



Circular Economy as a Driver of Ecological Transition and Sustainable Development: The RE-MED Project in Tunisia

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Abstract: This article interrogates the potential of the circular economy as a structuring paradigm for ecological transition and sustainable development in Tunisia, with particular emphasis on the management of construction and demolition waste (CDW). Situating the analysis within critiques of the dominant linear economic model, it elucidates how the circular reconfiguration of material flows may contribute to reducing environmental externalities, preserving natural capital, and stimulating territorially embedded forms of green employment. The study adopts a multidimensional and interdisciplinary methodological framework, combining a critical review of academic literature, the analysis of institutional and policy reports, qualitative interviews with key public and private stakeholders, and an in-depth case study of the RE-MED project, implemented notably in the Greater Tunis region. The study's results demonstrate the development of novel socio-technical configurations for reclaiming and recycling construction and demolition waste (CDW). Concurrently, they underscore how deeply entrenched institutional inertia, regulatory deficiencies, economic hurdles, and socio-cultural pushback continue to obstruct the widespread systemic adoption of circular economy models. The article concludes by advancing a set of policy-relevant recommendations aimed at reinforcing governance architectures, consolidating recycling value chains, and fostering the societal embedding of circular economy principles within the Tunisian context.

Keywords: Circular economy, Sustainable development, Waste governance, Tunisia.

INTRODUCTION

Environmental concerns occupy an increasingly prominent position in contemporary debates, particularly against a backdrop of rapid modernization and urbanization. These concerns are intimately connected to notions of sustainable development, ecological stewardship, and transformations in social relations. In Tunisia, the discourse on ecological transition faces a dual challenge: environmental awareness is compartmentalized within expert circles and grassroots initiatives, while the domestic academic field exhibits a pronounced deficit in literature addressing these pressing structural challenges.

The current hegemony of the linear "take-make-waste" economy, anchored in neoliberal principles, operates at a double cost. It fuels growing social stratification while accelerating ecological collapses, directly compounding the crises of environmental pollution and anthropogenic climate change. In response, various approaches to environmental management seek to reconcile economic activity with the preservation of natural resources. Among these, the circular economy has increasingly been promoted as a credible alternative to the linear model, advocating for the reuse, recycling, and valorisation of resources to reduce waste generation and the ecological footprint of production systems.

In Tunisia, the circular economy remains at an emergent stage. Informal recycling practices, such as those carried out by *barbechas*, reflect localized efforts, yet the transition to a genuinely circular model is constrained by institutional, regulatory, economic, and socio-cultural barriers. The management of construction and demolition waste (CDW) exemplifies these tensions: production volumes are substantial, environmental impacts are diverse, and valorisation mechanisms remain limited, even though these waste streams represent significant potential for sustainable development and the creation of local green employment (Le Moigne, 2014).

This article examines the role of the circular economy in Tunisia's ecological transition through the lens of CDW management. It is structured around three interrelated axes: first, a theoretical framework drawing on circular economy principles and the sociology of the environment; second, an assessment of the environmental, economic, and regulatory challenges associated with CDW; and third, an in-depth case study of the RE-MED project, conceptualized as an experimental dispositif for integrating circular solutions into the management of construction-sector waste. By combining theoretical insights with empirical investigation, the study aims to illuminate the socio-technical and institutional dynamics shaping the emergence of circular economy practices in the Tunisian context.

OBJECTIVE AND METHODOLOGY

This research aims to provide a comprehensive and contextually grounded understanding of the circular economy in Tunisia, highlighting its opportunities, challenges, and the principal socio-economic obstacles it presents. It seeks to evaluate the extent to which circular economy practices can contribute to the creation of sustainable wealth, the generation of green employment, and the promotion of a development model that is both ecologically sound and socially responsible.

More specifically, the study pursues four interrelated objectives: firstly, to document the current state of the circular economy in Tunisia, through the analysis of its mechanisms, its progress and the institutional obstacles that hinder its diffusion; secondly, to identify the economic and social levers likely to accelerate the transition towards more circular production models; subsequently, to assess the potential impact of this transition on waste management, particularly in the construction and demolition sector, which generates significant volumes of waste; and finally, to highlight existing good practices and innovative projects, drawing in particular on an in-depth study of the RE MED project, considered an exemplary case of integrating circular solutions into waste management in Tunisia, in order to formulate concrete recommendations for strengthening institutional, regulatory and economic frame works and for promoting the broader adoption of circular economy principles nationally.

To ensure a rigorous and comprehensive analysis, the research adopts a multidimensional methodological framework that integrates multiple sources and data collection tools. First, a thorough documentary analysis was conducted, encompassing a critical review of the scientific literature, examination of national and international institutional reports, and the utilization of official statistical data relating to the circular economy and waste management in Tunisia. This phase consolidated the conceptual framework of the study and precisely situated the empirical context. Second, a qualitative inquiry was undertaken through semi- structured interviews with key actors from both public

and private sectors involved in environmental governance, recycling, and waste management. These interviews provided fine-grained empirical data on perceptions, challenges, constraints, and stakeholder recommendations. Finally, an in-depth case study of the RE-MED project was conducted, serving as a concrete illustration of the operational implementation of circular economy principles in the management of CDW. The analysis examined the project's objectives, technical and social outcomes, and economic and environmental impacts. The triangulation of these theoretical, institutional, and empirical sources ensures the robustness of the findings, effectively integrating conceptual analysis, field insights, and practical illustrations in accordance with the highest standards of research on socio-ecological transformations and circular economy practices.

THEORETICAL FRAMEWORK

The Circular Economy as a Paradigm for Responsible and Sustainable Development

The circular economy refers to an economic system designed to optimize resource use throughout the life cycle of goods and services, minimising waste and environmental impact while promoting collective well-being. Unlike the traditional linear model ("extract-produce-consume-discard"), it draws inspiration from natural ecosystem loops to establish regenerative cycles of production, exchange, and consumption.

Its theoretical foundations can be traced back to the pioneering work of Kenneth Boulding(1966), who highlighted the physical and energetic limits imposed by a world of finite resources on any notion of unlimited growth. More recently, the Ellen MacArthur Foundation (2012, 2013) has popularised this paradigm as a strategic instrument for ecological transition, responding to global economic and environmental crises by promoting waste reduction, extending product lifespans, and systematically reintroducing materials into new production cycles.

The construction and demolition sector particularly illustrates the challenges and opportunities of this model. Generating massive volumes of waste, it offers significant potential for valorisation through recycling and material reuse, thereby conserving natural resources and limiting illicit environmental discharges, as demonstrated by recent studies (Hormozi et al., 2021). Such practices encourage integrated and responsible waste management, in line with the principles of industrial ecology.

Ultimately, the circular economy emerges as a key lever for ecological transition, integrating economic, social, and environmental performance through a systemic redesign of production and consumption patterns.

The Environmental Issue as a Social Fact

The environmental issue has increasingly become a major social fact in the Durkheimian sense of the term—that is, a collective phenomenon external to the individual, endowed with its own coercive power, which structures behaviours and the collective representations of society. Challenges such as pollution, ecosystem degradation, climate change, and waste management cannot be reduced to purely technical or natural dysfunctions; they are socially constructed through shared perceptions, institutional norms, conflicts of interest, and collective mobilisations.

Environmental sociology, which emerged in the 1980s, has precisely contributed to moving beyond an objectivist understanding of the ecological crisis, revealing its fundamentally social dimension (Buttel, 1986; Kalaora, 1993; Newby, 1997). This field examines how institutional, cultural, and discursive dynamics shape the recognition and management of environmental problems, embedding them within social structures and power relations that connect societies to their physical environment.

Drawing on Durkheimian foundations, this perspective incorporates nature as an intrinsic component of social facts, emphasising that societies cannot exist independently of their ecological conditions. In Tunisia, the environmental crisis thus appears as a symptom of a disruption in the socio-ecological metabolism -a concept derived from critical Marxist approaches (Foster et al., 2010)- characterised by a systemic disconnect between productive activities and the regenerative capacities of ecosystems, particularly in resource-intensive sectors such as construction.

This disruption manifests concretely in inadequate management of natural resources, the anarchic accumulation of waste, and socio-territorial inequalities that disproportionately expose certain populations to environmental hazards. It therefore calls for a multidimensional transformation that combines technical developments, the configuration of social representations, changes in collective practices, and the definition of institutional relationships with the environment.

Ultimately, approaching environmental challenges as social facts allows one to move beyond technicist or naturalist perspectives, enabling an analysis of both resistance and levers of change by articulating social transformations and ecological transitions inseparably. Such an approach mirrors recent developments within the fields of social ecology and environmental sociology. These disciplines call for a systemic lens, arguing that the material dimensions of socio-ecological interactions must be deeply embedded within investigation of social processes (Mol, 2003; Wezel et al., 2009; Foster et al., 2010).

Environmental and Economic Challenges of Construction and Demolition Waste (CDW) Management in Tunisia

Construction and Demolition Waste

The management of waste generated by demolition and construction activities constitutes a critical environmental challenge in Tunisia, as such waste represents a significant proportion of the total solid waste stream and has increased markedly in recent years. According to data provided by the Ministry of the Environment, in 2015 Tunisia managed between 7 and 8 million m³ of construction and demolition waste (CDW). Since then, annual flows have increased by approximately 1 million tonnes per year. By 2019, CDW volumes were estimated at approximately 8.1 million m³ cumulatively, and by 2020 they had reached between 10 and 15 million m³. This trend reflects a consistent increase in CDW volumes.

The majority of this waste is stored or deposited without adequate control in saturated municipal landfills or in illegal dumping sites, particularly in large urban centres such as Greater Tunis, Sousse, and Sfax, where over 70% of the waste is concentrated (Ministry of the Environment, 2023). This uncontrolled accumulation poses significant environmental problems: soil and water pollution due to the infiltration of toxic leachates,

fine dust emissions degrading air quality, odour nuisances, landscape degradation, and increased flood risk by obstructing stormwater drainage systems.

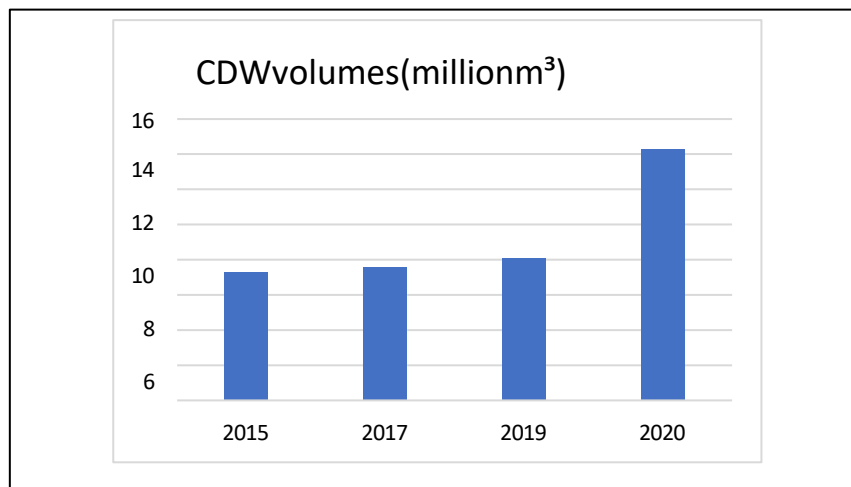


Figure 1: Trends in construction and demolition waste (CDW) generation in Tunisia, 2015-2020 (million m³)

The emergence of these wild dumpsites is generally driven by individual cost-saving strategies, aiming to evade the levies and taxes associated with legal waste treatment channels. To this end, they hire carts or trucks to dispose of waste in plains or undeveloped areas. Such irresponsible behaviour has led to the gradual emergence of uncontrolled dumping sites, which are no longer limited to construction waste alone. Indeed, these locations increasingly attract other citizens who deposit household waste, thereby amplifying environmental nuisances. The proliferation of illegal dumping across major metropolitan centers uncovers a structural breakdown. In these contexts, state interventions and public policies fail to execute robust regulatory mechanisms or sustain institutional surveillance. This institutional failure facilitates the development of illegal practices with multiple consequences: soil and water pollution, visual and olfactory disturbances, and serious public health risks associated with dust and toxic odours. According to Ms. Ben Ahmed, President of the Professional Association for Waste Cleaning, Collection, Transport, and Recycling (N.C.T.R.D.), “the number of uncontrolled sites receiving construction waste exploded after the Revolution, reaching approximately 290. These ‘black spots’ disfigure the natural and urban landscape and damage the environment.”

These illegal landfills have severe consequences and pose a significant health risk to nearby populations due to dust emissions and noxious odours. This situation also reflects a deeper crisis in resource management and ecological transition in a developing country.

Moreover, the annual consumption of natural aggregates used in the construction sector is estimated at 55 million cubic metres, of which only a small proportion—approximately 2%—is currently substituted with recycled materials derived from construction waste (National Engineering School of Tunis, 2018). This limited utilisation of recycled resources exacerbates pressure on natural reserves and accelerates quarry degradation.

According to Mr. Meksi, Director General of Technical Services at the Municipality of Tunis, around 160,000 m³ of construction and demolition waste have been illegally dumped into the environment in recent years. This estimate highlights the scale of the illegal dumping phenomenon, which is rooted in an anarchic accumulation of waste primarily originating from unregulated practices.

In response to these challenges, Tunisia has developed national strategies aimed at the integrated management of CDW, including the establishment of sorting, treatment, and waste recovery centres. An operational manual produced by the Ministry of the Environment outlines the technical, financial, and regulatory procedures necessary for implementing this strategy at the local government level (Ministry of the Environment, 2021).

The development of CDW recycling channels offers numerous advantages, both environmentally—reducing the extraction of virgin materials and decreasing illegal dumping—and economically, through the creation of green jobs in waste collection, sorting, treatment, and recovery, as well as the provision of competitively priced recycled materials for the construction sector (World Bank, 2024).

The Fragility of National Regulatory and Policy Frameworks

The Tunisian policy framework is based on strategic documents prepared by the Ministry of the Environment, as well as operational guides designed to formalise the integrated management of hazardous and controlled waste (CDW). These instruments emphasise the necessity of reducing the depletion of natural resources, controlling the anarchic accumulation of waste, and promoting its recovery and recycling through a structured system encompassing collection, source separation, treatment, and valorisation via dedicated centres operating under public-private partnerships. However, implementation on the ground faces significant shortcomings that compromise the effectiveness of this policy, threatening public health, environmental protection, and the sustainability of natural resources. Despite the development of several legislative texts and strategies over the past decade, their application remains limited, primarily due to a lack of accountability, weak enforcement mechanisms, and insufficient coordination across different levels of governance. For example, current legislation does not systematically mandate source separation, nor does it establish rigorous monitoring and control mechanisms for illegal dumping sites.

Another major weakness lies in the deficit of monitoring and enforcement. The current policy still lacks operational surveillance mechanisms and does not consistently enforce regulations such as the prohibition of illegal dumping or mandatory waste separation. Local agencies frequently suffer from shortages of human and material resources, which hinder the implementation of regular inspections and the imposition of sufficiently deterrent sanctions. Moreover, awareness among relevant actors—construction professionals, demolition companies, and the general public—remains inadequate. The absence of a strong culture of responsible CDW management perpetuates informal and illegal practices, thereby exacerbating environmental impacts. Thus, although the regulatory foundations exist, the effectiveness of CDW management policy depends largely on improving control mechanisms, strengthening sanctions, and enhancing stakeholder awareness. Furthermore, the reinforcement of institutional capacities—particularly that of

environmental enforcement agencies—and the improvement of transparency and accountability within managing authorities are also essential levers for ensuring effective and sustainable management. This coordinated mobilisation, combining regulatory rigor, enhanced operational resources, and strengthened awareness, constitutes the cornerstone for better protection of the environment and public health in Tunisia.

Environmental Challenges of Construction and Demolition Waste (CDW)

Construction and demolition waste (CDW) constitutes a significant environmental challenge in Tunisia. The accumulation of CDW in saturated municipal landfills, illegal dumps, and even streets and public spaces leads to substantial soil pollution, particularly through the infiltration of leachates—liquid effluents loaded with pollutants originating from waste washing. These illegal sites also generate fine dust emissions, including particles of plaster, gypsum, or cement, which contribute to local air pollution. Moreover, such sites degrade urban and natural aesthetics, adversely affecting residents' quality of life and living environment. This situation also reflects a deficiency in shared responsibility among the State, local authorities, and citizens, contributing to a generalized ecological neglect.

In urban areas, these uncontrolled dumps are often a direct cause of flooding, as they obstruct stormwater drainage systems. Furthermore, inadequate waste management exacerbates socio-territorial inequalities, as the most vulnerable or poorly governed areas frequently bear the brunt of illegal dumping. The phenomena on thus highlights a complex interplay between environmental degradation, social inequality, and power relations.

Furthermore, construction in Tunisia relies heavily on non-renewable natural resources, particularly aggregates such as sand and gravel. The intensive exploitation of these resources results in quarry degradation, the destruction of natural habitats, and the reduction of arable land. In light of these challenges, it is essential to establish a comprehensive waste management plan that includes mandatory source separation, structured collection, treatment, and valorization of waste. Tunisia has developed a national strategy dedicated to establishing a CDW management system. Several emerging initiatives across different sectors—such as plastic recycling and the valorisation of organic waste through composting—aim to protect the environment, conserve natural resources, and improve the quality of life for local populations. The pilot project in Ezzahra exemplifies an innovative approach to building waste valorisation through the creation of the country's first dedicated unit for recycling and recovering construction and demolition waste (CDW).

Local initiatives that actively involve citizens in awareness programs and behavioral adaptation demonstrate promising results. These efforts highlight the crucial importance of structured environmental education and collective mobilisation in establishing waste management practices that are efficient, sustainable, and socially and institutionally accepted in Tunisia. These observations reinforce the idea that the success of environmental policies relies largely on social appropriation of the issues and informed citizen participation.

Economic Issues in the Management of Construction and Demolition Waste (CDW) in Tunisia

In Tunisia, the management of construction and demolition waste (CDW) presents significant economic challenges, linked to the scarcity of natural resources, the costs associated with waste management, and the opportunities offered by recycling and valorisation.

Despite recent efforts, public funding remains limited and often insufficient to meet the investment requirements for infrastructure dedicated to CDW treatment and recycling. Moreover, the inefficient management of CDW, with its anarchic accumulation in landfills and illegal dumping sites, generates substantial costs for local authorities, particularly for site cleaning, decontamination, and maintenance. Landfilling, which represents the primary method of waste management in Tunisia, is highly costly. According to Tarek Masmoudi, CEO of a waste recycling company, the controlled landfill at Jbal Borj Chakir—the largest facility of its kind in the country—processes over 900,000 tonnes per year, with treatment costs estimated between 150 and 200 Tunisian dinars per tonne.

In addition to its high cost, this process does not constitute a viable solution, given that regulated landfill sites are already saturated and serve only 55% of the population.

Furthermore, the composition of buried waste reveals both an economic and ecological paradox: these wastes contain a substantial quantity of recyclable materials, including organic matter, plastics, metals, and other construction-derived objects, all of which could be valorised. The land filling of these valuable resources highlights institutional inefficiency and an economic model characterised by structural waste.

Beyond their material dimension, these wastes serve as a mirror of social and political dynamics. Their systematic disposal reflects a social organisation in which the management of natural and material resources is not fully integrated into sustainable development or circular economy strategies—still limited in Tunisian institutional practices. In sum, this represents an economic and ecological loss embedded within a social structure that struggles to mobilise the skills, technologies, and political will necessary to transform an environmental problem into a socio-economic opportunity.

This issue also reveals a profound sociological dimension, highlighting both institutional shortcomings and economic decisions that reflect the structural constraints and strategic priorities of a society confronted with major challenges such as economic crises, high unemployment, and social vulnerability.

This observation underscores the imperative to rethink waste management practices, favouring more horizontal, integrated, and participatory approaches. Such strategies should not only enable the optimal valorisation of materials but also promote the creation of local wealth while minimizing environmental impact. From this perspective, waste should no longer be viewed merely as a burden to be disposed of, but as a valuable social capital to be reinvested sustainably. This sociological lens thus opens a critical avenue for reflection on the conditions required to effect substantial structural, social, and political change—an essential prerequisite for the sustainable and effective management of resources in Tunisia.

In light of these considerations, the challenges remain numerous and complex, including the need to establish a robust and coherent regulatory framework, to secure the active engagement of key stakeholders in the construction and public works sector, and to develop comprehensive awareness and education programmes targeting all relevant actors.

The literature emphasises that the sustainability of construction and demolition waste (CDW) management fundamentally depends on a rigorous and integrated coordination of legal, institutional, economic, and social mechanisms. This holistic approach aims to substantially reduce reliance on landfilling—a management method that is both costly and temporary—while fostering the development of a circular economy specifically adapted to the realities and constraints of the Tunisian context.

Consequently, the transition to a circular model of CDW management emerges not only as a pragmatic and strategic economic solution but also as an essential pathway to embed the construction sector within a sustainable, resilient, and competitive trajectory, particularly in the face of mounting pressures from the scarcity of physical and financial resources. This evolution is directly aligned with the structural, social, and political changes previously discussed, which are critical prerequisites for the effective and enduring management of resources in Tunisia.

The Circular Economy as a Sustainable Development Process: Assessing Industrial Ecology Through the Re-med Project in Tunisia

The RE-MED project represents a paradigmatic example of the innovative and concrete integration of circular economy principles into the management of construction and demolition waste (CDW) in Tunisia. Launched in October 2020 and completed in December 2023, the project was implemented through a collaborative framework involving France, Italy, and the European Union (EU), with the initial aim of supporting two Mediterranean countries, Lebanon and Tunisia.

The project's primary objective is to transfer and pilot technologies that enable the conversion of research and development outputs into usable resources for the construction and maintenance of transport infrastructure. Within this framework, RE-MED envisages the establishment of a structured CDW recycling value chain, conceived as a lever to facilitate societal, environmental, and digital transitions across Mediterranean territories. With a total budget of €3.1 million, 90% of which is financed by the European Union, the RE-MED project seeks to mitigate the environmental and public health impacts associated with the challenges of CDW management, while simultaneously promoting the dissemination of more sustainable practices within the building and civil engineering sectors.

In Tunisia, the project's principal partners include the Ministry of the Environment, the Centre for Studies and Expertise on Risks, Environment, Mobility and Urban Planning (CEREMA), the Construction Testing and Technical Centre (CETEC), as well as innovative private-sector actors such as Respect Environment Group (REG).

The project was particularly distinguished by the implementation of a flagship pilot in Ben Arous, involving the construction of an innovative 1.2 km road incorporating approximately 20,000 tonnes of recycled aggregates derived from demolition waste. This pilot project demonstrates the technical, economic, and environmental feasibility of the large-scale use of recycled materials in road infrastructure, while contributing to the reduction of the ecological impact associated with the extraction of non-renewable natural resources (Ministry of Equipment, 2023).

Furthermore, the RE-MED project fostered a significant dynamic of training and knowledge transfer in Tunisia whereby more than 50 Tunisian students were trained in

circular economy practices and waste management techniques, while a collaborative digital platform was established to facilitate the exchange of best practices among partner countries (CETEC, 2021; ENI CBC Med, 2023). These actions contribute to strengthening local capacities and to integrating future engineers into the ecological transition.

RESULTS AND DISCUSSION: RE-MED AS A CASE STUDY OF SOCIO-ECOLOGICAL TRANSITION DYNAMICS

Empirical findings position the RE-MED project as a paradigmatic case of socio- technical innovation within the management of construction and demolition waste (CDW) in Tunisia. The project exemplifies the emancipatory potential of the circular economy in the context of a disruption of the socio-ecological metabolism.

Within this framework, Respect Environment Group (REG), a leading Tunisian actor in environmental protection, has played a proactive and central role in the RE-MED initiative. As an innovative small and medium-sized enterprise (SME), REG distinguishes itself through its commitment to advancing sustainable development via environmental innovation, implementing ambitious pilot projects in Tunisia that closely integrate research activities, training programmes, and operational deployment in the field.

One of REG's flagship initiatives within this framework has been the establishment of three construction waste sorting and treatment facilities, strategically located in Greater Tunis and Gabès. These facilities transform millions of tonnes of waste into recycled aggregates that comply with European quality standards, thereby contributing to the structuring of a national value chain for construction waste recovery. In addition, REG has developed an innovative digital application dedicated to waste traceability, enhancing transparency, reliability, and efficiency throughout the entire recycling chain.

The most emblematic achievement, however, remains the 1.2 km pilot road in Ben Arous (National Road No. 3), which incorporated nearly 20,000 tonnes of recycled aggregates under REG's supervision. This project transcends a mere engineering accomplishment, representing a symbolic requalification of waste into "reinvestable social capital."



Figure 2: Schematic illustration of the construction and demolition waste (CDW) recovery process



Figure 3: Photograph of a construction waste recovery site showing on-site crushing and sorting, with recycling into road construction materials



Figure 4: Photograph showing the preparation of the alignment for the RE- MED pilot road on National Road No. 3 in Tunisia



Figure 5: Photograph of the RE-MED pilot road on National Road No.3 in Tunisia, showing sections constructed with recycled materials alongside a control section using natural materials

This approach resonates with the ecological rupture (or metabolic rift) dialectic revisited by Foster et al. (2010), striving to restore a social metabolism in which urban residues are no longer excluded from the production cycle, but reintegrated as resources for territorial development. This initiative has demonstrably confirmed the technical, economic, and environmental feasibility of large-scale recycling for transport infrastructure. It illustrates the viability of using recycled demolition materials as partial substitutes for virgin aggregates, while simultaneously mitigating the environmental impacts associated with the extraction and processing of primary materials.

Furthermore, the Executive Director of REG, Boubaker Ben Yacoub, states that the company operates within a green and circular economy strategy, recycling residues from construction sites into reusable materials for road infrastructure, which are sold at prices 30 to 40% lower than those of quarry-extracted products. In this respect, REG paves the way for a circular economy model with multiple advantages, including the reduction of construction costs through the reuse of recycled materials, the limitation of the extraction of non-renewable raw materials, and pollution reduction through the decrease in landfill use.

Thus, this approach contributes not only to the recovery of construction waste, but also to the reduction of expenditures for stakeholders in the sector, while minimising the ecological footprint associated with the extraction of natural resources.

Moreover, the development of CDW recycling chains generates the creation of direct jobs linked to waste collection, sorting, treatment, recycling, and recovery operations, as well as indirect employment associated with related activities such as transport, logistics, the marketing of recycled materials, and maintenance and technological innovation services. Nevertheless, the waste sector has been estimated to be capable of generating approximately 3,100 permanent jobs with an investment of 1 billion Tunisian dinars.

Furthermore, according to a World Bank study, the implementation of a circular economy in Tunisia could create nearly 100,000 additional jobs across various waste management sectors, with a significant share in construction and recycling.

According to Mr BenYacoub, Executive Director of REG, the company directly employs around ten people and generates approximately 300 indirect jobs, primarily serving construction contractors and operating on a demand-driven basis. The scale of REG's indirect employment (approximately 30 times its direct workforce) suggests a strong local economic multiplier effect, typical of firms engaged in circular economy activities, which often involve complex supply chains and service networks. Although REG's current level of direct employment is modest, it holds strategic significance in Tunisia's emerging circular economy sector. This trend is consistent with several economic studies (Anna-Lena Rebaud, 2016; ILO, 2018) showing that specialized sector companies, particularly those in the circular economy, can exert substantial indirect employment effects even when their direct workforce is limited.

Within this dynamic, RE-MED represents a major innovation by integrating several advanced technologies, notably a digital application assisted by artificial intelligence. This application enables the reporting of construction-generated waste, thereby facilitating the automatic identification of demolition waste suitable for recovery. By promoting more efficient waste processing and engaging citizens through geolocated photo reporting, RE-

MED contributes substantially to the reinforcement of circular economy dynamics, similar to the multiplier effects observed in the indirect employment generated by REG. Moreover, the project incorporates strategic components of training, research, and technology transfer, ensuring strong territorial anchoring and a lasting impact on public policy and industrial practices.

In this context, the role of academic actors and training institutions is crucial. The collaboration between REG and ESPRIT (Private Higher School of Engineering and Technology) exemplifies this synergy, combining applied research, specialised training, and the raising of awareness among future engineers regarding environmental challenges and sustainable development.

This collaboration enables future engineers to acquire the skills and practical experience necessary to address environmental challenges and promote sustainable development. By combining REG's industrial expertise with ESPRIT's academic resources, the partnership develops solutions that reduce the ecological footprint of various industries, notably through waste management and digital innovation.

The initiative also prepares students for careers in sustainable development and supports REG's broader mission: promoting environmental responsibility and the adoption of the circular economy in Tunisia. This alliance demonstrates how the integration of higher education into innovative projects fosters sustainable systemic change, contributing to the creation of green jobs, the reduction of inequalities, and the preservation of natural resources.

To some extent, these observations corroborate those made by (Künzli David and Bertschy (2011), who note that "Education for sustainable development constitutes an interdisciplinary educational concept in which the integration of knowledge from different disciplines becomes indispensable for addressing current ecological, social, and economic challenges."

However, despite the evident advantages of this model, REG faces a series of challenges related to the reluctance of economic, institutional, and social actors to fully adopt recycled materials.

One of the main challenges relates to the long-standing negative perceptions associated with recycled materials. Many actors in the construction sector—whether clients, contractors, or end-users—often regard recycled materials as inferior in quality, less durable, or less reliable than virgin materials. This reflects an extractivist habitus rooted in post-colonial collective representations that privilege "pure" natural resources. This mistrust is reinforced by a lack of information and visible feedback regarding the performance of these materials in sustainable infrastructure. Beyond these perceptions, this resistance is not idiosyncratic but systemic: it is embedded in primary socialisation where linear logic predominates professional practices, hindering the adjustment of habitus towards a circular ethics (Bourdieu, via Darmon, 2018). Additionally, a certain reluctance to change traditional practices and deeply ingrained habits further limits the large-scale adoption of recycled materials.

To overcome these obstacles, it is essential to actively promote recycled materials. Such promotion relies on presenting tangible evidence of their performance, obtaining certifications that attest to their quality, and communicating concrete examples of

successful applications in innovative projects. Within this framework, it becomes indispensable to carry out comprehensive awareness-raising, training, and communication efforts to demonstrate the technical and scientific advantages of recycled aggregates. This approach complements and reinforces the previously discussed strategies of social acceptance and collective learning, which are essential for establishing lasting trust in this innovation. This process aligns closely with Everett M. Rogers' theory, corresponding to strategies of social acceptance and collective learning that are fundamental for fostering confidence in innovation.

However, despite the barriers and challenges associated with the reluctance to use recycled materials, REG continues to actively promote the environmental and economic benefits of its model. Nevertheless, the Tunisian regulatory framework, which is still evolving to better integrate circular economy principles, remains a major obstacle. In particular, the absence of clear, certified, and harmonised technical standards for these materials limits their recognition and integration into both public and private markets. This lack of standardisation generates legal uncertainty for project owners, who are hesitant to mandate the use of recycled aggregates, despite the validation of their performance in pilot projects such as RE-MED. Furthermore, the fragmentation of current regulations across multiple ministries complicates inter-institutional coordination, thereby hindering the establishment of coherent and effective governance for the circular economy.

Additional challenges include complex administrative procedures for setting up recycling facilities, as well as a lack of strong institutional support, particularly for small and medium-sized producers, which further impedes sector development.

Bureaucracy and administrative burdens are frequently cited by stakeholders as major obstacles. The multiplicity of procedures and an overly restrictive approval framework slow the growth of formal enterprises, while informal competition remains widely predominant. From a technical perspective, the quality of collected waste and the capacity of treatment facilities play a major role. Demolition materials often contain impurities or exhibit particle sizes unsuitable for public works requirements, necessitating sophisticated equipment and specialised expertise to ensure effective sorting and recycling.

Moreover, the geographic dispersion of waste and the cost of its collection represent an additional logistical challenge. An optimal value chain, ensuring traceability and intelligent management of waste flows, is often lacking in many regions, thereby limiting the potential for the valorisation of recycled materials.

From an economic perspective, the circular model promoted by RE-MED allows for a significant reduction in construction costs, potentially achieving a decrease of 30 to 40% compared with virgin materials. Beyond profitability, the employment impact reveals a remarkable local multiplier effect: while REG directly employs around ten staff members, it generates approximately 300 indirect jobs within the collection and logistics chains. This 1:30 ratio corroborates forecasts by the ILO (2018) and the World Bank regarding the potential of the circular economy to stimulate local development, while providing a concrete response to structural unemployment in Tunisia.

This dual dynamic, combining environmental and economic benefits, fully illustrates the relevance of the circular economy as a driver of sustainable development in Tunisia.

However, in a sometimes-unstable economic context, the initial costs associated with establishing recycling facilities, acquiring modern equipment, and providing specialised training can constitute a barrier for investors and operators. The profitability of circular projects is often envisaged over the long term and may not meet the expectations of private actors seeking rapid returns. Furthermore, the absence of robust financial incentives in certain cases reduces the attractiveness of the economic model. Despite the undeniable benefits in terms of reduced costs and environmental impact, the perception of financial risk persists as a major obstacle to the widespread adoption of this model.

Furthermore, this transition towards a circular economy also necessitates profound social adjustment, requiring the integration and support of informal actors such as traditional material collectors so as to prevent any form of exclusion or job loss. This social dimension, often overlooked, is nevertheless crucial to ensure the sustainability and equity of the envisaged economic and environmental transformation.

While the challenges associated with the reluctance to use recycled materials in Tunisia are numerous—including cultural, regulatory, technical, economic, and social barriers—the work of Respect Environment Group demonstrates that these obstacles can be overcome through an integrated approach. This approach combines technological innovation, institutional advocacy, awareness-raising, and inclusive economic development.

From this perspective, development sociology invites us to consider waste not merely as a technical or environmental problem, but as a major social and political issue. This vision requires rethinking governance modes by fully integrating local actors into decision-making processes and valuing local knowledge, thereby transforming waste into genuine social and economic capital. In this way, demolition and construction waste could become an effective lever for the circular economy, enhancing local autonomy and contributing to more equitable and sustainable development.

Integrating a sociological dimension into waste management therefore calls for a profound transformation of practices, where by material recovery is accompanied by social and political reorganisation. This holistic approach requires a reconsideration of policy priorities, intensified awareness-raising, improved training, and the fostering of multi-stakeholder partnerships. Only by adopting such an integrated perspective—one that takes social dynamics into account—can Tunisia fully exploit the “hidden treasure” represented by its waste and build a society more resilient to environmental and economic challenges.

At the same time, social norms theory offers valuable insight into individual and collective behaviours related to waste sorting and recycling. The activation of personal moral norms, which evokes a sense of obligation towards others and the environment, facilitates the adoption of pro-environmental behaviours. Consequently, environmental awareness and education emerge as essential levers to transform social representations and establish sustainable habits.

These sociological analyses demonstrate that simply confining waste to landfills constitutes a partial, inadequate, and socially unjust solution. For demolition and construction waste to become a resource fully integrated into Tunisia’s economic and social fabric, it is essential to adopt a comprehensive strategy that combines citizen participation, social justice, economic innovation, and inclusive governance. Such an approach enables the construction of policy that is genuinely sustainable, legitimate, and broadly accepted.

Finally, the concept of environmental justice highlights the need to pay particular attention to inequalities in exposure to waste-related nuisances and disparities in access to resources. This critical perspective underscores the urgency of restructuring waste management according to principles of equity, participatory democracy, and the fair redistribution of benefits derived from waste valorisation, in order to prevent certain social groups from bearing disproportionate disadvantages.

CONCLUSION

The analysis of construction and demolition waste (CDW) management in Tunisia demonstrates that the circular economy represents a strategic lever for ecological and sustainable transition. The findings of this study highlight that the integration of circular solutions, exemplified by the RE-MED project, enables a break from the linear “extract-produce-dispose” model by transforming rubble into recoverable resources. This dynamic not only contributes to the preservation of non-renewable natural resources but also generates positive economic externalities, notably through the creation of green jobs and the reduction of construction costs.

However, the widespread adoption of this model remains contingent on overcoming multidimensional barriers. At the institutional level, the absence of certified technical standards and the complexity of administrative procedures hinder private sector engagement.

At the scientific and societal level, the paradigm shift encounters entrenched collective representations that still associate recycling with a loss of quality. To transform these “social facts” and ensure the sustainability of the sector, it is imperative to strengthen governance frameworks, introduce targeted economic incentives, and promote a culture of circularity through education and awareness-raising. Ultimately, the circular economy in Tunisia should not be perceived merely as a technical option, but as a structural necessity for building sustainable socio-ecological resilience.

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