Territorial intelligence and circular economy: a twinning that enhances the sustainable development of territories? An analysis based on statistical indicators

The circular economy is a systemic model that aims to limit the production of waste and the use of resources and to reduce the environmental impact of resource extraction right through to the end of a product's life. Although the origins of the concept date back to the 1970s, it is now increasingly present in public policy objectives at both national and regional levels.

Based on the definition proposed by Ademe, the circular economy is based on three main areas of action :

1. supply from economic players,
2. demand and consumer behavior,
3. waste management .

Therefore,the circular economy is based on a fundamental paradigm shift. Economic system and ecological system are not, as in traditional economic analysis, on the same plane, where natural resources, factors of production, economic goods and services, waste and refuse are exchanged. What emerges, in fact, is the need to analyse the global economic system as a closed system, in which the economy and the environment are not characterised by linear correlations, but by a circular relationship: the economic system is located within a broader ecological system and, while benefiting from its natural resources and ecosystem services, it must respect its operating rules and physical, biological and climatic limits. Unlike the so-called linear system, which starts from matter and ends in waste, the circular economy is an economy in which today's products are tomorrow's resources, in which the value of materials is retained or recovered as much as possible, and in which there is a minimisation of waste and impacts on the environment. The transition to a circular economy requires a cultural and structural change, a real territorial intelligence: a profound revision and innovation of production, distribution and consumption models are the cornerstones of this change, with the abandonment of the linear economy, the overcoming of the recycling economy and the landing in the circular economy, passing through new business models and the transformation of waste into resources with high added value**.**

Cities and local territorial areas (such as municipalities, consortia of municipalities, provinces, mountain communities, districts) are strategic places in the development of circular economy approaches capable of making the management of resources (materials, water, energy, soil) more efficient. Urban areas, in particular, play a crucial role in driving sustainability in the production and consumption of goods and services, since they are home to more than half (55%) of the world's population (in Europe, 70% of the population is concentrated there), generate more than 80% of GDP, are responsible for 75% of natural resource consumption, produce 50% of global waste and 60-80% of greenhouse gas emissions.

The territorial and local dimension is one of the salient features of circular economy approaches: the more locally 'closed cycles' are developed, the more effective they are. The creation of closed material cycles within territorial areas allows, for example:

- to limit transport costs, which in many cases reduce the profitability of circular economy strategies;

- to develop and leverage specific skills and characteristics of the local economy, involving educational organisations (schools and universities) and businesses in synergy with local economic specificities
- to exploit local political and administrative instruments, e.g. when the area targeted by the strategies corresponds to a local administrative unit;
- to integrate circularity as an element of local identity, helping to develop it as part of the local brand, constituting an element of attractiveness and cohesion.

As indicated by the United Nations New Urban Agenda, the Amsterdam Pact and the 2030 Agenda, cities are the engines of innovation and sustainable economic development, but also the battleground for the new challenges of this century, such as population growth, urban sprawl, climate change, waste generation, and environmental degradation.

Cities are laboratories for the development of circularity approaches and can be places of experimentation and catalysts for the circular transition for the following reasons

- they present density, scale and concentration of businesses and people generating flows of materials and resources with circular potential;
- they can have a certain degree of autonomy in regulating and incentivising and, therefore, making rapid decisions;
- they have dimensions that may allow the creation of new circular functions, services and business models;
- are equipped with infrastructure and services (public and private) with circular potential;
- the local dimension facilitates connections between different stakeholders and a culture of collaboration;
- local governments can lead the way by offering and purchasing circular solutions and services;
- local institutions can define and communicate a vision and strategy of circularity and incorporate circular principles into infrastructure and services.

The transition of cities and territories towards economic models capable of ensuring economic, environmental and social sustainability requires a step change in collaboration between sectors and between territories themselves, the dissemination of new models of consumption (sharing, reuse, etc.), the involvement of key players in the design and implementation of innovative solutions, as well as the development of technologies, the implementation of sharing platforms and integrated projects, and greater involvement of citizens. This is a systemic and cross-sectoral approach that often emerges in the preparation of national and local Urban Agendas that outline the themes and guidelines that characterise the new European Urban Agenda.

The solutions to be proposed and tested, therefore, must not only be of a technical and technological nature, but also of a reconfiguration of governance and management systems.

Looking at circularity from the point of view of the urban and local dimension can make a difference in its effective development: as discussed, efficiency in the use of resources is all the greater when they remain in limited territorial areas, minimising transport costs and reducing the risks arising from long supply chains. In addition, focusing circular development models on local specificities makes it possible to enhance the resources present in the area,

nurture virtuous circles of knowledge development and dedicated technologies, and leverage the participation and involvement of local stakeholders.

There are several opportunities for developing circularity at the local level, in particular:

The introduction of dedicated strategies that can identify the strengths of local economies for a circular transition and provide the most suitable tools;

The identification by businesses of circular initiatives at local level;

Various tools at European level designed to foster the sharing of circular approaches applicable to cities and territories.

The transition to a circular economy requires a structural change, a rethinking of strategies and market models in order to safeguard the competitiveness of industrial sectors and the natural resource base. In addition, from the perspective of the circular economy, not only must the added value of materials and energy be maintained for as long as possible over several production and use cycles, but this added value, and the economic benefits derived from it, must remain within the systems directly involved and not be delegated or transferred to third parties. To this end, it is of course to take action on the following lines:

-identification of economic instruments to create adequate incentives for the adoption of circular and sustainable production and consumption models, promoting the transition towards environmental tax reform

- organisation of communication and awareness-raising activities to inform citizens on new consumption models, central and local administrations on the opportunities and benefits related to the circular economy and to foster cooperation among all the actors of the circular economy - public administrations, enterprises, scientific and technological research institutes

- promotion of research to foster innovation and technology transfer and the competitiveness of industrial sectors and the training of managers and technicians to meet the new requirements of the circular economy;

- promotion of the use of digital technologies as a tool for measuring and monitoring the use of resources, waste and production residue management and a broader transformation of business models.

With this in mind, the measurement of circularity is an essential requirement to enable concrete actions to be pursued and measurable results to be achieved, to move towards greater transparency for the market and the consumer.

The purpose of this work is therefore to provide tools for measuring the circular economy through the construction of ad hoc indicators based on official statistical data