness, impact, enterprise potential, import substitution, and policy urgency.	Priority matrix and scorecard.
Framework design	Integration of circular mechanisms with diversification outcomes.	Circular diversification model for Libya.
Policy translation	Development of staged interventions, governance architecture, and monitoring indicators.	Roadmap, policy recommendations, and future research agenda.



**Table 3.** Criteria used in the circular diversification scorecard

<b>Criterion</b>	<b>Definition</b>	<b>Interpretation of high score</b>
Material-flow significance	Estimated scale and visibility of the resource stream in the Libyan economy.	Large material stream with clear economic losses under the linear model.
Local enterprise potential	Capacity to create viable small and medium-sized enterprises and local services.	Many possible enterprises in collection, sorting, repair, processing, or manufacturing.
Import substitution potential	Ability to replace imported materials, parts, services, or products with local circular alternatives.	Secondary materials or repaired goods can reduce import leakage.
Implementation readiness	Presence of technical knowledge, basic infrastructure, and possible pilot sites.	Projects can begin with a moderate investment and available capabilities.
Policy urgency	The degree to which the sector addresses a visible public problem.	Strong alignment with municipal, fiscal, environmental, or social priorities.
Diversification impact	Expected contribution to non-oil value added, employment, and productivity.	High contribution to non-oil activities and local value chains.

## RESULT

The structured review produced four main results. First, circular economy pathways in Libya are most promising when they are connected to existing domestic resource streams rather than designed as abstract environmental initiatives. Second, the highest-priority sectors are construction material recovery and municipal waste valorization because they combine visible material losses, public-sector demand, and potential local enterprise creation. Third, circular diversification requires integration across municipalities, private enterprises, public procurement, finance, technical standards, and data systems. Fourth, the main implementation risk is not technological feasibility alone, but the absence of coordinated governance and reliable market incentives.

The sector-readiness assessment shows that construction materials, municipal waste, plastic recycling, agri-food residues, repair and remanufacturing, and water reuse all have diversification value. However, they differ in readiness and expected economic impact. Construction materials received the highest diversification impact score because Libya's reconstruction and urban development needs can create demand for recovered aggregates, recycled concrete components, gypsum-based products, marble and ceramic waste use, and standards for secondary construction materials. Municipal waste also scored highly because it directly affects cities and can support sorting, composting, recycling, transfer stations, and waste-to-energy feasibility studies.

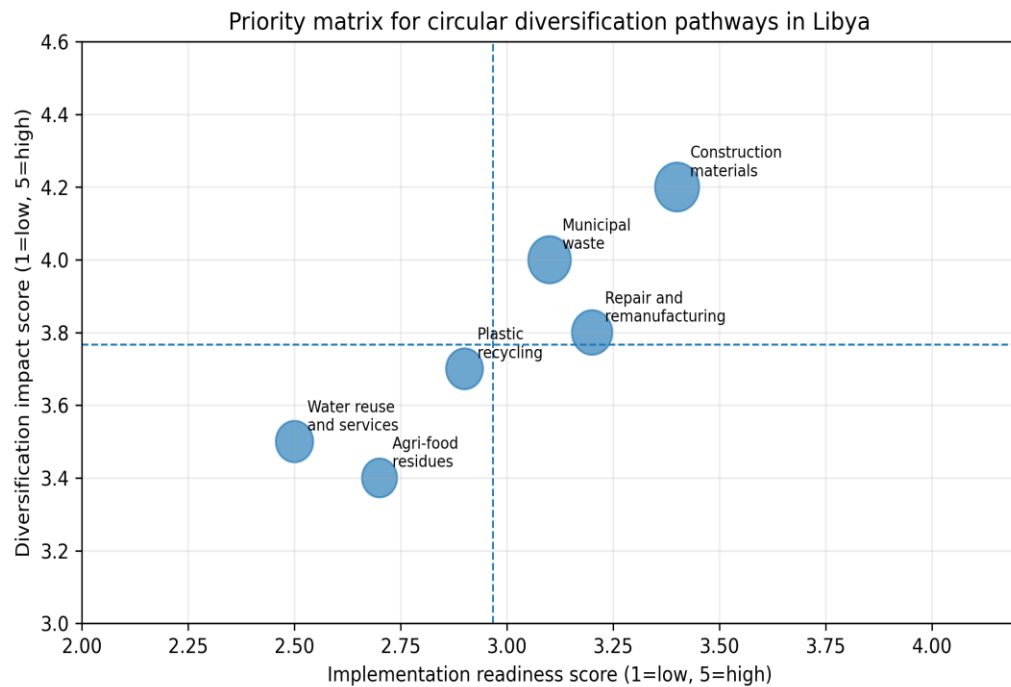


Plastic recycling and repair services have strong enterprise potential but require quality standards, market aggregation, and reliable supply chains. Plastic recycling can generate local value from a visible waste stream, while repair and remanufacturing services can reduce import dependence and extend the life of equipment, vehicles, appliances, and industrial components. Agri-food residues and water reuse scored moderately because they are important for local circular systems, but they require stronger data, technical capacity, and regulatory support.

**Table 4.** Priority circular economy pathways for Libya

Pathway	Circular activities	Diversification mechanism	Main constraint
Construction material recovery	Sorting rubble, crushing aggregates, reusing concrete, using marble, gypsum, ceramic, and brick residues.	Creates local material markets and reduces dependence on virgin and imported construction inputs.	Lack of standards, testing facilities, and procurement requirements.
Municipal waste valorization	Separate collection, sorting, composting, recycling, landfill diversion, and selected energy recovery.	Creates municipal service jobs, recycling enterprises, and new inputs for agriculture and industry.	Weak collection systems, informal disposal, and limited treatment infrastructure.
Plastic recycling	Collection, washing, shredding, pelletizing, and use in packaging or construction products.	Turns a visible pollution stream into a source of local production and value creation.	Fragmented collection and uncertain demand for recycled plastic.
Agri-food residues	Composting, animal feed, bioenergy, and organic fertilizer production.	Links agriculture, food systems, and local circular enterprises.	Seasonality, logistics, and quality control.
Repair and remanufacturing	Maintenance, spare-part recovery, refurbishment, and product-life extension.	Reduces import leakage and builds technical service capabilities.	Limited formal recognition and certification of repair markets.
Water reuse and services	Wastewater reuse, efficient irrigation, leak reduction, and circular water services.	Supports agriculture, municipalities, and climate resilience.	Infrastructure costs and regulatory oversight.





**Figure 3.** Readiness and diversification impact matrix for selected circular economy pathways in Libya

**Table 5.** Sector-readiness scorecard for circular diversification in Libya

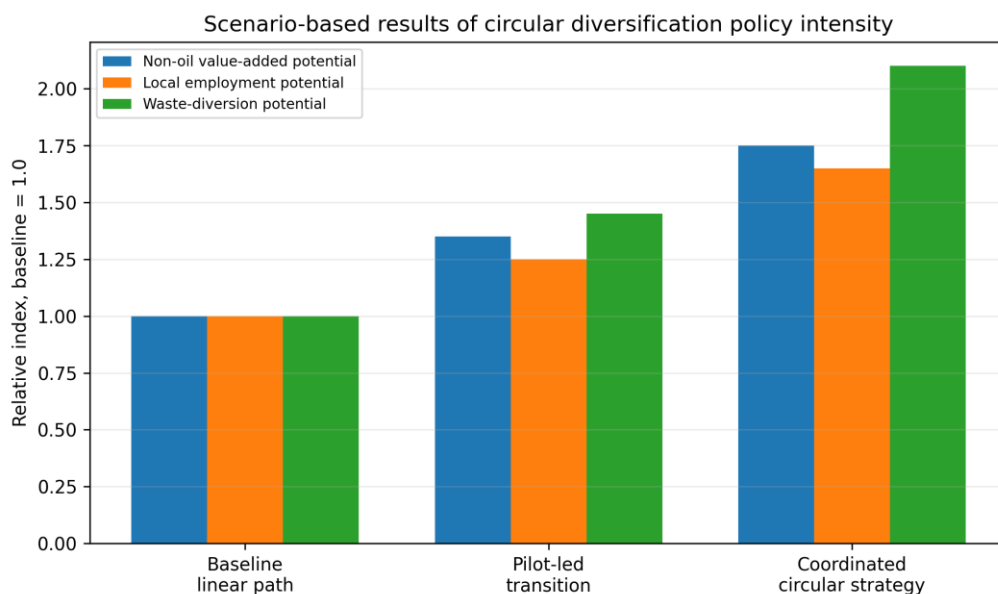
Pathway	Material-flow significance	Enterprise potential	Import substitution	Readiness	Policy urgency	Overall priority
Construction material recovery	High	Medium-high	High	Medium-high	High	Very high
Municipal waste valorization	High	High	Medium	Medium	High	Very high
Plastic recycling	Medium-high	High	Medium	Medium	High	High
Repair and remanufacturing	Medium	High	High	Medium-high	Medium	High
Agri-food residue utilization	Medium	Medium	Medium	Medium-low	Medium	Medium
Water reuse and services	Medium	Medium	Medium-high	Medium-low	High	Medium-high



The scorecard also indicates that Libya should not begin with a single national megaproject. A more robust strategy would combine municipal pilots, construction-material standards, enterprise finance, and circular procurement. This finding is consistent with circular economy

implementation literature, which stresses that transition depends on ecosystems rather than isolated technologies (Chakraborty et al., 2025; Ndoka, 2025).

The scenario-based analysis compares three policy paths. The baseline linear path assumes that waste and resource flows continue to be treated mainly as disposal problems. The pilot-led transition assumes limited municipal recycling and isolated private initiatives. The coordinated circular strategy assumes national data systems, procurement incentives, finance, standards, and municipal-private partnerships. The scenario results show that coordinated policy has the highest relative potential for non-oil value added, local employment, and waste diversion. These results should be interpreted as policy-scenario outputs rather than official forecasts.



**Figure 4.** Scenario-based results of circular diversification policy intensity

**Table 6.** Expected outcomes by policy intensity scenario

Scenario	Policy characteristics	Expected outcome	Risk
Baseline linear path	Limited circular policy, weak data, and mostly disposal-based municipal services.	Low non-oil value creation and continued material leakage.	Growing municipal costs and missed enterprise opportunities.
Pilot-led transition	Selected recycling pilots, donor-supported initiatives, and limited municipal engagement.	Visible local improvements, but limited scale and weak integration.	Projects remain fragmented and dependent on external support.
Coordinated circular strategy	National framework, city pilots, green procurement, standards, finance, and monitoring indicators.	Higher potential for non-oil value creation, jobs, and import substitution.	Requires governance capacity and sustained political commitment.



## DISCUSSION

The results show that the circular economy can contribute to Libya's diversification agenda only when it is treated as an economic policy instrument. If circularity is framed only as recycling or cleaning streets, it will remain a narrow municipal service activity. If it is framed as a diversification strategy, it can create new value chains around construction materials, plastics, repair services, organic residues, and water efficiency. This distinction is essential because Libya's development challenge is not only environmental degradation; it is also the limited depth of non-oil production and private-sector activity.

The priority given to construction material recovery is consistent with the economic logic of circular diversification. Construction and reconstruction generate demand for materials, while demolition and building activity generate material residues. A circular construction strategy can connect these flows through sorting, quality testing, aggregate recovery, recycled concrete products, and public procurement. Recent circular construction studies show that digital tools and circular waste practices can improve planning and recovery of construction and demolition waste, although much of the evidence remains concentrated in developed-country contexts (Saka et al., 2024; Muzioreva et al., 2026). For Libya, the immediate priority is not advanced digital integration alone; it is the establishment of basic standards, testing centers, and procurement rules that allow secondary materials to enter legal markets.

Municipal waste valorization is the second major priority because it is both a service problem and an economic opportunity. The Libya-focused systematic review by Maafa and Badi (2026) suggests that inadequate infrastructure, uncontrolled disposal, and weak treatment systems continue to constrain sustainable solid waste management. These barriers should not be interpreted only as obstacles; they also indicate where circular enterprises can emerge. Separate collection, sorting centers, compost production, plastic aggregation, and controlled material recovery can create entry points for local businesses and municipal-private partnerships.

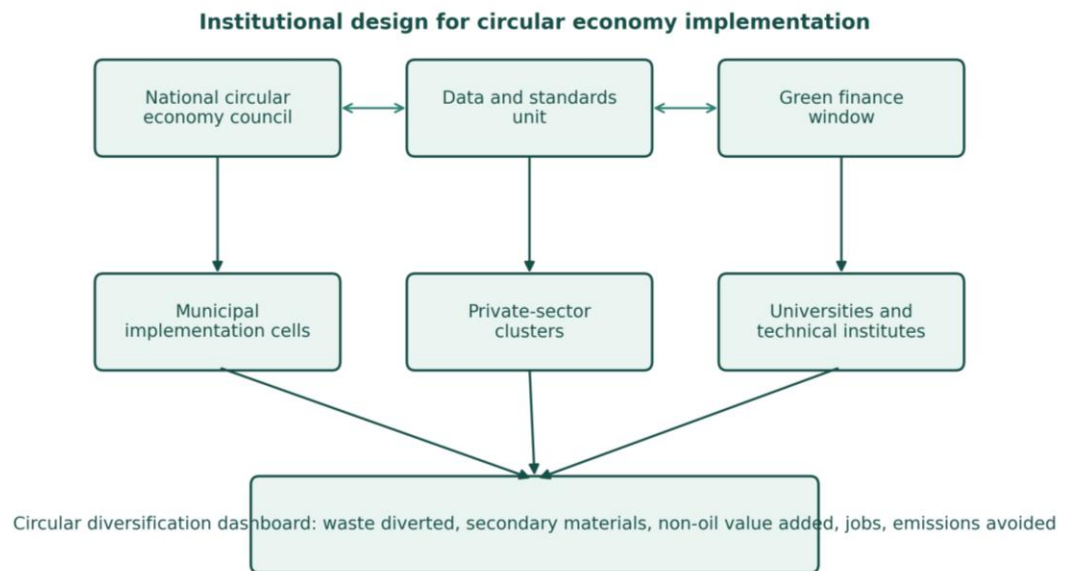
Plastic recycling deserves special attention because it is visible to citizens and can be linked to practical pilots. The United Nations Office for Project Services (2024) frames plastic waste in Libya as both a municipal challenge and a potential source of value creation. However, plastic recycling will not scale if collection remains fragmented and if recycled materials are not accepted by manufacturers or public buyers. Policy should therefore combine collection systems with product standards, purchase commitments, and support for recycling firms.

Repair and remanufacturing are often underestimated in circular economy policy. They are important for Libya because import dependence, foreign exchange constraints, and limited industrial depth make product-life extension economically



valuable. Formalizing repair markets can support technical skills, reduce premature product replacement, and create service enterprises in vehicles, machinery, appliances, electronics, and industrial equipment. This aligns with recent circular economy scholarship that argues that value retention through repair and reuse may be more economically significant than recycling-centric measures (Rashid, 2025).

The discussion also shows that governance is the decisive variable. Libya’s circular diversification strategy would need a national circular economy council, municipal implementation cells, technical standards, a circular finance window, and a national dashboard. Without such coordination, circular projects may remain small, donor-dependent, and disconnected from industrial policy. This is similar to findings from developing-country circular business model literature, which identifies finance, regulation, capabilities, and market uncertainty as core barriers to implementation (Ndoka, 2025; Chakraborty et al., 2025).



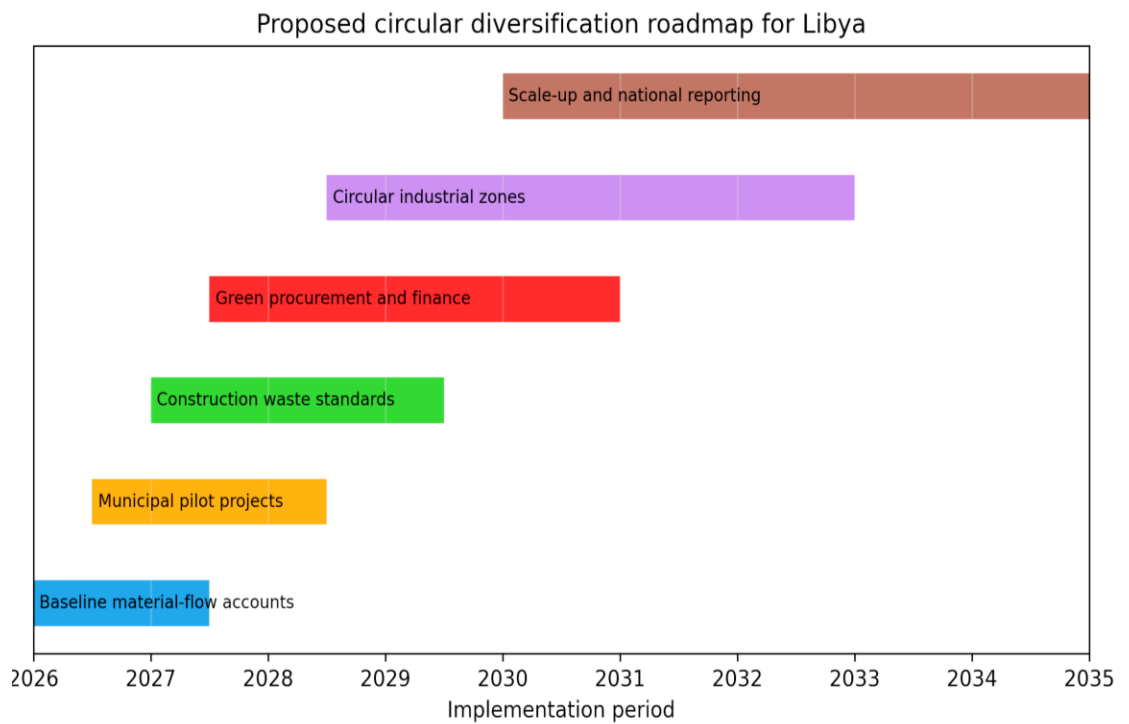
**Figure 5.** Proposed governance architecture for circular economy implementation in Libya

**Table 7.** Main barriers, policy responses, and expected economic effects

Barrier	Policy response	Expected economic effect
Weak material-flow data	Create municipal and national material-flow accounts and waste composition surveys.	Improves investment planning and reduces uncertainty.
Fragmented municipal systems	Pilot city-level circular economy cells with private-sector participation.	Creates practical implementation capacity and local service enterprises.
Unclear quality standards	Develop standards for recycled aggregates, compost, plastics, and refurbished products.	Builds market confidence in secondary materials.



Limited finance for circular firms	Establish small grants, credit guarantees, and concessional loans for circular enterprises.	Encourages private investment and job creation.
Low demand for circular products	Use green public procurement and municipal purchase commitments.	Creates stable demand and accelerates market formation.
Skills and technology gaps	Develop technical training for repair, sorting, material testing, and recycling operations.	Strengthens local capabilities and formal employment.



**Figure 6.** Proposed 2026-2035 policy roadmap for circular diversification in Libya

The policy roadmap should begin with measurement because the absence of reliable data prevents effective planning. Libya needs municipal waste composition studies, construction and demolition waste estimates, repair-sector mapping, and secondary-material market assessments. The second step is pilot implementation in selected municipalities and sectors. Pilots should not only test technology; they should test contracts, tariffs, collection arrangements, public procurement, and enterprise models. The third step is scale-up through standards, finance, and national reporting. This sequence reduces risk because it allows Libya to learn from pilots before committing to large infrastructure investments.

The study also has limitations. It uses a conceptual and evidence-synthesis method rather than primary survey data or econometric estimation. The scorecard is an analytical prioritization tool, not an official measurement of sector output. Some Libya-specific data are fragmented, and many municipal waste and recycling activities are underreported. These



limitations do not weaken the policy relevance of the study, but they show the need for future empirical research. A stronger evidence base would require firm-level surveys, municipal waste audits, life-cycle assessments, cost-benefit analysis, and input-output modelling of circular sectors.

## CONCLUSION

This article examined the circular economy as a strategy for economic diversification in Libya. The main finding is that circular economy policy can support diversification when it is connected to resource efficiency, local enterprise creation, import substitution, municipal services, construction material recovery, repair markets, and secondary-material standards. The study identified six priority pathways: construction material recovery, municipal waste valorization, plastic recycling, agri-food residue utilization, repair and remanufacturing services, and water reuse. Among these, construction materials and municipal waste show the strongest combined potential because they connect large resource streams with visible public needs and local value-chain opportunities.

The article contributes to circular economy scholarship by shifting the Libya discussion from an environmental service perspective to a diversification-oriented economic development perspective. It shows that circularity should not be treated only as recycling, but as a system for creating non-oil value from materials, products, assets, and services that are currently lost or underused. The proposed framework links circular interventions to non-oil value added, enterprise development, employment, reduced import leakage, and improved municipal performance.

The main policy suggestion is that Libya should develop a national circular diversification strategy supported by municipal pilots, material-flow data, secondary-material standards, green public procurement, circular finance instruments, and technical training. Early implementation should focus on sectors with high readiness and high diversification impact, especially construction material recovery, municipal waste valorization, plastic recycling, and repair services. These areas can create practical results before larger and more capital-intensive projects are attempted.

Future studies should test the framework empirically. Recommended research directions include municipal waste composition analysis in major Libyan cities, cost-benefit studies of recycling and composting facilities, assessment of construction and demolition waste recovery, surveys of circular economy readiness among small and medium-sized enterprises, life-cycle analysis of secondary construction materials, and input-output modelling of non-oil value added from circular sectors. Further research should also examine how digital tools, geographic information systems, blockchain traceability, and artificial intelligence can improve circular material tracking and reverse logistics in Libya.



**Table 8.** Future research agenda for circular diversification in Libya

Research direction	Research question	Suggested method
Municipal waste audits	What is the composition and recoverable value of municipal solid waste in major Libyan cities?	Sampling, weighing, material characterization, and spatial mapping.
Circular construction materials	Can recycled aggregates and construction residues meet quality standards for local projects?	Laboratory testing, pilot projects, and procurement evaluation.
Small enterprise readiness	What barriers prevent Libyan small and medium-sized enterprises from adopting circular business models?	Survey research, interviews, and structural modelling.
Economic impact assessment	How much non-oil value added and employment could circular sectors generate?	Input-output analysis and scenario modelling.
Digital circular systems	How can digital tracking improve waste collection and reverse logistics?	Prototype development and municipal pilot testing.
Governance and finance	Which policy instruments most effectively stimulate circular investment?	Comparative policy analysis and stakeholder consultation.

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