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Territories' Challenges and Opportunities to Promote Circular Economy in the Building Sector

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***Abstract*—**The rapid development of cities implies significant material inflows and outflows. The construction sector is one of the main consumers of raw materials and producers of waste. The waste from the building sector, for its quantity and potential for recovery, constitutes significant deposits requiring major efforts, by combining different actors, to achieve the circular economy's objectives. It is necessary to understand and know the current construction actors' knowledge of stocks, urban metabolism, deposits, and recovery practices in this context. This article aims to explore the role of local governments in planning strategies by facilitating a circular economy. In particular, the principal opportunities and challenges of communities for applying the principles of the circular economy in the building sector will be identified. The approach used for the study was to conduct semi-structured interviews with those responsible for circular economy projects within local administrations of some communities in France. The results show territories' involvement in the inclusion and application of the principles of the circular economy in the building sector. The main challenges encountered are numerous, hence the importance of having identified and described them so that the different actors can work to meet them.

***Keywords*—**Building stock, circular economy, interview, local authorities.

I. Introduction

ONE of the circular economy strategies' goal is to reduce the total primary resources extracted from the environment and, at the same time, to reduce and better manage wastes generated by human economic activities. The construction sector has strategic importance because of its impact on the economy and society. Nevertheless, its development requires a vast quantity of natural resources representing around 50% of all extracted material; besides, the construction and demolition wastes (CDW) account for almost 40% of the total solid wastes generated in the European Union [1]. In France, the situation is similar, for instance in 2018 were generated 240 million tons of CDW [1]. The growing urbanization [2] increases the amount of CDW and the negative impacts on the environment and society. Consequently, the CDW is defined as a priority in the European Union circular economy plans [3] and French laws [4] to promote sustainability of the building industry.

The CDW management is an interdisciplinary subject [4]-[6] that implies economic, social, and environmental aspects; additionally, it surrounds challenging issues from technology, engineering, sociology, management, and policies. In addition to transversality, the new directives highlight the need to understand the circular economy on a multi-scalar level.

In France, the local authorities have to organize and collect waste and their treatment [8]. But the anti-waste law for a circular economy [7] gives to them a competence of coordination and animation of the actions carried out by stakeholders in terms of circular economy, including the development of the territorial network of the infrastructures of treatment and management of waste [7]. Moreover, regional authorities are responsible for planning waste management. To achieve these goals, stockholders need to know their territory to identify the stock's anthropogenic resources and the waste flows.

Faced with the circular economy's challenges, interviews with various French local authorities were carried out to collect their testimonies and identify their needs to encourage the circular economy strategies' application in their territories. The article focuses on the opportunities and challenges encountered to apply these strategies.

II. Challenges and Opportunities

A. Urban Metabolism and Territorial Diagnosis

Urban metabolism is defined by [9] as «the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste». In practice, urban metabolism implies the quantification of the inputs (imports), local extraction (local production of resources), local circular economy loops (local reuse and recycle loops), outputs (exports), and storage of resources and wastes for a territory. Therefore, urban metabolism becomes a key tool for territorial diagnosis.

Circular economy strategies revolve around several stages: a diagnosis of the territory, a roadmap, public initiation and support policies, and evaluation. A territorial diagnosis is used to identify and quantify the stocks and flows of materials; this diagnosis will answer questions such as: What is the nature and quantity of these stocks and flows? What percentage of these flows are imported and exported? Which are the characteristics of waste flows, and how to reduce them? Spatially and temporally, what are the characteristics and availability of resource deposits? What percentage of the flows are reused or recycled? What are the main recycling and reuse channels in the territory? Which economic actors are involved?

Although stockholders are currently aware of the questions and issues, most territories and actors have insufficient knowledge of this information and a lack of quantitative analyses of the flow and stock of materials.

Interviews showed that the level of knowledge about CDW at the territorial level varies from one territory to another.

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Stockholders said that to support the deployment of reuse or recycling channels is necessary to know the flows according to a relatively detailed nomenclature (finer than inert waste, non-hazardous waste, and hazardous waste). This information on nature and quantities is decisive for identifying opportunities in the sector, thus predefining secondary material storage and treatment needs.

Some territories have initial elements to estimates material flows and stocks while these models are frequently based on historical economic data. They mention that these kinds of models do not allow to include and visualize circular economy strategies benefits. It is then more interesting to have models based on physical descriptions of flows because they allow evaluating circular economy strategies' impact.

B. Avoiding Deconstructions

A building is commonly sized for a lifespan of 50 years; however, the use of the building will influence its longevity. A residential building's lifespan is estimated to be between 70 and 100 years, while for a logistics or industrial building, it is only estimated at 30 or 40 years [10]. Such a difference is not linked to the building's structural resistance, except that tertiary buildings must be profitable on investment and meet the needs of investors. Therefore, they are demolished or deconstructed before reaching their programmed lifespan.

As buildings' structure is not flexible and adapted to future uses, the buildings with still good mechanical resistance are deconstructed to give rise to new constructions. This type of logic only strengthens the linear economy and increases the environmental impacts. It is still a sensitive issue because deconstruction is currently standard practice, and it could take some time to change if the stakeholders are not aware of the subject and do not control strategies to communicate and change this practice.

In a circular metabolism context, it is intended that buildings are preserved instead of being deconstructed by applying actions of maintenance, restoration, and renovation. In a circular economy logic, deconstructing a building would be the last option if the building can offer good structural and sanitary characteristics. Furthermore, when this stage has arrived, it is necessary to institute a selective dismantling and deconstruction process because dismantling an element without damaging it authorizes its reuse. Therefore, it is possible to better separate resources and optimize their reuse and recycling.

A first step to avoid deconstruction is to sensitize the actors and encourage them to renovate, rehabilitate, and change the use of existing buildings instead of deconstruction, only if the buildings can guarantee the safety and health conditions of the users. Besides, avoiding deconstruction needs a rethinking of the building's materiality and usefulness during its life cycle. That would involve designing buildings that would not be destroyed at the end of their scheduled life cycle and re-think in the multi-use for buildings both in the case of new and existing buildings. Moreover, the new economic models are leading us to reflect on the conversion of a building single-use to that of shared-use, such as the implementation of home-shared temporary spaces; it is the case with Airbnb, or the co-living and co-working offices. Furthermore, individuals with available home spaces can rent them as co-working spaces to other professionals during the daytime to generate other economic incomes. Companies with excedent spaces can also implement these models. It is also essential to design and build modular buildings adaptable to tomorrow's lifestyles because the longevity of a building depends mainly on its flexibility towards the evolution of the distribution of surfaces and its adaptation to future needs.

C. Training and Qualification

Training and awareness-raising for stakeholders are essential to encourage them to consider the questions and challenges raised by the circular economy. Simultaneously, they should be trained in buildings diagnostics, reusing and recycling networks, and the integration of secondary resources in construction practices from the building design until the building deconstruction. This awareness will make it possible to modify the practices of the various actors who intervene throughout the building's life cycle.

To act at the building level, diagnosticians should be trained to correctly diagnose the materials and identify which ones will be reusable and how they will be reused. Project owners' and local authorities' feedback is that diagnostic experts have databases with materials and densities types to estimate stock and future material flows nowadays; nevertheless, the comparison between the estimate of materials and the reality gives significant deviations that concern principally the nature, quantity, and state of secondary resources. Consequently, local authorities mention that diagnosticians' qualifications and training are essential to reconcile both the knowledge of materials in the building sector and the knowledge of waste and potential sectors to reuse and recycling. Because, currently, these two worlds do not speak to each other, and the objective is that diagnosticians not only speak to each other, but they are grouped within the same person who will carry out the diagnosis.

Still at the building level, nowadays, demolishers have the necessary knowledge to effectuate a deconstruction. Classical demolition is mostly mechanized, and consequently involves fewer workers than selective deconstruction. Even when the demolishers have time to do a selective deconstruction, they tend to go back to their usual techniques because they are not yet fully aware of the challenge of selective sorting, reuse, recycling, and material recovery. Besides, they do not yet have the technical and economic means to carry it out naturally. Although the owners can apply sanctions, the work should be carried out inherently to guarantee its resilience over time.

To encourage the application of sustainable and circular techniques, the overrun cost due to selective deconstruction time and drudgery work could be shared between the owner and the demolisher, thus encouraging them to change their traditional methods. Although resistance to change may be ironclad, awareness-raising could make it possible to establish a culture of anticipation, preparation, control, and monitoring of the entire deconstruction process and its actors. In this context, the stakeholders mention that the chambers of commerce are interested in this issue and understand that it is also part of their interest to find the levers to establish the new technical and economic model in which their circularity objectives can also converge. Architects, project managers, construction companies, and control offices must also be trained to handle sustainable and circular techniques related to using secondary materials and promoting their reintegration into the local economy.

D.Characterizing the Deposits and Scales of Action

The application of the circular economy transcends geographic scales as the exchange of resources most of the time takes place beyond administrative borders, however, one of the principles of the circular economy is proximity and short circuits. Nevertheless, the circular economy local application principle is not always the most relevant due to logistical or economic constraints. Some materials flow, for example, must first be massified and then recovered. According to the actors' opinion, the main points of interest for implementing a circular economy are the fields and the scale of action.

According to the actors' opinion, the main points of interest for implementing a circular economy are the fields and the scale of action. Moreover, a structured characterization of secondary resources deposits and flows must include time scale to use it as a prospective tool. Besides, it is important to know too the state of mechanical and sanitary of resources.

At the building scale or a development operation, one of the essential steps in re-employment is realizing a resource diagnosis instead of a waste diagnosis because this will allow characterizing the possibilities of reuse materials; nevertheless, a resource diagnosis should require completeness in order to unexpected materials can find takers. Moreover, the advantage of resource diagnosis is that it presents the quantities, characteristics, photos, location and anticipates the deposits and future use conditions. Stakeholders highlight the importance and need to have information about the structure's quality to assess the potential for reusing or recycling the entire structure. This information should be included in the diagnosis, together with data on the potential for ex-situ or in-situ resources and land availability, thus making the outlet or deployable channels more reliable. After the characterization of materials by the diagnosis of resources and the client's decision-making on the reuse of materials in situ, outside takers' identification for the secondary resources that could not be reused in situ is essential. Finally, circular strategies for selective removal, packaging, transport, and possible intermediate storage should be put in place.

The temporality of operations, availability, and the requirements of resources requires thinking at the territorial level. Reuse platforms are the temporal link between material deposits and outlets; that is, the link between supply and demand. These platforms' service, physical or digital, represents one of the main levers for implementing the circular economy at the territorial level.

Currently, the territorial network of collection points is insufficient, especially in rural areas, limiting access to secondary materials, thus preventing large-scale processing that will reduce costs and impacts mainly related to transport. Therefore, the temporal and territorial characterization of potential deposits is relevant for setting up local platforms to structure the sector of reuse and recycle. The characterization of the deposit at this scale is essential because a reduced or deficient quality deposit can call into question the platform's creation. Indeed, the creation of platforms involves identifying operators, planning the land that will accommodate it, and the charter of use. Local authorities also have control at this scale because they manage a large part of the territorial land and they can use the prospective characterization of deposits to plan land for the development of platforms in their territory.

E. Storage and Land

Resource collection and development companies are essential to manage secondary resources better. To store the secondary resources collected, the availability of land is also necessary in order to stabilize the deposits. One of the main levers of communities is their management of public lands. Therefore, they can provide spaces or areas dedicated to the storage, sorting and treatment of fixed and temporary materials. The networking of these platforms will facilitate exchanges and qualification of materials; however, for “specific singular flows”, these platforms will have to be installed on a larger geographic scale (for example, inter-municipal, inter-departmental, regional).

F. Traceability and Digitalization

The main objective of traceability is to make the complete follow-up of secondary resources and share the information with the actors. Thus, the development of traceability models is a major challenge to ensure the quality of secondary resource because it will allow the quantification of flows and real-time monitoring of resources, but also to share information so that each stakeholder can take part in his responsibility throughout the processing chain, that is to say, from the site to the outlet.

Local authorities' feedback left clear that the sector must combine with new digital tools to promote traceability and optimal flow management. With digitization, it would be possible to link actors, create networks to access data, and help decision-making. Having information in real-time will also make it possible to observe any slippages to react quickly.

G.Performance of Secondary and Standard Materials

The use of secondary materials is hampered because of regulations, standards, or insurance not yet ready because there is still the issue of testing to verify these materials' performance in the context of their use. Therefore, the owners and insurers, little reassured about the resources' technical and sanitary quality, hesitate to use them in their projects.

In a building construction, the structural office and the project engineer are criminally responsible for the structure's stability with a ten-year guarantee, while the second work only involves civil liability. To be insured, it is necessary to justify the work using current techniques covered by current technical standards or documents. However, reuse is not considered a standard technique, and projects may therefore be subjected to additional premiums. With sufficient data available for reuse materials, they can be considered non-standard techniques by the Construction Quality Agency and not be subjected to a premium. In this context, designers and builders need first the information of the mechanical performance of the resource secondary; that is to say, 1) define the quality of the material over time according to project specifications, 2) categorize the techniques and constructive solutions with reuse materials, and finally 3) develop synergies between the actors to encourage the reinsertion of materials.

H.Census and Synergy of Stakeholders

The circular economy needs the participation of all stakeholders to be effective. This implies articulated thinking, from the moment of design, production, to the end of the building's life and the reintegration of secondary materials into the economic chain. Each of the participating parties plays a role that will contribute to the success of the transition. The communities' role is to develop synergies between the actors; that is to say, to manage the governance that is characterized by the development of the capacity for animation and collaboration between stakeholders. Strengthening the link between elected officials, developers, and project owners is essential to move towards an iterative approach. This governance's main objective is the convergence between the strategic and operational part of the application of the pillars of the circular economy in the sector.

III. Conclusion

The construction sector represents an opportunity and a necessity for the application of the circular economy. Reaching the objectives of the circular economy in the sector will depend on the construction actors and their ability to evolve and adapt to the challenges generated by the economic, societal, technical, environmental, and legal factors.

At the territorial scale, the circular economy imposes the understanding of urban metabolism, that is, of the territory's needs for resources and its capacity to create local loops within a logic of cooperation of actors. This encourages territorial collectivities to consider waste flows as a governance stake to improve their resource footprint and at the same time improve their modes of production and consummation; this requires the cooperation of both administrative actors and economic actors, and civil society.

Due to their competencies and their animation and facilitation roles, the territorial communities are privileged actors to develop and coordinate the circular economy strategies in the territory. Although there are many challenges to overcome, they must be seen as opportunities to achieve circular, resilient, and sober territories.

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