The Canvas Model to Support the Circular Urban Regeneration Projects

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Abstract. In contemporary cities, abandoned industrial areas represent a significant problem. They are considered true "urban voids" characterized by underutilized land and buildings that have a negative impact on the urban environment, the local economy and resident's quality of life. However, underutilized heritage can serve as a valuable resource that enhances productivity across multiple dimensions, generating economic, social, and environmental value.

In this perspective, circular economy offers a co-evolutive perspective in conservation/management of the disused heritage.

Circular economy applied to urban regeneration aims to create socially inclusive and equitable cities through strategies that improve the quality of life for all residents, promote social cohesion, and enhance access to essential services and amenities.

Business Models are recognized as very useful support tools in urban regeneration processes. Through the analysis of community needs, available resources, and market trends, Business Models allow for the identification of sustainable and economically advantageous development perspectives.

This paper aims to provide an overview of how specific business models can support sustainable brownfield regeneration projects from a circular economy perspective. Specifically, the Smart City Model Canvas was applied to assess the feasibility of a reuse project for the disused buildings in the former Siri industrial area in Terni, Italy.

Keywords: Dismissed area · Cultural heritage · Urban regeneration · Circular economy · Smart city model canvas

1 Introduction

The problem of dismissed areas in cities refers to the existence of abandoned or neglected urban spaces, often found on former industrial or commercial sites.

These areas have undergone various transformations over time, leading to their complete abandonment and creating what are known as "urban voids" [3–5]. The causes of abandonment can be attributed to the crisis of some traditional economic sectors of industrial production. The decline of the european industrial system began around the 1960s, coinciding with the energy crisis and the transition from large to small and medium

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enterprises. From a redevelopment perspective, brownfields can represent an important opportunity to redefine the future layout of the city [6].

This has left many cities with large areas that are obsolete and show clear signs of environmental degradation and even poverty. Such brownfields have increasingly become a source of political concern and have spurred the emergence of various land-use regeneration initiatives. Different cities in Europe, such as Amsterdam, Rotterdam, London, Antwerp, Hamburg, Marseille, Lisbon, Porto, etc. are addressing the issue of reuse of these abandoned areas by implementing new policy mechanisms based on the general principles of sustainable urban planning able to improve their socio-economic and ecological resilience [7–9].

In this regard, the circular economy is seen as a model for addressing urban problems. It is an economy that considers metabolic processes and analyzes the waste stream, as well as the issue of energy and its central role [7, 8]. It focuses on the use of high-quality energy sources that are obtained from the surrounding environment [10–12].

Innovative circular business and financial models play a crucial role in supporting urban regeneration efforts by providing frameworks and strategies for sustainable development [13].

The aim of this paper is to provide an overview about business models can support sustainable brownfield regeneration projects, according to the circular economy perspective.

Specifically, the attention is fosuced onf "Smart City Model Canvas", a strategic tool that uses visual language to break down complex projects and simplify them. It is an operational approach that stimulates creativity and challenges established mechanisms and habits, focusing on potential users and reversing perspectives by starting from customers' needs [14–16].

This business model was applied to assess the feasibility of a regeneration project of the former Siri industrial area in Terni, Italy.

2 The Circular Economy as a Development Model for the Regeneration of Dismissed Urban Areas

As anticipated in the previous paragraph, there are a lot of european cities characterize by urban areas in a state of complete abandonment, correspond to former industrial zones.

Sometimes these urban spaces are the places where environmental degradation, social fragmentation and marginalization manifest themselves as frequent phenomena [17].

For several years, industrial areas suffered a loss of productive function until they were decommissioned. They were identified as extraneous to the urban fabric, ruins without identity, losing their architectural and social value.

Industrial areas, once decommissioned, create "urban voids" that are problematic due to safety issues, social and environmental degradation. But, investing in their redevelopment means turning a problem into a strength, returning new valuable spaces to the area [18].

In particular, the "open wound of urban cities" is represented by neighborhoods that have abandoned historic buildings [19]. There are numerous examples of urban

regeneration as Bilbao, La Ruhr, Glasgow, Lipsia, Rotterdam, Amsterdam, Liverpool, Barcelona, London, Hamburg, Barcelona, Turin, Lyon, etc. [19].

For example, in London the projects of King's Cross Central and Battersea Power Station redevelopment have transformed former industrial sites into vibrant mixed-use neighborhoods [20]. In Rotterdam, the M4H District and the Merwe-Vierhavens area are examples of successful brownfield regeneration projects, creating innovative spaces for creative industries, startups, and sustainable development [21].

The 22@Barcelona project has revitalized the Poblenou district, converting it into a knowledge and innovation hub, attracting technology companies and research institutions [22]. In Lyon, the Confluence district, located at the confluence of the Rhône and Saône rivers, has undergone a major transformation, creating a sustainable urban neighborhood with residential, commercial and recreational spaces [23].

The winning strategies of these best practices is tied to the ex industrial buildings reuse, according to the circular economy principles.

Infact, the perspective of circular economy linked to the circular adaptive reuse of cultural heritage is the possible way to define the projects for the regeneration of dismissed urban areas.

The circular economy model has been defined by Ellen Macarthur Foundation as an economic model which is "regenerative by design", with the aim to retain as much value as possible of products, parts, and materials [24], focusing on the life-cycle of materials to "close-the-loop" by recovering all wastes as a resource for new productive cycles [24].

Ellen Macarthur Foundation define the "cradle-to-cradle" strategy as a process in which all materials and products are collected and renewed at the end of their useful lives [24].

Instead, circular adaptive reuse refers to the process of recovering and redeveloping old industrial sites to transform them into a new use, different from the one for which they were conceived and built. The strategy of circular adaptive reuse is the only possible approach for the preservation of historic industrial monuments that are generally unsuitable and too obsolete to host new production sites [25].

Adaptive reuse is also the most sustainable solution for the rehabilitation of these urban areas: demolishing buildings, disposing of residual materials and having to construct new buildings using new materials and machinery implies the expenditure of more energy (in terms of resources and consumption) than is required for an asset redevelopment process.

According to Fusco Girard, the "ideal" project of reuse is to transform a dead (in general) site into a living system, to be managed as a complex adaptive system, i.e. an organism capable of continuous learning and adaptation capacity to a changing/dynamic context, through re-organization, repair, regulation, and therefore capable of evolution and resilience [11].

The site object of the re-functionalization process should be transformed into an ecosystem that can also contribute to the vitality of the local context, in a symbiotic relationship (for example, giving and receiving renewable energies etc.), involving other topics and activities especially in management, potentially resulting in the creation of other ecosystems [11, 26, 27].

In the context of the circular economy, functional reuse suggests that there are differences between it and the linear model in terms of design, implementation, and particularly management.

2.1 Smart City Model Canvas

Business Model Canvas (BMC) is a tool originally developed by Alexander Osterwalder and Yves Pigneur (2010) to visually represent the logic of a company and how it organises its operations to create and deliver value. The BMC consists of a model coposed of nine blocks, each of which deals with a specific aspect of the business model. This structure allows companies to develop innovative business models by reorganising or re-engineering the content of any of the nine blocks to reveal a new market and business opportunity [28].

Business models can help the different stakeholders involved in urban planning to organise future design choices on the basis of community needs. In particular, the Canvas business model can be interpreted as a "participatory process" capable of rapidly building design strategies to improve the quality of urban spaces [29, 30].

Canvas model is a visual prototyping tool that helps operators and stakeholders during the conception and development phases of an urban planning or real estate project [31, 32]. It is a prototip that providing users with a visual overview and a quick perspective of an urban project.

This tool is particularly useful during meetings and workshops to highlight validated facts, unvalidated assumptions, project risks and opportunities, skills and information gaps and even identify dangerous blind spots in the project team [32].

In other words, the Canvas model is an easy-to-use tool to research, prototype and gradually develop an urban project without getting lost in the process or neglecting its important elements.

In this research, a particular attention was given to Smart City Model Canvas, a model experimented within a European research "Replicare Project-Horizon 2020" - REnaissance of PLaces with Innovative Citizenship and Technology [32].

Smart City Model Canvas is as the integration of two business canvas models già esistenti:

1. The first is an adaptation of the traditional BMC, better suited to companies whose primary goal is not profit maximization but the achievement of a particular mission [14–15].
2. The second is the adaptation of the BMC, which is based on the triple-layered business model canvas [15] i.e., a model that considers the three levels of sustainability that a company must pursue: economic, social, and environmental.

The Smart City Model Canvas is thus an adaptation of these two models, but reoganized to identify the objectives that municipality (or company) should pursue in implementing an urban regeneration project. While the traditional BMC is one consisting of nine elements, the CMC is composed of fourteen blocks (see Fig. 1).

The first block refers to the identification of the "value proposition" considered comeaning the central element of the City Model Canvas. It indicates what benefits are generated/expected from the project. The "value proposition" should address specific

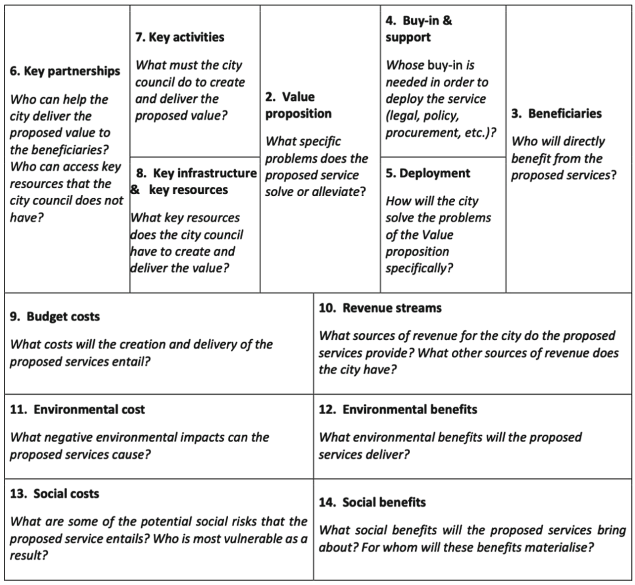

Fig. 1. Smart City Model Canvas [15]

needs identified by the population and provide a clear picture of how those needs will be addressed by the business model. Generally, there should be at least one value proposition for each type of benefit identified [15].

The second block concerns the identification of the direct and indirect "beneficiates" of the project actions, i.e., the recipients for whom the strategy proposes to solve specific needs or problems ("pain points") [15].

The third block relates to "buy-in & support". This element refers to the stakeholders involved in the project (groups or entities, companies, government organizations, etc.) whose approval is necessary for its successful implementation.

The fourth block "deployment & delivery" indicates how the value proposition will be delivered to the client or beneficiary, i.e., it explains to the different stakeholders how the different project actions will be developed [15].

The fifth block addresses the "key partner(ship)s", i.e. the various partnerships that will be activated for the implementation and operation of the project.

The sixth block refers to "key activities", or the activities that should be undertaken for the business model (the project actions) to be effective [15].

The seventh block is on "key resources and key infrastructure". For a company, key resources are the main assets it needs to create a value proposition and provide a product or service to customers. Depending on the company's goal, the most important resource may be human capital, money, patents, trademarks ecc. In the case of the city, the key resources are not only the financial and physical assets it can use, but also the political and strategic resources it can deploy in support of certain policies [15].

The eighth block refers to "economic costs", i.e. the costs that the city will incur to implement regeneration project services. These costs will range from the initial project investment to the "soft" incentives that will be offered to users.

The ninth block is "revenue/income streams". This refers to all sources of revenue that the municipality and stakeholders involved will get from the project. Cities have a number of revenue streams to evaluate, including taxation, smart service fees, and external subsidies.

The tenth step refers to "environmental costs". These include impacts on land use, water and fuel requirements, greenhouse gas emissions along the production chain, etc. Environmental costs can be monitored through indicators, when data are available.

The eleventh step refers to "environmental benefits" tracked by specific indicators where data are available [15]. In the absence of data, this can be a useful exercise to determine existing data needs and information gaps. The exercise of assessing the environmental impacts and benefits of urban regeneration strategies in each sector will help the city get a clearer picture of where to focus its attention and resources.

The twelfth block refers to "social impacts" or the social sustainability of projects. The element of social impacts refers to the negative costs that the strategy may have on the city's residents and communities. The challenge for the city is to define what social impacts to consider and how to measure them.

The thirteenth block refers to "social benefits". It focuses on the positive social value creation aspects of the urban regeneration strategy. These are elements that arise specifically from interventions on the city, but can include indirect benefits [15]. As with social impacts, social benefits should be measured with specific indicators that allow the city to assess over time whether its interventions are having a positive or negative impact on the social well-being of society.

3 The Case Studie: The Regeneration Project of Siri Ex Industrial Area in Terni (Italy)

Terni is an Italian city of 106.285 inhabitants, its historical vocation coincides with its industrial nature from the mid-19th century onwards, only to undergo a slow and unstoppable decline after the second post-war period [28].

The city of Terni, already in Roman times, was configured as a city of water due to the presence of multiple springs and their high potential. Terni in Latin is a translation of "Interamna Nahars", a city between two rivers (Nera and Serra). Water was used for agriculture through channelization. The Nera was a navigable river and allowed river connections to Rome and the Marmore Falls (165 m, the highest in Europe) also built by the Romans.

Over time, the water resource has increasingly become the potential source of hydro-electric energy to serve industry and urban settlements, so much so that the city of Florence (Italian city), too, finds much of its energy resources in this area.

It was after the Italy Unification that the city experienced a turning point in its development. Local administrators took steps to establish an arms factory in Terni and, along with it, an iron and steel industry was also set up, which would later considerably influence the economic and social development of the city.

In 1884, Italy's first iron and steel industry, the Alti Forni society, Fonderie and Acciaierie of Terni, was founded. Terni's industry grew so massively and quickly that the city went from 14.000 inhabitants in 1871 to 31.400 in just twenty years [33].

The definitive development of the city came in the early 1900s thanks to the strong growth of the chemical industry.

Among these important industries, SIRI (Italian Industrial Research Society) was established in 1925 and occupied the complex of the former Ferriera Pontificia, built in 1794 [15]. The industrial complex produced synthetic ammonia, used for explosives and nitrogenous fertilisers. The industry occupied a flat area of over 40.000 square metres between the Nera river and the slopes of the Obito hill (see Fig. 2).

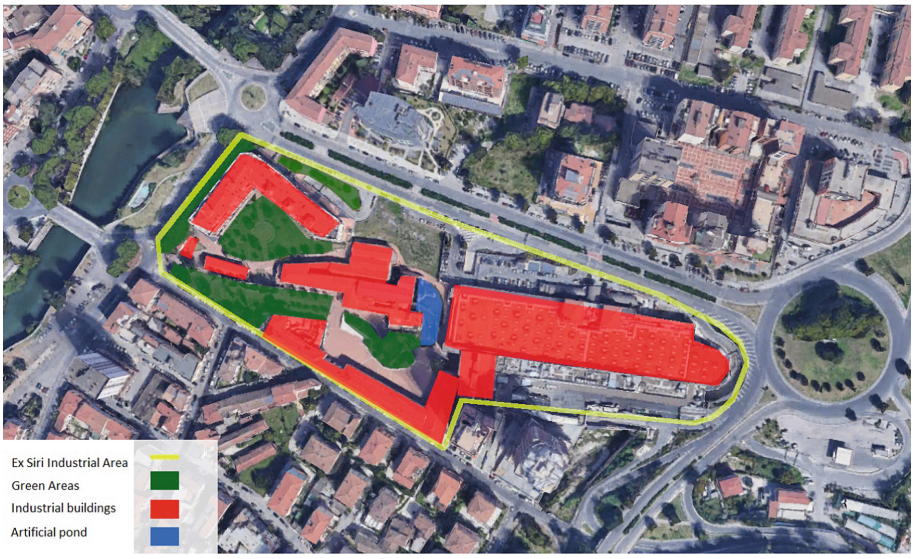

Fig. 2. The SIRI industrial area. The source of the satellite image: Google Maps.

Subsequently, when progressive difficulties in industrial activity emerged due to changing market and technological conditions, the plant closed in 1985 [33].

The growth of the factory took place unequally, with new buildings leaning against the pre-existing ones, leaving a large free area in the middle, where the pond that was fed by the waters of the Nera River still stands.

The industrial complex had important architectural, environmental and industrial archaeological values.

After its closure, in 1985, the SIRI industrial site went through a phase of progressive decline and abandonment.

In 1998, the Municipality of Terni lauched a project to regenerate the entire area, with the aim of recovering and enhancing the industrial archaeology buildings and the surrounding park.

Specifically, the renovation work covered an area of 44.210 square metres, involving the recovery of four buildings, called CAOS site, that were converted into new functions:

modern art museum, palaeontological museum, civic museum archaeological section, refreshment areas, theatre-auditorium and new residences [34].

The entire area (in which the buildings are located) was reclaimed through the creation of an urban park with bicycle and pedestrian paths. The project cost 6.248.612 € of which 3.111.136,36 € was financed by the Region, 1.045.825,02 € by the municipality, and 2.091.650,44 € by private individuals. The project was completed in 2009 [34].

The regeneration of this large urban area was made possible by a series of complex urban planning instruments and acts (Urban Redevelopment Programme, the Complex Urban Programme).

The conditions on which the entire recovery project was based by the awareness that the industrial buildings, although not characterised by a significant formal value or typological layout, represented an evocative testimony of the first industrial settlement in the city of Terni.

With the recovery project, the intention was to testimony of an important historical phase of the city, adopting a correct restoration criterion that would make it compatible with the new planned functions.

The redevelopment of this area is part of a larger urban planning project, aimed at creating new urban spaces to be integrated with the nearby historic centre, characterised by the preservation of the industrial memory.

The recovered buildings were in an advanced state of decay, having been abandoned for many years. Atmospheric agents, seismic events and vegetation growth to a lack of maintenance had severely damaged them, causing part of the roofs to collapse and considerable cracks in the load-bearing walls.

Specifically, thanks to this project, all the building facades were recovered. Some exterior spaces have retained their original layout, such as the driveway. The original housing system and some infrastructural elements, including water intake works for the power plants, were extended and restored. All of the pre-existing buildings are now used for cultural services.

The building, which today is destined for the Museum of Contemporary Art (optical cone 5, in Fig. 3) (see Fig. 3), was renovated by preserving and replacing the degraded structural parts, maintaining the formal and material characteristics while respecting the overall integrity of the public complex.

The external volume has not been changed, only the plasterwork and the reconstruction of the collapsed parapets and the excessively degraded masonry parts were redone.

The areas that were used as chemical laboratories and warehouses saw an adaptation of the roofs, floors and masonry where damaged.

The warehouses used as former experimental laboratories (optical cone 4, 9, 1, in Fig. 3) are the ones with the greatest height and formal value, presents significant aesthetic elements. In fact, the “decò” style decorative bands (present under the roofing imposte), the “Palladian” cut window frames framed by the face brick arches of the façade and the wooden trusses with metal tie-rods have been recovered.

The former electrolysis halls were in a very poor state of preservation, especially the masonry and roofing.

In order to meet the need to continuously obtain electricity through water, a reservoir was recovered that is fed by conduits from the Nera River.

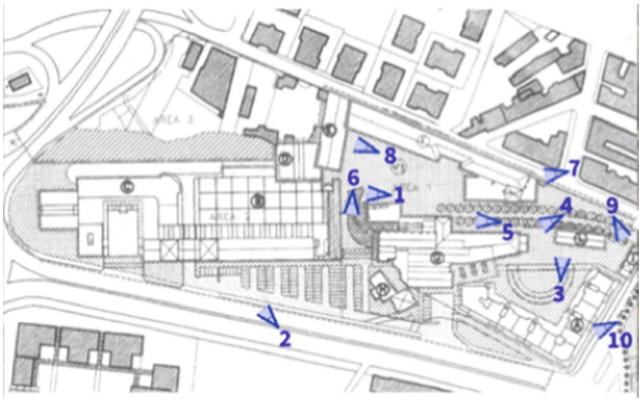

Fig. 3. The buildings that were redeveloped in the municipality's project for the conversion of the ex Siri industrial area

After several years since the opening of all these new activities, the municipality made an overall assessment of the economic, social and environmental impacts generayed by the project, which showed clear imbalances.

It emerged that the residential, commercial and tertiary functions, located in the two towers (optical cone 10 in Fig. 3) and in the hypermarket (optical cone 2 in Fig. 3) are characterised by autonomous productivity. The cultural, social and museum functions are in a fragile condition, i.e. they are characterised by a deficit between income and expenditure. This requires support actions by local institutions, both public and private, either alternatively or in synergy.

The museum system was managed for eight years at a cost of €1.859.620,04 plus VAT. The municipality of Terni also pays the concessionaire € 230.000/year as a subsidy for the use of certain areas [34]. An analysis of the 2019 budget revealed a lack of attractiveness of the museum system [34]. The costs of tickets and the rental of rooms to third parties do not cover all the costs incurred by the operators on an annual basis [34].

The real attractor is therefore the hypermarket, which, however, does not determine any external effect on the site and appears as an autonomous entity in relation to the other functions.

After analyzing the impacts generated by the area redevelopment project, the question was raised on what indications, what proposals can be made to improve this status quo? What solutions to reduce the contradictions between the private functions (that are self-sustainable economically and financially) and public functions?

To answer these questions, a design solution for the regeneration of this industrial site is proposed with the aim to improve the attractiveness of the site. The design proposal consists in the industrial building's energy renovation, which have already been redeveloped in the project carried out by the municipality, in coherence with the European Green Deal (2019) [35].

Infact, one of the critical points is the energy issue related to the operation of the rehabilitated historical buildings, a large amount of energy is spent, with negative repercussions in terms of both environmental and economic impacts.

One of the main project objectives was to transform the buildings (used for cultural activities) into zero-impact architectural fabrications, through the installation of an integrated system for the energy production: photovoltaic panels and a hydrogen system that produces energy through the process of electrolysis.

In particular, the project envisages the installation of 3 kWh of photovoltaic panels for every 200 square metres of surface area (contemporary art museum, archaeological museum, Secci theatre) and storage batteries, to the extent of 6.5 kWh for every 9 kWh of panels for the production of electrical energy, which would be partly used during operating hours, partly stored for the times when it is not possible to produce from solar radiation, and partly for the production of hydrogen through electrolysis, restoring the pipes and reservoirs that brought water to the site directly from the Nera river.

The energy that will be produced by the panels is divided between that used directly, that stored in the battery, and that used for the production of hydrogen through the electrolytic process. The hydrogen produced will then be used for domestic water heaing and space heating in winter [36–38].

This project was developed in collaboration with Giacomo Palombi, a student of Pegaso Telematic University, resident in the Terni city. For this reason, it was possible to organize a workshop within the municipality to evaluate the feasibility of the project using the Smart City Canvas business model.

4 The Smart City Model Canvas Applied to the Regeneration Project of the Former SIRI Industrial Area

The Smart City Model Canvas was used as a business evaluation tool during the workshop organised with different Terni local stakeholders (students, members of associations, members of the municipality, small entrepreneurs and citizens) with the aim to discuss and understand what concrete actions are necessary to realize the buildings energy efficiency project.

It was possible to organise this event thanks to the participation of student Giacomo Palombi, a resident of Terni, who was developing his thesis work.

The workshop was based on an adaptation of the World Café method [39]. The World Café is a participative method that focuses on the expertise and experiences of its members to investigate a problem.

This approach has the benefit of allowing participants to form relationships and learn from one another while looking into a problem [40, 41].

The workshop was characterized by an opening session for participants to share expertise, group discussions, and a closing session for discussing the results of such conversations.

Before starting the activities, the workshop participants discussed about the impacts of the previous recovery project fir the regeneration of Siri ex industrial area, implemented by the Municipality of Terni. No significant social, economic and environmental impacts were identified, as it was found that the real attractor is the hypermarket and

not the cultural sites, which, however, does not determine any external effect on the site, and appears as an autonomous entity in relation to the other functions.

The energy issue was identified as the unresolved critical node of the previous project, also because the massive presence of industries means that the city is one of the most polluted in the country, particularly with high numbers of annual PM10 particle exceedances and presence of heavy metals in the air.

Having clarified these issues, the designers explained the new energy efficiency project for the industrial archaeology buildings within the site. The project, as explained in Sect. 3, involves the use of renewable energy sources and the use of hydrogen as an energy carrier for the operation of the buildings.

After this step, stakeholders began to discuss of the project, following the steps suggested by the Canvas model (see Table 1).

Table 1. Smart City Model Canvas for the renovation project ex Siri industrial area

Topics	Actions
Key partnerships	- plant service providers; - public administration; - contractor cooperatives; - residents; - business owners
Key activities	- monitoring activities of the entire project implementation; - relationship management with project beneficiaries; - awareness campaigns with different stakeholders involved in the project, especially with citizens
Value proposition	- energy efficiency strategies for historic buildings; - create business opportunities in the energy efficiency and renewable energy sector
Buy-in & support	- involvement of managers of historic buildings in the building energy efficiency project
Beneficiares	- residents of new housing; - business owners; - managers of cultural activities; - businesses that install photovoltaic panels; - start-ups and local businesses
Deployment	- building retrofitting; - installation of photovoltaic system

(*continued*)

Table 1. (*continued*)

Topics	Actions
Key infrastructure & key resources	- new energy networks; - abandoned historic buildings
Budget costs	- costs for the photovoltaic panel's installation; - costs for testing facilities; - costs of retrofitting for buildings
Revenue streams	- saving energy purchase; - selling surplus energy
Social costs	- possible increase in housing prices due to project
Environmental costs	- environmental impact of new construction
Environmental benefits	- reduced energy waste due to photovoltaic system; - reduced emissions due to better energy production and lower consumption; - general awareness of energy use by users
Social benefits	- improved living conditions through more efficient heating system, better access to clean energy

4.1 Results

The results of the Smart City Canvas model applied for the Terni case study have clarified the strategies to be deployed for transforming the industrial buildings into con-structions with almost zero energy impact.

During the workshop, there were some points of the business model that were most taken into consideration, such as the identification of "Key partnerships" to determine partners who can actively contribute to the implementation of interventions.

Also, the identification of "value propositions" was a topic considered very interesting by stakeholders, because they have identified the benefits for future users of the site.

When they discuss about the "budget costs", a reflection was made on the possible sources of funding for the project.

All workshop participants unanimously agreed that economic investments should focus on reducing CO_2 emissions while promoting new economic development, new employment opportunities, improved welfare, and the protection of ecosystem services.

Regarding the "Environmental costs, environmental benefits, social costs, and social benefits" it was recognized that the technological solution adopted for enhancing the energy efficiency of the industrial buildings would result in several positive impacts both environmentally and socially, with significant benefits particularly in terms of emissions reduction.

5 Conclusion

Reusing industrial cultural heritage within the circular economy framework can drive a new development model that promotes the circulation of processes, leveraging synergies in the financial, economic, social, cultural, and institutional sectors through innovative partnerships involving the public and private sectors for the management of common goods [42].

Economically, investments in adaptive reuse create jobs, income, attract new capital, creative start-ups, and contribute to tourism and local businesses.

Socially, adaptive reuse preserves the character of neighborhoods, enhances community identity and involvement, improves services, and enhances safety perception.

From an environmental perspective, adaptive reuse aims to reduce traditional energy consumption, increase the use of renewable energy, and reduce carbon emissions in alignment with the goals of the European Green Deal.

Adaptive reuse strategies for the regeneration of industrial buildings they can be evaluated through specific business models.

Business models are crucial for driving the transition and governance of a "smart economy" and "smart society", leveraging ICT to promote growth, environmental sustainability, and social inclusion [43].

The smart city business model serves as an initial step in identifying or creating new models that can be utilized by specific companies, research organizations, or private citizens.

The results of the Smart City Urban Canvas model implemented in Terni have shown that participants feel actively involved in the preservation of cultural heritage perceived as "common good". The team involved has identified potential opportunities for innovation, revenue generation, and sustainable growth. Togheter, they have identified the possible risks of the project. The most interesting outcome was the discussion held together on the actions to propose for further improving the project. Some participants put forward intriguing solutions for project funding, including the idea of launching a crowdfunding campaign.

In conclusion, the application of the business model canvas provides a structured approach to analyze, develop, and communicate the regeneration project's business model.

The future aim of this research is to understand if it is possible to combine multicriteria evaluation tools with the Smart City Model Canvas with the purpose of developing an evaluation framework capable of assessing the economic, social, and environmental impacts of an urban regeneration project.

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