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Questa è la Versione finale referata (Post print/Accepted manuscript) della seguente pubblicazione:

Original Citation:

Sustainable re-use of spaces and buildings: application of the principles of circular economy to urban regeneration / Leonardo Borsacchi; Daniela Tacconi. - ELETTRONICO. - (2021), pp. 0-0. (Intervento presentato al convegno 27nd International Sustainable Development Research Society Conference).

Availability:

This version is available at: 2158/1259456 since: 2022-03-01T12:28:29Z

Publisher:

Mid Sweden University, Östersund, Sweden

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(Article begins on next page)

PROCEEDINGS

of the 27th Annual Conference, International Sustainable Development Research Society

Accelerating the progress towards
the 2030 SDGs in times of crisis

Östersund, Sweden, July 13–15 2021



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Proceedings of abstracts and papers

ISBN 978-91-89341-17-3

Publisher Mid Sweden University, Östersund, Sweden

Editors Catrin Johansson and Volker Mauerhofer

Sustainable re-use of spaces and buildings: application of the principles of circular economy to urban regeneration

Case study of the City of Prato, Tuscany (Italy)

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Abstract

Cities are complex systems subjected to continuous transformations. The changes in society and the different production requires the redesign of urban spaces, often favouring some areas and marginalizing others. As time goes by, buildings change their usefulness, remaining unused and abandoned. The consumption of new land for new buildings, together with the production of waste materials from the demolition, contribute to burdening the negative balance of the city system in consumption of resources and production of waste. With regard to the life cycle of a building, similarities can be highlighted with the life cycle of a commodity. In the current debate, production process are shifting according to sustainability criteria. By innovative solutions, it is possible to rethink production processes, enhancing for example the use of secondary raw materials and by-products, creating the conditions to minimize negative impacts, implementing recovery and reuse, as well as by the adoption of responsible solutions.

Today, public decision-makers must define urban planning policies capable to guarantee, in the long term, a sustainable development in line with the objectives of the United Nations 2030 Agenda. In doing this, policy makers could try to consider the city as a commodity, whose life cycle is made up of continuous use and transformation of flows of materials, energy and ideas. In fact, this approach could offer opportunities for improve the innovation and the sustainability of cities. More, by increasing the level of awareness at the urban level can push citizens towards more sustainable consumption models. Through working groups formed by qualified stakeholders, it is possible to highlight the barriers (i.e. technological, regulatory, and economic) that slow down the full application of circular economy principles. Through participatory processes of co-design, it is possible to assign new functions to unused buildings.

This paper aims to describe examples of urban regeneration based on a circular economy approach, taking into account the case of the city of Prato, Italy. In fact, within the city system, the integrated understanding of interconnection between inhabited areas, commercial, industrial areas, green, and agricultural areas, enables the implementation of good circular practices.

The paper mainly relates to SDG 11, target 11.3. Thanks to the adapting reuse and the transformation of existing buildings, cities will be more sustainable and resilient in the future, contributing to the increase in the well-being and quality of life of citizens, strengthening their identities, memories, cultures, respect for the environment, contributing to social inclusion and economic growth.

Keywords: Buildings, Urban regeneration, Selective demolition, Sustainable materials, Circular economy.

1. Introduction

Cities are dense and highly congested physical spaces that are prone to a myriad of challenges such as population growth, urban sprawl, climate change, environmental degradation (United for Smart Sustainable Cities, 2020). The strategies the cities must adopt to reduce the consumption of new exhaustible resources involves the shift from productive systems to generative systems (Latour, 2017). Urban regeneration policies should provide adequate solutions for each phase of the city's transformation, exploiting the opportunities and strengths that can potentially make them key players in the transition to more sustainable solutions. Indeed, cities are increasingly moving to actions aimed at reconsidering settlement models based above all on the re-use, recycling and development of creative economies. The sense of physical community that exists within cities facilitates people's engagement in political change, compared to the regional or national level. Thus, participatory processes must contribute to regeneration, it is up to public administrations to decide and facilitate re-use within a more comprehensive design based on medium-long term policies.

In 2015, the European Commission adopted the "Circular Economy Package" in order to stimulate the transition from a linear economy to a circular economy. The "Roadmap to a Resource Efficient Europe" sets the goal to achieve zero net land take by 2050. Thus, an important aspect required to make efficient use of soils within a circular economy, is the clever use of space (Breure et al., 2018). Even if the package has represented a significant development in EU policies, land itself is rarely viewed as a resource on its own. The main reason for that might be the fact that it is not easy to include land into consumption and production loops and, even more importantly, the EU has less direct influence on urban development and planning issues than on more concrete environmental factors (Urban Agenda for the EU, 2019). According EU policies, cities play a central role in the development of a circular economy. They act as test-beds of potential measures, by which transition can be achieved. This has also been emphasised in the United Nations agreements of the New Urban Agenda and the 2030 Agenda on Sustainable Development and is now more relevant due to the effects of the Covid-19 pandemic

crisis (Feeleki, 2021). However, this is not a process without obstacles. In fact, the transition depends not only on strong commitment of local policy makers, but also on overcoming constraints that mostly depend on higher levels of decision-makers than urban ones.

The application of the circular approach within a territory (e.g. urban area) involves municipalities, production activities, relevant stakeholders and citizens, in order to create opportunities lowering the depletion of new resources. The model for circular city, proposed in figure 1, aims to describe a holistic and systematic governance, bringing together public authorities, universities, enterprises, NGOs and citizens. The system includes three areas within the city, each interconnected: residential, industrial, and agricultural land and forestry.

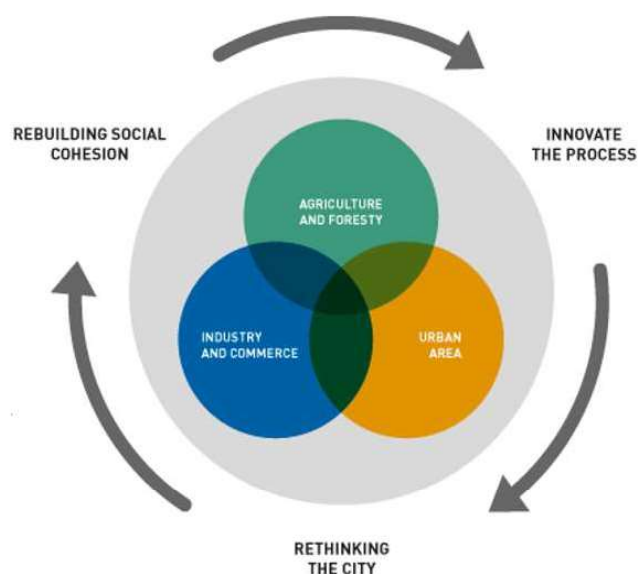


Figure 1. Circular city model (Source: authors)

For the public sector as well as enterprises, the transition to circular economy requires innovation in order to adequate technologies and processes (“*Innovate the process*”). Therefore, new challenges are the ones of re-use and transformation of existing buildings, in particular the unused ones (“*Rethinking the city*”). The aim is to create new economic and social opportunities without consuming new land, and at the same time to improve the environmental performance of buildings and infrastructures in their entire life cycle, proposing new urban scenarios and solutions (Borsacchi et al., 2019). Beyond the environmental aspect, the challenge of the sustainability within a city entails as well economic and social facets. New policies have to take into consideration, involving both citizens and entrepreneurs, in order to reduce issues about a bad waste management and to reinforce the social cohesion (“*Rebuild Social Cohesion*”). In particular, through the construction of an inclusive and supportive community, based on the principles of sharing economy and by the adoption of creative re-use practices (i.e. innovative driving forces for business activities, social purposes and charity) (Borsacchi, et al., 2020).

At the European level, there are many positive experiences of effective temporary or permanent employment of certain previously abandoned or unutilized spaces and buildings enabled through participation and active citizenship. Participatory processes must contribute to regeneration, however, it is up to public administrations to decide and facilitate re-use within a more comprehensive design based on medium-long term policies. In fact, compared to new extensions and new constructions, which usually depend only on the decisions of developers, re-use offers a greater possibility of transforming and reinventing the city according to one's desires and through forms of social and civic activism (Scandurra, Attili, 2013).

2. Methods

Within a city, it is possible to implement good circular practices, but at the same time, there are barriers that slow down the fully application of principles of circularity in the reuse of buildings and spaces. Considering that, this paper aims to describe examples of urban regeneration based on a circular economy approach, taking into account the case of the city of Prato, Italy, focusing in particular on the following specific objectives: i) To understand the main relations among local stakeholder (both public and private) in the building sector. In fact, developing partnerships involving local authorities (including different departments within the local administration), beneficiaries/ users, NGOs, public agencies, the private sector and the civil society has proven to be a key component in the design and implementation of efficient urban policies. ii) To explore the main issues and barriers that affect the transition to the adoption of circular principles in the building sector. iii) To collectively identify and suggest potential initiatives and proposals. In order to achieve the above-mentioned objectives, the study has adopted a participatory methodology based on the active involvement of local stakeholders. In particular: a) Desk-based analysis of official reports released by relevant government institutions, sector authorities and private organizations. b) Conduction of semi-structured interviews with representatives of local institutions and stakeholders, ranging from the Municipality of Prato, production categories, professionals and associations. c) Facilitation of focus group discussions with local stakeholders, to discuss collectively the main needs concerning the building sector (i.e. materials, regulation, standards, awareness) and the relations with relevant value chain actors, paving the way for an open brainstorming on potential solutions. Interviews and focus groups were organized in the framework of the activities foreseen by the URGE - URBACT project and in those organized in the framework of the local strategy "Prato Circular City".

URGE (standing for "circUlaR buildinG citiEs") is an Action Planning network on circular economy in the construction sector, bringing together nine cities and their stakeholders to inspire and learn from each other in developing their integrated urban policy. This supports integration of circularity in the construction tasks, thus contributing to sustainable cities. Prato has been selected to contribute to the

definition of an action plan together with the cities of Utrecht, Munich, Copenhagen, Kavala, Granada, Riga, Oeste and Nigrad. Every city partner is required to set up an URBACT Local Group (ULG) that bring around the table all relevant stakeholders, representing different interests and perspectives, to frame problems, agree policy priorities and design concrete solutions. In this context, partners' ULG are expected to co-produce city strategies. Developing partnerships involving local authorities (including different departments within the local administration), beneficiaries/ users, NGOs, public agencies, the private sector and the civil society (citizens and inhabitants) has proven to be a key component in the design and implementation of efficient urban policies.

Prato Circular City is the strategy operates to overcome the barriers that slow down the transition to the circular economy. For this reason, Prato Circular City focuses on better regulation, better funding and better knowledge. Organised as a living lab, it works as follow: 1) Identification of relevant stakeholders, according the topics, and willingness to participate in meetings. 2) Organisation of thematic working tables in the identified areas and for specific topics. 3) Focusing on specific topics, chosen and validated by the participants. Discussion of the specific topics in working groups. 4) Presentation of the proposals for action to others outside the working group and collection of feedbacks. The defined actions are compiled in an operational plan containing implementation modalities and timing. Group participants are invited to identify and share initiatives; good practices and existing networks (knowledge); relevant legislation (regulation); relevant funding calls (funding). Based on the information gathered, a hypothesis of action is formulated, which is then evaluated through criteria and by a decision tree. Specifically, the working groups that discuss issues related to the construction industry are the Operational working group on circular public procurements and the Crosscutting working group on municipal regulations.

The novelty of the study, and in the approach, consists in the adoption of an integrated approach that consider: 1) the legislative framework at European, national and city level; 2) the discussion and the share of best practice about circular reuse of buildings at different levels and involving multiple stakeholders. This harmonic range of different inputs has allowed diversifying the sources of information, digging deeper in the topic and crosschecking findings and results, in order to obtain a comprehensive and consistent picture about the main issues affecting the building sector and the application of circular principles. The flexibility of the selected method has been crucial to tailor them to the relevant target (e.g. different interviewees or group participants). In addition, the focus group discussions have represented crucial occasions for participatory collective brainstorming, leading participants to openly recognise the need for a more frequent interaction (both within and between cooperatives) to discuss relevant needs and potential solutions.

3. Results and Discussion

In Prato, the concept of re-use is part of the genetic heritage of the city and its inhabitants. Prato, with its almost 200,000 inhabitants is the second largest city in Tuscany and the third largest in central Italy in terms of the number of residents. Famous worldwide for its textile district, it has over 3,500 companies. Textile production in Prato has historically based its fortunes on the reuse of textile waste from manufacturing, and used clothing from all over the world. The application of circular economy principles to the textile chain has also created over the years virtuous symbiosis phenomena. Alongside the textile district, since the 1990s the fast fashion district has grown, with a sector of over 4,000 companies, mainly conducted by ethnic entrepreneurs. The availability of disused industrial buildings no longer in use due to relocation to more modern and functional ones, together with the gradual closure of certain activities, has led to a succession of public and private initiatives to recover and rehabilitate buildings and space. In fact, the City of Prato's approach to sustainability also includes issues such as modular and flexible building design; efficient, resilient and renewable energy systems; production systems based on the recovery, recycling and reuse of materials and energy. This approach is part of an integrated short- to medium-term plan based on digital and ecological transition, as well as on regeneration and inclusive policies. This vision of local public administration is pushed mainly by three conditions: 1) The presence of a homogeneous production district (i.e. textile) in which common interests and knowledge converge. This allows policies to be targeted. The textile sector is also a sector where innovative and sustainable production solutions can be introduced. At the same time is possible to cooperate in order to overcome regulation barriers, as well as to favours symbiotic phenomena among different materials chains (i.e. *innovation*). 2) The relocation of numerous production activities from the previous areas in new ones. This emptied numerous buildings in various parts of the city. By means of urban *regeneration* processes, the disused buildings can be rethought in terms of their functions and destinations. 3) The presence of a multicultural society on the territory represents a fertile ground for innovative solutions to strengthen social *cohesion*.

These conditions, together with Prato's experience within the European Partnership on Circular Economy (among the outputs produced by Prato in this frame were a position paper about the reuse of treated wastewater in agriculture and a Handbook on sustainable and circular re-use of spaces and buildings), led to the definition of Prato's strategy on circular buildings. More specifically, Prato has promoted a general vision on environmental issues that has configured the "Prato Green Deal 2050", in the logic of promoting healthy lifestyles, improving people's physical health, their relationships and the ability to take care of the quality of public places. As part of this overall strategy, a series of steps have been undertaken and a variety of programs have been and are still in progress. Over the years, there have been numerous initiatives to recover and reuse spaces and buildings. In many cases, the initial function of the building has been changed. This responded to emerging new needs of citizens. In general, in fact, regeneration interventions have involved the conversion of buildings previously used

for production that have become places with recreational and social purposes. At the same time, in some abandoned spaces have been created the conditions for a newfound sociality. In Table 1 a selection of interventions are explained:

Table 1. Example of reuse of spaces and buildings in Prato (Source: authors from *Urban Agenda for the EU*, 2020)

Location	Previous function of the building/space/area, and main regeneration activities	Results
Textile Museum and Lazerini Library	The Municipality of Prato purchased the area of the former factory at the end of the 1990s. In the first restored portion, the Prato Textile Museum (the largest of its kind in Italy) is located. The restored spaces of the remaining portions are home to the new public library inaugurated in 2009.	Conversion of a former textile factory into a museum and library (completed).
Officina Giovani	In 2005, after the closure of the Macelli Pubblici (public slaughterhouses), the Municipality decided to dedicate the entire area to projects and functions linked to the world of youth, creating Officina Giovani. The intervention has preserved the original appearance of the building. In the following years, various interventions have taken place in the other buildings, which have gradually become theatrical spaces, places of dissemination and exhibition, points of cultural exchange and study.	Transformation of the former slaughterhouses into a place for youth participation and culture (completed).
Bisenzio river banks	Prato has a strong historical bond with the Bisenzio, the river that flows through it. Riversibility is a scientific project, which promotes health and wellness. The design and functional choices arise from needs highlighted in a participatory process with citizens. Along the banks of the Bisenzio have been organized equipped areas for sports, recreation, socialization, in addition to the bike path.	River park for the promotion of sustainability, health and wellness (in progress).
Old hospital area	No longer used since 2014 following the construction of the new hospital in Prato and the subsequent transfer of all departments, the municipal administration has considered the possibility of returning the area to the old "Podere dello Spedale" to create an equipped urban park. Through selective demolition, the old hospital building was completely demolished in 2020, managing to recover and send to recycling and reuse chains more than 90% of the materials	Creation of a new large public urban park (in progress).
Mountain village of Mezzana	On the Calvana mountains, in the surroundings of Prato, a small village of a dozen houses has remained uninhabited since the 1970s. The project to restore the village is being carried out by the religious community of "Ricostruttori nella Preghiera". Monks and numerous volunteers work to recover all the buildings through a faithful reconstruction. The intervention is inspired by the idea of integral ecology and the values of solidarity and hospitality.	Recovery of an abandoned mountain village for spiritual activities (in progress).

In this context, it is interesting to focus and discuss more in deep the process of regeneration of the area called "Macrolotto 0" is being carried out. Among the planned interventions, there is the reconversion of an old disused textile factory into a covered space for the short chain food market. The space also integrates interventions of urban forestation and the promotion of social inclusion activities. The

creation of the first permanent and covered food market in Prato willing to be a driver to attract and boost initiatives, including private and rethink other specific parts of the city. Moreover, together with the market, the regenerated area also includes a medialibrary and coworking space and the requalification of an open area into playground, equipped for outdoor sports. The so-called "Macrolotto 0" area, located just outside the city walls, was characterized by a multitude of textile companies and workshops in the 60s and 70s. With the relocation of textile activities to another area of the city, nowadays is the place where one of the largest Chinese community lives. In the intentions of the municipal administration, the idea is to transform the area into a creative district. The aim is the creation of an area with new functions, more technological and more contemporary. The intervention was funded through two projects: "PIU", co-financed by the Tuscany Region, and "Prato Urban Jungle", within the framework of Urban Innovative Action. One intervention interested a former textile industrial building, transformed into a market of short chain agri-food products and street food, in a permanent and covered space of 900 m².

In the same building, there is the idea to create the largest Italian so called "air factory" in Italy, increasing the environmental and social value of the place. In the renovation, the original building has been completely preserved. With its high energy efficiency qualification and by the use of certified environmentally friendly materials for the flooring, the building has been regenerated with the intention to have fully recyclable components at the end of its life. Renovations were completed in December 2020 and from May 2021 it has been hosting the "Terra di Prato" short supply chain farmers' market. The intervention represents a best practice of circular reuse of the industrial heritage, by the promotion of urban ecology, social interaction, cultural exchange, creativity, creation of value for the city. The main challenge was to preserve a building of the industrial heritage by regeneration, giving it a new function according environmental, social and economic principles. Good environmental practices have been adopted by the use of recovered and recycled materials. On the one hand, for the external walls, use of about 650 m² of insulating panels, made of secondary raw materials derived from the recovery of textile wasted material from the Prato district. On the other hand, for the 1,100 m² large roof were used various insulating elements not derived from the local textile chain but still with a high content of recycled materials. Moreover, the insulations have been assembled with system which can be easily disassembled, with the possibility of recovering most of the materials used. Among the difficulties encountered, there was the adoption in an old building of current regulations (i.e. structural, seismic and sanitary). The topic of the reuse of buildings is debated: preserving and regenerating a historical and/or industrial building is important because it allows us to maintain the memory of a previous productive structure and the tradition of a place, of a city. However, it is essential a strong commitment and vision by the local public administrators. Replicating this type of initiative without the intervention of Municipality could be problematic in terms of cost/benefit and technical aspects. The lessons learned during this experience can be summarised as follows:

- This kind of public interventions represent an element of urban and functional requalification that acts as a best practice to drive and push private interventions;
- The fragmentation of ownership in a specific area (i.e. buildings of former factories) can make it difficult to implement larger-scale, integrated regeneration projects;
- It is requested to conduct the analysis and classification of the industrial heritage by identification of unused buildings and their properties.

With the above-mentioned examples of urban regeneration, the city of Prato demonstrates that collaboration through public-private partnerships is crucial for the implementation of circularity, strongly based on three pillars: innovation, cohesion, regeneration.

Findings and lesson learned emerged can be consider also in general terms about the application of circular economy principles at the construction sector. In more general terms, during the interviews and the focus group, the main barriers and the related action needed have been identified, as reported in the following table 2:

Table 2. Main barriers and action needed in the application of circular economy at the construction sector

CHALLENGES	
(i)	Material reuse and transformation of existing unused buildings (and spaces);
(ii)	Improvement of the environmental performance of buildings and infrastructures in their entire life cycle;
(iii)	To boost the circularity of materials and the industrial symbiosis phenomena.
BARRIERS	ACTION NEEDED
Minimum environmental criteria in public procurement inflexible and difficult to apply in the case of products made from recycled materials.	Increase the awareness of minimum environmental criteria among civil servants. A guidance is needed on their application to ensure their positive environmental impacts.
Lack of knowledge among professionals (e.g. architects) about new materials made from recovered or recycled materials.	Targeted training activities for professionals and technicians of the building sector. Organization of specific workshops on circularity criteria destined to construction companies. Targeted training activities destined to civil servants on sustainable materials and circular economy concepts.
Building materials made from secondary raw materials and from recovered materials may encounter standardisation and certification issues. Problems are largely due to the variability of recovered materials, also depending the chain.	Selection of secondary raw materials and definition of critical aspects (i.e. protocol of reuse) by definition of quality characterization, traceability and standardization.
Lack of knowledge regarding the availability of sustainable materials at local level.	Creation of local platforms to increase awareness about “short chain” recoverable/recyclable materials.
The construction sector has not invested enough in the reuse of materials.	Enable conditions to increase demand for recycled materials, starting with interventions on public buildings.

The barriers identified insist on legislative aspects, the lack of knowledge and the need for funds for the sector innovation. In the regeneration process of a building, by considering its life cycle in a similar

way to the one of a commodity, it is possible to apply circular principals regarding economic, environmental and social aspects.

At the local level, it is advisable for the municipality to create an inventory of vacant buildings. Keep the inventory of unused entities constantly updated in the form of due diligence (property, type, reusability). There are several ways to inventory vacant properties, including through urban agencies, computer platforms or by checking consumption on households. Being aware of the availability of certain unused buildings in certain areas can direct towards the definition of regeneration strategies (i.e. coordinate, intercept, aggregate and promote the formation of demand for unused spaces and buildings). In this sense, specific requests can also come from citizens. In any case, using participatory processes it is possible to rethink collectively new functions and destinations of buildings, spaces, areas (i.e. harmonize the forms of active participation in the territory. Promote and develop appropriate communication strategies). The interventions of recovery and renovation of the building should be done as much as possible with environmentally sustainable materials and components. On the one hand, the use of building materials made from recovered materials. On the other, the importance of having recyclable materials at the end of the life of the building. In this sense, by innovative solutions, it is possible to rethink construction processes, enhancing for example the use of secondary raw materials and by-products, creating the conditions to minimize negative impacts, implementing recovery and reuse, as well as by the adoption of responsible solutions. This will be increasingly possible as knowledge barriers and constraints on regulations and standards are overcome.

Following the above listed flows, it is possible to elaborate the idea of circular economy approach. Goods placed on the market, after a longer or shorter period of use, turn into waste. These material flows contribute to a waste count whose upward trend must be reversed. Cities experience similar processes, albeit more complex and large-scale. The recovery and redevelopment of unused spaces and buildings, urban regeneration policies, and the rethinking of places where people live, do business, and live together, all redesign cities over time, using transformations that maximise their usefulness for those who live, work and travel in them. Today's public decision-makers must have the farsightedness to define urban planning policies capable of guaranteeing, in the long term, sustainable development in line with the objectives of the United Nations 2030 Agenda. In doing that, the idea of a “city as a commodity”, by following circular economy principles, can contribute in minimize waste in building sector.

Figure 2 summarizes the circular process of urban regeneration and assigning a new function to a building.

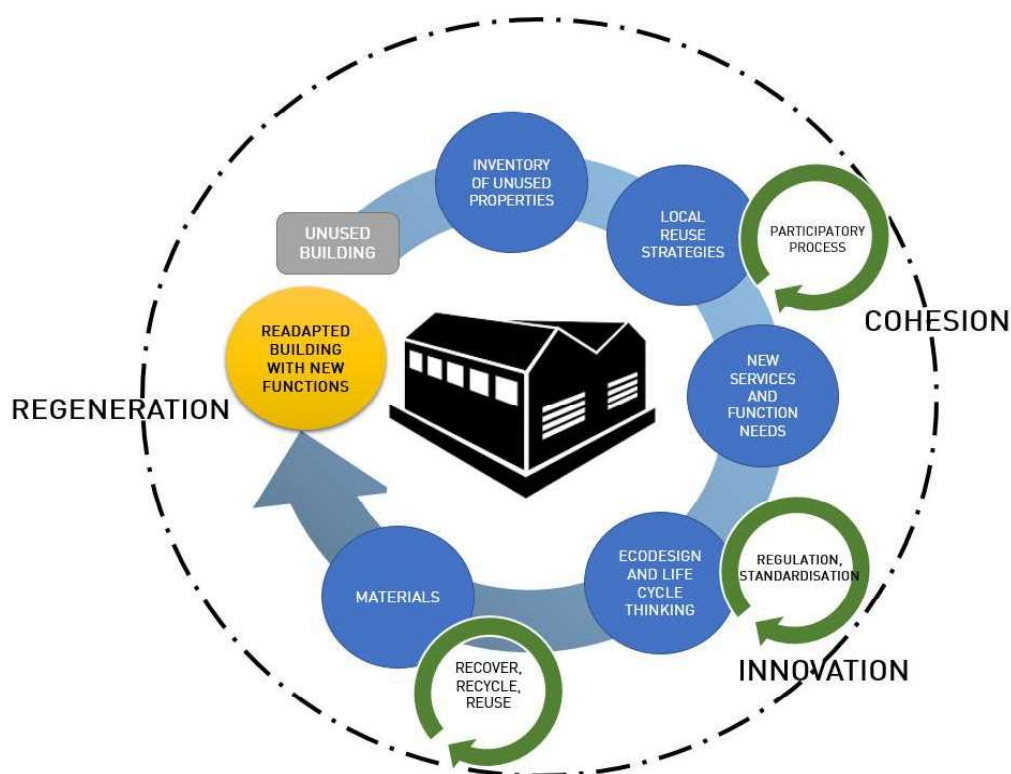


Figure 2. Circular economy principles in urban regeneration and building restoration (Source: authors)

The circular model proposed in figure 2 can be replicate in other cities that are already in place similar platform like “Prato Circular City”. Thus, open discussion environment where local policy makers are able to discuss and share good practices with local stakeholders, as well with upper level or policy makers. This approach can offer great opportunities for innovation and sustainability in cities and production systems. It also means enhancing virtuous initiatives by transferring and exploiting them in a wider system capable of fostering symbiosis phenomena. It is also possible at urban level to help, motivate or push citizens towards more sustainable consumption models.

4. Conclusions

Nowadays, circularity can be extended beyond solely economic activities and production processes to other social and environmental areas. Thus, the application of the circular approach within an urban area involves all stakeholders in order to create opportunities lowering the depletion of new resources. Circular actions within a city minimize the quantity of waste, contributing to reduce resources consumption by extending their lifetime. The successful implementation of circularity actions still require to overcome barriers. The case of the city of Prato demonstrates the successful circular initiatives carried out, and how collaboration through public-private partnerships is crucial for the

implementation of circularity. Thanks to the adapting reuse and the transformation of existing buildings, cities will be more sustainable and resilient in the future, contributing to the increase in the well-being and quality of life of citizens, strengthening their identities, memories, cultures, respect for the environment, contributing to social inclusion and economic growth.

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