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Circular Economy and the Role of Universities in Urban Regeneration: The Case of Ortigia, Syracuse

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Abstract: Regeneration processes activate stable regimes of interaction and interdependence among the architectural, economic, cultural and social sub-systems in settlements. The thesis of this paper is that in order to progress towards sustainable and inclusive cities, urban governance should widen the decision-making arena, promoting virtuous *circular* dynamics based on knowledge transfer, strategic decision making and stakeholders' engagement. The historic urban landscape is a privileged lab for this purpose. The paper adapts the Triple-Helix model of knowledge-industry-government relationships to interpret the unexpected regimes of interaction between Local Authority and Cultural Heritage Assets triggered in the late 90s by the establishment of a knowledge provider such as a Faculty of Architecture in the highly degraded heritage context of the city of Syracuse, Italy. Following this approach, the authors explain the urban regeneration happened over the last 20 years in the port city of Syracuse, based on knowledge sharing and resources' protection that promoted processes of social engagement and institutional empowerment for both new residents and entrepreneurs.

Keywords: Triple-Helix model; knowledge; cultural heritage; urban regeneration; performance indicators

1. Introduction

Urban regeneration is a process aimed at improving settlements' qualities and creating the conditions for a sustainable and social inclusive growth [1]. According to the EU vision, regeneration intertwines architectural and urban dynamics with economic development, social inclusion and environmental protection. It represents a collective opportunity to increase both the potential for communities' cohesion and the capacity to produce innovation. Strong partnerships between civil society, business and government at different levels are crucial to this extent [2–5].

The paper tackles the issues associated with the reversal of a dissipative metabolism traditionally characterizing settlements, decoupling growth from finite resource consumption, forecasting performances' upgrade, social engagement and institutions' empowerment [6]. The authors consider the process of urban regeneration within the circular economy paradigm and the role that urban heritage conservation can play in this context. Based on sharing, leasing, reusing, repairing and recycling, the circular paradigm is strengthened through the shift from a punctual heritage vision to the historic urban landscape perspective [7]. The paper focuses on the historic layering of cultural and natural values and attributes, extending beyond the notion of urban centre, or ensemble, to include the broader city context and its geographical setting. The Historic Urban Landscape (HUL) approach promoted by UNESCO [8] emphasizes the systemic interrelation between the economic, human,

natural and cultural capitals [9] and the inherent complexity of any intervention aimed to transform the urban setting.

The paper addresses the main research question of how the circular city model could be made operational for the regeneration of port cities. In particular, the authors aim to assess the impact that higher education can have on heritage-led urban regeneration. The argument of this paper is that the transition towards circular economy is a long-term process of coherent co-evolution [10], based on the potential of cultural capital to empower the civil society [11,12]. The World Economic Forum [13,14] defines a circular city as a settlement that applies the principles of circular economy in its space/territory in order to regenerate its values. Within this framework, the transition to a circular economy cannot be achieved by single actors working in isolation but requires collaborative efforts among actors. This would involve three main dimensions: (1) the institutional one, promoting policies and regulations; (2) the entrepreneurial one for resources mobilization; (3) educational one, involving training and communication institutions that can contribute to the process by providing experts in the professional and scientific fields and attracting talents whilst promoting civil culture. The transition to a circular economy is supported by the integrated actions of knowledge transfer, strategic decision making, stakeholders' engagement that are promoted by the overlapping dynamics created through the encounter of the economic, human, natural and cultural sub-systems.

The paper uses a mixed methods approach based on the systematization of key features [15], to analyse the regeneration strategies, through the development of a theoretical model adapted from the university-industry-government relationships Triple Helix model introduced by Etzkowitz and Leydesdorff [16].

The analysis of the regeneration process that started in 1997 in the ancient Mediterranean port city of Syracuse validates the theoretical model. As other port cities, Syracuse has been the place of secular co-evolution between community—material culture—built environment. Circular relationships have traditionally informed the building processes, thanks to the synergies created among the environmental, physical, human, economic and cultural sub-systems. The settlement in the island of Ortigia is the result of a balanced and original mix between technical awareness and practical ability, tradition and creative intuition, a mix between artefact and nature. Because of its seismic vulnerability, the settlement in Ortigia has seen the continuous reuse of its own buildings affected by collapses and reconstructions. This attitude to the reconversion of the building stock saw a drastic change during the 20th century, when several unplanned actions compromised the trend that had characterized the urban landscape's transformations, deeply rooted in the skills of the workforce and in the community's needs.

Since 1997, a strategic localization choice made a crucial difference in the urban regeneration process of the city of Syracuse. The founding of the Faculty of Architecture in Ortigia became the new catalyst for urban regeneration, triggering virtuous processes of cultural heritage assets' re-adaptation. In Ortigia, local authorities, higher education and cultural heritage entrepreneurship became the main pillars of a circular process of built environment reuse and enhancement. Besides teaching and research, the Faculty of Architecture actively pursued the third mission, promoting outreach and engagement with the local community. Over the course of twenty years, the university increasingly played a role of anchor institution, promoting a domino effect triggered by the circularization of economy on the territory, which stimulated not only heritage conservation but also innovation promotion and civic engagement [17]. As a result, in 2005 the entire city of Syracuse, along with the Ortigia island, was awarded the World Heritage Site status by UNESCO.

Within this framework, the competitiveness of the results can be ascribed to the commitment to maintaining as far as possible the organizational structure of the city, which represents its particular identity, consistently with its inner co-evolution between community—material culture—built environment. The paper's hypothesis is that the transition towards circular economy requires the conscious reduction of any waste through the involvement of citizens, local administrators, entrepreneurs, working together with university researchers not only to train skills in the professional and scientific fields and to attract talents, but also to form citizens, taking responsibility for their choices.

This paradigm shift implies the acknowledgement of the role played by cultural assets in regenerating the community, the need for hybridisation between tradition and innovation and a participatory commitment towards historic urban landscape's protection.

From the lessons learned in the case of Ortigia, the study comes to foreshadow the challenges and highlights the potential for higher education institutions within historic urban landscapes [18]. In particular, against the pressures of an incompatible tourist fruition, today the University of Syracuse is called to further extend its third mission engagement within the circular economy paradigm, so that heritage-led urban regeneration can be inclusive, resilient and sustainable.

The paper is articulated as follows: first, the concept of circular economy is discussed within the context of urban regeneration; then the Triple Helix model is presented and adapted to interpret the process of heritage-led urban regeneration; finally, the case of Ortigia is described and discussed.

2. Literature Review

2.1. The Circular Paradigm for Urban Regeneration

The term regeneration has been used as an umbrella concept with a special focus on protection, preservation and transfer of natural and manufactured resources to future generations. The need to recover abandoned urban spaces has informed several approaches and strategies in Europe since the 90s [19–21]. Academic research and urban policy makers have focused on creating new cultural labels, with the intent of “rebranding” cities with problems of economic or social degradation and impoverishment [22,23]. Several studies outline the impact that knowledge infrastructures can have on urban economies and tourist attractiveness [24]. The communities' well-being is taken into account, highlighting opportunities and limits of local cultural productions and consumptions and contexts' adaptability [25,26]. One of the main challenges for regeneration is to activate stable regimes of interaction and interdependence between local resources and the identity of places, through synergies between spaces, functions and actors [27].

The application of the circular paradigm to settlements promotes the idea that a profitable, ever-growing economic development can happen without an ever-growing pressure on the environment [28]. Historic urban landscapes are the places where for centuries the co-evolution between community—built environment—material culture has occurred. Alongside the issues of waste reduction and reuse, when we transfer the circular development model to urban regeneration, this introduces the need to account for the compatibility of environmental, economic and social pressures on settlements due to transitions [29]. Urban regeneration processes involve planning and strategic design at both urban and architectural scale. Successful design approaches have to handle trade-offs between users' needs and design requirements accounting for our planet's needs [30], to reduce waste rebalancing pressures due to the increasing age of the built, climate change, users' and market's expectations changes. The shift from the make-use-dispose linear consumption approaches—cradle to grave -, towards the closed loops—cradle to cradle—[31] marks the pathway to urban symbiosis where buildings are considered as resources that should be reused, like recycling components and materials, in order to reduce consumptions and save energies [32].

The circular economy model applied to the historic urban landscape leads to the ability of maximizing the value of settlements, activating social, economic and environmental synergies [33]. Over time, urban landscapes give rise to a long-lived and ever transforming complex single system. As the result of historic layering, the transition processes produce waste in terms not only of leftover sub-systems and components but also in terms of not sustainable pressures exerted on the system [34]. Differently from the linear economy model, the circular paradigm responds better to pressures on urban landscape, as in the case of components reaching the end of the life cycle or falling in disrepair due to the reduction of their usefulness over time, or because they become out of fashion and out of date. Regeneration strategies can include both the reuse of obsolete and abandoned spaces and the inefficient components' maintenance. In doing so they have to account for both users' needs and

sites boundaries, by redefining roles and relationships among the involved actors: public and private, authorities and community. An active social and cultural involvement is a necessary condition for successful regeneration strategies. Such a cultural project involves keeping together the two concepts of regeneration and circularity by connecting the community with their material culture and built environment. This relational dimension is essential in the perspective of preserving co-evolution and cooperation.

2.2. Universities and Circular Regeneration

Universities are the driving force behind growth [35]. For long conceived as repositories [36] and generators of knowledge [37], their impact on communities lies in their ability to trigger stable relationships and synergies between territorial actors [38]. Since the late 1960es, universities have been recognized as institutions able to improve local economies, because of their rooting to settlements, providing employment, purchasing power and real estate stability [39,40]. The transition to the *knowledge society* places an increased emphasis on the public service mission of universities for local and regional socio-economic growth. Being innovative and ground-breaking while remaining physically bound to a specific location, universities' potential is argued by scholars who highlight how such institutions foster knowledge networks and economic competitiveness [41–44].

Despite their spatial immobility, the cultural mission, the location advantage and the capital investments exert powerful pulls on these institutions. Universities significantly affect the dynamics of urban development with the creation and management of devoted facilities—hospitals, sports facilities, libraries and telecommunications [45].

The circular economy perspective discussed in Section 2.1 highlights the role of the university as a promoter of circular regeneration. Within this perspective, the paper analyses a change already occurred in the city of Ortigia, which is clearly linked to the role played by Higher Education. Our case study confirms the results of previous studies that have focused on the role played by universities in improving living conditions of their territories, analysing the development trajectories promoted on settlements and the communities' empowerment relapses. The cultural production and the high-tech spill-over determine repercussions at local or regional scales [46], taking into account both the social and physical contexts where knowledge transfer happens [47]. Knowledge-intensive activities trigger symbiotic cooperation within local communities because they involve new actors in flexible and pro-active cross-sector processes of innovation and cultural hybridization [48]. In the circular economy perspective, universities are drivers of:

- Knowledge based innovation [49] consensus on an expanded vision of heritage;
- Culture-led economic development; through processes of transfer, spin-off companies, the knowledge generated by universities enriches the settlement and gives raise to economic benefits [50];
- Resources mobilisation and management; higher education helps to enhance the level of skills in relation to both civic matters and social integration.

Domino effects generated between university staff, students and local authorities emerge as a connotative aspect of circular regeneration [51]. Against unemployment, poor schooling and generational poverty, knowledge provider institutions raise the average level of communities' competences, contrasting through research, the traditional manufacturing-based contexts and facing the de-industrialization and globalization consequences [52]. Fostering bottom-up symbiosis between expert knowledge and inhabitants, universities are entrusted with the task of hybridizing the design and management processes. Indeed, universities not only support urban development by generating jobs but also attracting creative entrepreneurship.

3. Research Methodology: The Triple-Helix Model—University—Cultural Heritage Entrepreneurship—Local Authorities

The Triple-Helix model (TH) university-industry-government relationships, introduced by Etzkowitz and Leydesdorff [53], interprets the shift from Industrial Society to Knowledge Society arguing that universities can play an enhanced role in innovation. In such a model, knowledge production and dissemination generate innovation in the hybridisation of elements from university, industry and government.

Originally conceived as an analytical construct to systematize key features of the technological innovation process, the TH model emerged from the encounter between Etzkowitz's researches—dealing with the regeneration of productivity and the promotion of an entrepreneurial university [54,55]—and Leydesdorff's interest in the evolutionary dynamics of science, technology and innovation. Opposing to a linear vision of development as a one-way flow from fundamental to applied research and product development, the TH approach captures development's trajectories and changing frameworks [56–59]. As firstly noted by the sociologist Simmel (1902), the transition from a dyad to a triad of interacting systems is fundamental to stabilize the relations and impacts between sub-systems [60].

Over time, the TH has been critiqued for example, [61–63] and re-interpreted as a *theme* that binds together the transition from a political economy into a knowledge-based one. Nonetheless, the TH conceptual framework offers a broad perspective for understanding the sources of innovation and its development paths.

Starting from the debate on the hypotheses of Etzkowitz and Leydesdorff, the traditional Triple Helix model knowledge-industry-government is here modified to describe the circular economy's implications in urban regeneration. In HUL, cultural heritage is a resource for both the market and public institutions [64], which can enhance economic dynamics [65,66]. Being non-renewable, its exploitation requires awareness of its value and vulnerability. In the circular paradigm's perspective, Higher Education institutions can trigger virtuous processes of knowledge transfer, strategic decision-making, stakeholders' engagement, through the recognition of individual and collective responsibilities towards cultural heritage [67]. In our model, Universities are catalysts of public awareness and civic engagement by promoting novel coalitions/partnerships and collective expertise. Urban universities emerge as privileged promoters of citizenship because of their founding mission of research, experimentation, training and knowledge dissemination.

The proposed model (Figure 1) is characterized by the following elements:

- Helices, which represent an independent and organized system;
- Trajectories, which connect one helix/system to another in a circular way;
- Overlay environments, where interactions are determined and new phenomena are triggered.

In our adaptation of the Triple-Helix model, the three spheres are representative of three main capitals involved in urban regeneration. They can be defined as follows:

- Higher Education as Knowledge Capital provider and promoter;
- Cultural Heritage Entrepreneurship as Cultural Capital exploiter;
- Local Authorities as Institutional Capital regulator.

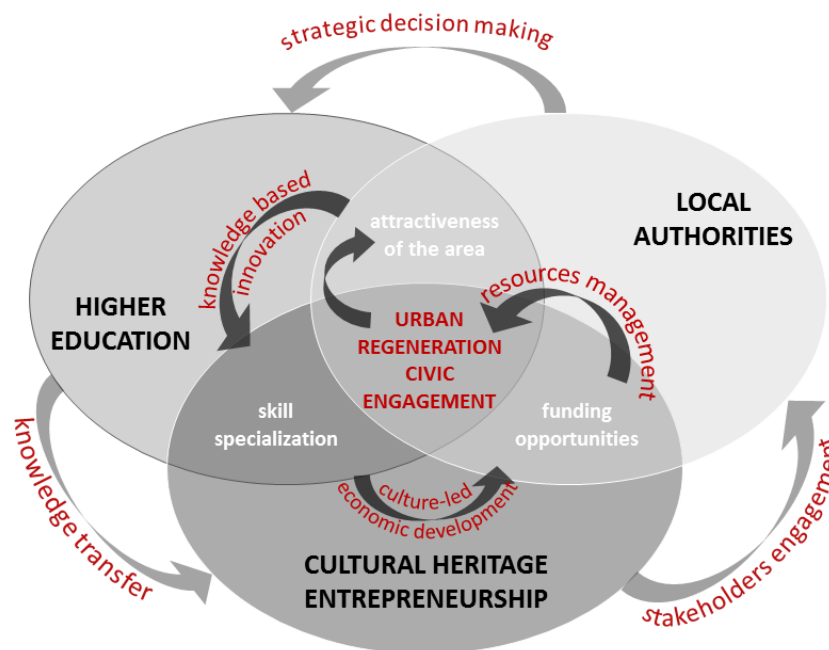


Figure 1. The Triple Helix model for urban regeneration.

The helices activate three main trajectories, which draw the virtuous circular process:

- The first trajectory is external to each helix, showing the influence of one upon another and representing the interacting processes that trigger the overlay environments;
- The second is internal, due to the recursive effect of the overlay environments and their interaction;
- The third is the innermost trajectory, which determines the urban regeneration and establishes the circularity of the processes by reconnecting the overlay environments with the helices.

In the case of heritage-led urban regeneration, the external trajectories activated by each helix upon the other represent:

- Strategic decision making between Local Authorities and Higher Education (or more in general, knowledge innovation hubs);
- Knowledge transfer, between Higher Education and Cultural Heritage Entrepreneurship;
- Stakeholders' engagement, between Cultural Heritage Entrepreneurship and Local Authorities.

The connection among the helices triggers each dynamic, which in turn activates the following three overlay environments:

- The first overlay environment represents the processes of skills enhancement, urban preservation and compatible/adaptive reuse. This is activated by the Higher Education—Cultural Heritage Entrepreneurship trajectory;
- The second overlay environment is triggered by the Cultural Heritage Entrepreneurship- Local Authorities trajectory and expresses the ability of professionals and organizations to attract funding, thanks to innovative entrepreneurial activities and new forms of partnership. They have different levels of responsibility and authority: ranging from private property owners, private cultural site managers, small and medium construction companies, management teams;
- The third overlay environment is prompted by the Local Authorities—Higher Education trajectory and expresses the process of urban regeneration that results in increased site attractiveness, reinforcing the overall virtuous socio-economic circle.

The innermost trajectories are due to the interaction of the three overlay environments and promote:

- Knowledge based innovation;
- Culture-led economic development;
- Commitment in resources management.

In the model, the process of urban regeneration is represented by the central intersection of the overlay environments; hence by the urban improvements/changes activated by the virtuous circle, resulting into civic engagement and an increased site's attractiveness.

Urban changes are determined by the encounter of different systems and in order to be socially and economically successful, they need to establish new circularities between resources and wastes. Cultural assets as cultural capital have the potential to act as catalysts for this but they necessitate of two other main components/systems/capitals. First, institutional capital, such as a Local Authority, ready to invest in knowledge and innovation, through a series of coordinated actions (strategic decision-making) able to foster knowledge transfer and innovation. Second, knowledge capital, such as a Higher Education institution or a similar innovation hub, capable to produce new knowledge and transfer skills to the local population. The interaction among the different capitals stimulates new forms of entrepreneurship and participation to the governance of the city.

In the next sections of this paper, we identify several performance indicators able to monitor the effectiveness of urban regeneration through secondary data. Such analysis outlines how the successful urban regeneration of Ortigia is linked to the strategic, policy decision to localise a knowledge production hub in an otherwise run down historic urban landscape. The next section describes the recent socio-economic history of Syracuse, using secondary data analysis.

4. The Case Study of Ortigia, Syracuse

Syracuse is a medium-sized town on the Eastern coast of Sicily. Thanks to an enviable geographic position, since the Greek period Syracuse has been the junction of commercial exchanges and a melting pot of customs and traditions of the populations that have succeeded in the Mediterranean area. The town was one of the main centres of Magna Graecia for artistic development and commercial power. It was also one of the first centres of diffusion of the Christian religion in the Middle Ages, and after periods of misfortune, it was 'reborn' after the earthquake of 1693. The city preserves everywhere memories of its cultural growth, from its ancient history to the Baroque age, in an exciting landscape. The oldest urban centre is located in the small island of Ortigia (approx. 45 hectares), at the eastern end of Syracuse and is separated from it by a narrow channel. Two bridges connect the island to mainland Sicily.

In the 50es the chemicals and petrochemical industry was one of the most important and successful export industries with its large multi-plant site, which at the time was the largest in Europe. However, the economic situation changed dramatically in recent years [68–70]. Chemical industry is now in decline while agriculture, food and wine production, as well as tourist services, play a vital part in the economic and everyday life of Syracuse. Public sector employment levels are over 30% but Syracuse does not show high levels of digital development and remains on a downward trajectory despite wider use of digital tools amongst employers [71]. In 2008, unemployment in Syracuse was at 11.5%. In 2016, there was a noticeable difference in the unemployment rate and in particular, youth unemployment rate reached 58%.

During the 20th Century, the main productive activities developed on the mainland Sicily and the ancient district of Ortigia was depopulated and progressively abandoned. As a result of this trend, in the late 20th Century Ortigia was characterised on the one hand, by stunning archaeological sites and heritage assets, on the other, by poor housing conditions and few public spaces, due to the high population density. Since the 1960es, the poor quality of living in Ortigia has caused a constant depopulation process (Figure 2): on a 45 hectares area, the number of inhabitants decreased

from 23,000 units in 1960, to 12,000 units in 1970, 5994 in 1991 and 4725 in 2007 [63]. In particular, the comparison between the resident population of the Ortigia district and that of the Municipality of Syracuse over the last twenty years shows an almost coinciding decreasing trend between 1997 and 2002 and a subsequent decrease of residents in Ortigia compared to those of the municipal territory (Figure 3). This trend might not be due to the depopulation of the historic centre, whose number of residents is steadily increasing but to the increasing presence of non-residents (e.g., students and tourists). Such interpretation is confirmed by data on the presence of foreign residents in the Municipality of Syracuse (Figure 4a,b), which is significant and constantly growing.

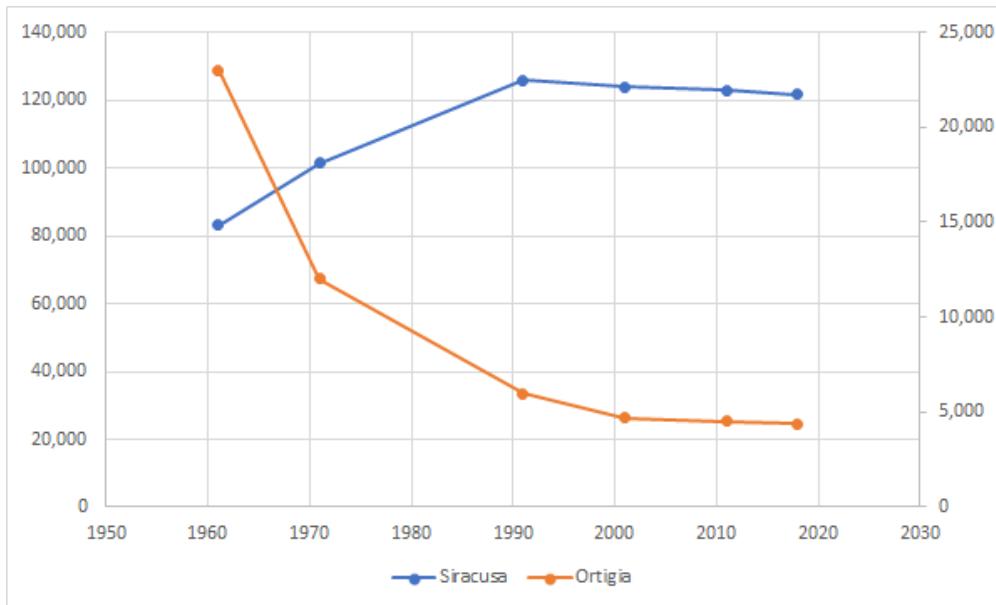


Figure 2. Population growth in Syracuse since 1961 (data source: National Institute of Statistics—ISTAT).

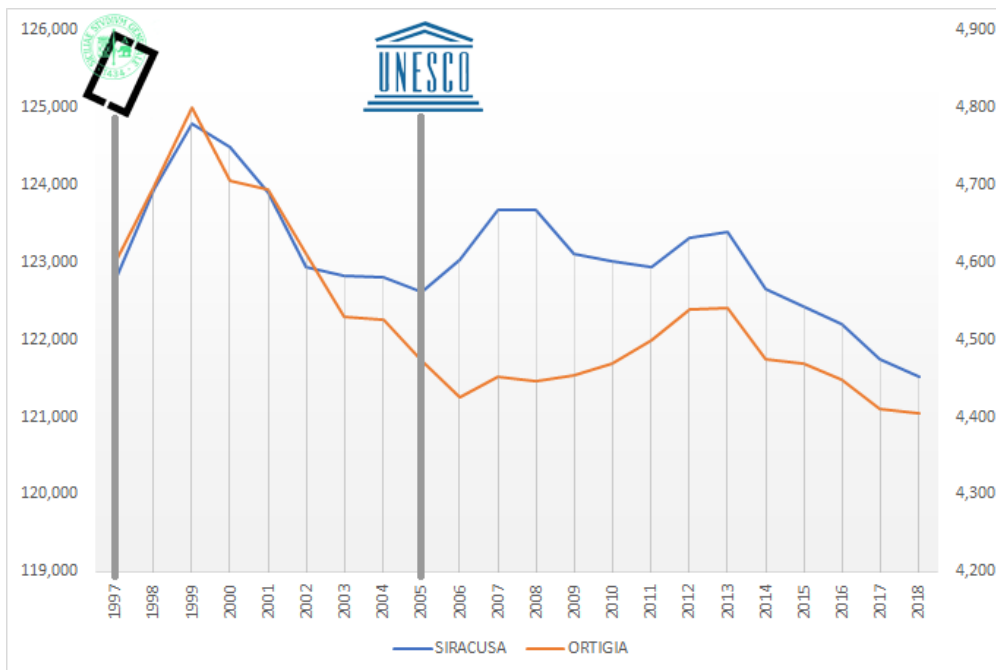


Figure 3. Resident population’s trends in Syracuse and Ortigia from 1997 to date (data source: Municipality of Syracuse).

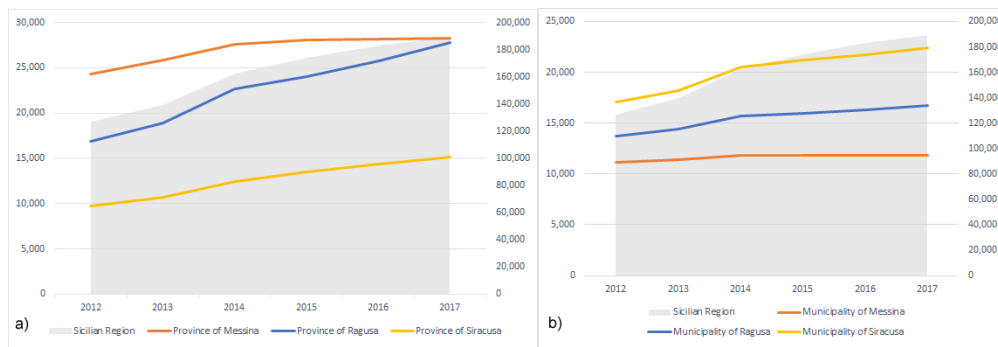


Figure 4. (a) Foreign residents trends within provinces (data source: National Institute of Statistics—ISTAT); (b) Foreign residents trends within municipalities (data source: National Institute of Statistics—ISTAT).

The following graphs show an analysis of the data available on Syracuse, surveyed by the Italian National Institute of Statistics (ISTAT), in comparison with trends registered by other medium-sized cities in Eastern Sicily, such as Ragusa (included in the UNESCO World Heritage List in 2002) and Messina, both characterized by the presence of cultural heritage entrepreneurship and universities. This analysis can help understand the socio-demographic changes, which took place in recent decades in Syracuse as a result of the Faculty of Architecture’s foundation.

When compared to the provinces of Ragusa and Messina (Figure 4a) the province of Syracuse is the one with the lowest number of foreign residents. However, the picture changes when we compare the municipal areas: in this case Syracuse has the highest number of foreign residents with respect to the Municipalities of Ragusa and Messina and such number is also more rapidly growing (Figure 4b).

Figure 5a shows how the employment rate has increased in all three urban centres in recent years except in the case of Syracuse that in 2001 witnessed a decline, probably due to the impact of the divestment in the petrochemical industry. This result is confirmed by the data on unemployment rate that is constantly decreasing in Syracuse in the period 2001–2011 whilst remaining stable in the cities of Messina and Ragusa (Figure 5b). The above data seem to indicate an upward socio economic trend after a brief period of reassessment due to the delocalization of the industry.

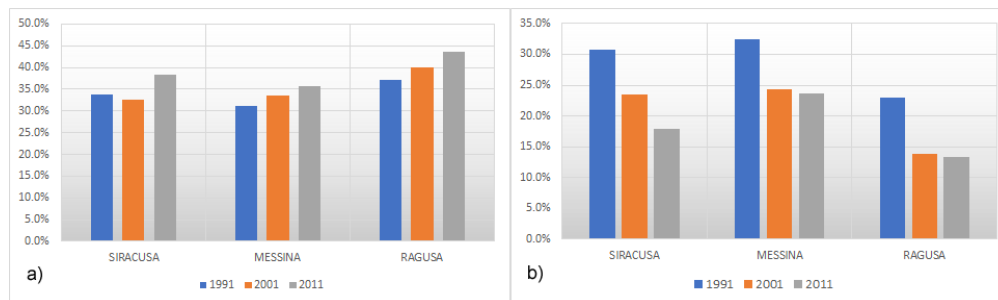


Figure 5. (a) Employment rate in Syracuse, Messina and Ragusa (data source: National Institute of Statistics—ISTAT); (b) Unemployment rate in Syracuse, Messina and Ragusa (data source: National Institute of Statistics—ISTAT).

The Regional Laws n. 70 of 1976 and n. 34 of 1985, aiming to protect historical centres and providing special rules for the Ortigia district and the subsequent Detailed Plan for Ortigia (PPO), approved by the Region in 1990, were pivotal in reversing a process of economic downturn.

The draft law for Ortigia was approved by the Sicilian Regional Assembly in 1971; it proposed a strategy of conservative restoration in the historical centre. In 1976, the special law n. 70 for the protection of Ortigia established public financial contributions to citizens willing to intervene on their historic properties. The law was created with the dual purpose of blocking all forms of building

speculations and encouraging private residents to directly intervene on the cultural built heritage. The Municipality performed a deliberative and technical/executive function, while the Region managed the financial aspects. The law authorized (article 19) the following expenses: 800 million Italian liras for compulsory purchasing orders and 1500 million liras for capital investments grants (art. 14) for the implementation of the first two-year program. It envisaged the preparation of a Detailed Plan for Ortigia as a variant of the existing Masterplan. For buildings of particular historical, artistic and monumental interest included in the list prepared by the Commission, the law allowed the Region to allocate grants of up to 30% of the eligible expenditure and provided subsidized loans at 3% interest rate for the remaining amount.

According to the Plan, the “rebirth” of Ortigia should have started from its heritage buildings potential, to be adapted and reused for housing, tourism, services, cultural activities, administration, education and university. The Plan aimed to renew the historic centre by means of minimal physical transformations and significant changes in the use of buildings. Therefore, it envisaged only a few demolitions, indispensable to create new public spaces and to improve lighting and ventilation. The Plan established the introduction of a higher education provider in Ortigia, as “one of the most powerful engines for a functional and economic relaunch of the historical centre [. . .] able to build significant reuse processes in the abandoned areas of the island” [72] (p. 167). The transformation of Ortigia into a university city was based on the adaptation of ancient buildings into student housing, preserving their typological features. The Plan represented the stepping-stone for the knowledge-based development of the island of Ortigia, thanks to the localization of a new campus of the University of Catania, which included the Faculties of Architecture, Humanities, Mathematical, Physical and Natural Sciences and the Mediterranean Centre for Arts and Sciences of the Arcadia University. In 1997, an agreement with the Province and the Municipality of Syracuse allowed the University of Catania to locate the Faculty of Architecture in Ortigia and subsequently to launch several master’s degrees programmes. The Plan promoted urban regeneration of the historic centre also for tourist and cultural activities. For this purpose, it increased the number of hotels and tourist resorts near the marina and established a new tourist terminal. The Detailed Plan for Ortigia was successfully implemented through grants for building rehabilitation projects carried out by the Municipality, promoting citizens’ participation and new forms of Public/Private Partnerships.

At the end of the 1990s, the administration was particularly sensitive to the conservation and enhancement of Ortigia’s built heritage, as a result not only of the special laws but also of a new focus on cities [73,74]. In these years Syracuse was also part of the PIC Urban project. The first phase of the URBAN Community Initiative (“URBAN I”) covered the period 1994–99. The total European funds exceeded 900 million funding and involved 118 cities. According to the European Commission, Syracuse received only 22,510 Euros of the total amount and 9188 of contributions from structural funds.

5. Results and Discussion: The Triple-Helix Model for Ortigia

This section discusses the Triple-Helix model in the case of Ortigia. The discussion focuses on the challenges faced by the historic urban landscapes, aiming to trace the dynamics among heritage conservation, innovation promotion and civic engagement. The validation of the Triple-Helix model is carried out for the whole city of Syracuse in the lapse of time between 1997 (the year of institution of the Faculty of Architecture in Ortigia) and 2017. In fact, the effects of the interactions between university and territory are detectable only in the long run.

In order to understand the regeneration processes triggered by the knowledge institution, following the TH model discussed in Section 3 of this paper, we have to consider the following aspects:

- Knowledge based innovation;
- Culture-led economic development;
- Commitment in resources management.

In the case of Ortigia, the impact of the university's presence in the region goes hand in hand with the promotion of research, innovation and knowledge transfer/capacity building in the sector of urban regeneration. Since 1997, the impact of the university on the local economies in Ortigia has progressively grown and local administration took advantage of the heterogeneous knowledge spill-over. In recent years, the most significant development of Syracuse has been related to tourism, especially after the year 2005, when the town was included in the UNESCO World Heritage List. The increasing rate of buildings reuse and maintenance, the creation of new pedestrian areas, the introduction of electric public transport improved the urban quality and consequently, the tourist attractiveness of the district. These dynamics were accelerated by the organization of cultural events such as the re-enacting of Greek tragedies in the ancient theatre and the cinematographic productions taking place in Ortigia.

In the next sections, the validation of the TH model for Ortigia is carried out considering performance indicators for the overlay environments and identifying possible activating factors which trigger the trajectories' trends. Such analysis is constrained by the availability of secondary data. Nonetheless, the results seem to confirm our initial hypothesis.

5.1. The Overlay Environments

In this section we analyse secondary data related to the identified three overlay environments of our model: (1) Skills specialisation; (2) Funding opportunities; (3) Site attractiveness. We gathered data related to identified performance indicators that can help monitor the effectiveness of the urban regeneration process in Ortigia triggered by the strategic decision made by the Local Authority to invest in Higher Education. In particular, we examine data related to the three main overlay environments to explore the mutual influences among the three helices. Per each overlay environment, Table 1 lists the indicators and the data needed to measure their performance.

Figure 6a,b show the preservation status of the housing stock in Syracuse compared with other medium-sized cities in Eastern Sicily, such as Ragusa (included in the UNESCO World Heritage List in 2002) and Messina over a 10 year interval. The Data is given by the National Institute of Statistics (ISTAT) and indicates a steady trend towards the redevelopment of residential buildings in the region. Nevertheless, such a trend is more prominent in Syracuse compared to the other sample cities: the incidence of well-preserved buildings has significantly increased from 73.6% in 2001 to 90.3% in 2011 (Figure 6a). Similarly, there has been a substantial reduction of the percentage of buildings in a poor conservation status, which decreased from 2.6% in 2001 to 0.4% in 2011 (Figure 6b).

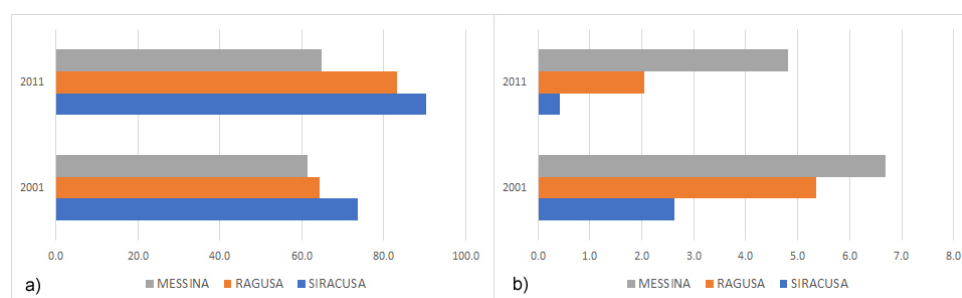


Figure 6. (a) Incidence of well-preserved buildings in Syracuse compared to Ragusa and Messina (data source: National Institute of Statistics—ISTAT); (b) Incidence of decayed buildings in Syracuse compared to Ragusa and Messina (data source: National Institute of Statistics—ISTAT).

Table 1. Overlay environments' performance indicators.

Overlay Environment	Indicator	Data	Source of Data Used
Skills specialization	Percentage of buildings in good conservation state	Increase in number of buildings in good conservation state over total historic building stock wrt to medium sized cities in Eastern Sicily	National Institute of Statistics (ISTAT) Census (Figure 6a)
	Percentage of buildings in state of disrepair	Decrease in number of buildings in state of disrepair over total historic building stock wrt to medium sized cities in Eastern Sicily	National Institute of Statistics (ISTAT) Census (Figure 6b)
	Number of applications approved by LA on private-owned buildings	Increase in number of applications approved by LA for maintenance and restoration works on private-owned buildings in Ortigia	Municipality of Syracuse, Ufficio per il Centro Storico Ortigia (Figure 8)
	Skills enhancement in the construction sector	Percentage of Architects wrt to whole resident population (Syracuse—Messina—Ragusa)	Architectural Registration Board of Syracuse—Messina—Ragusa (Figure 9)
Funding opportunities	Strengthening of social networks	Number of non-profit active organization wrt to number of residents (Syracuse—Messina—Ragusa)	Non-profit Organization Website Available online: http://www.nonprofit.viainternet.org (accessed on 11 September 2018) (Figures 10 and 11)
	Funding in the cultural tourism sector	Increase in funding awarded to the firms working in the cultural tourism sector wrt to number of residents (Syracuse—Messina—Ragusa)	Invitalia, National Agency for inward investment and economic development
Site attractiveness	Tourist enjoyment	Increase in the number of accommodation facilities in Ortigia between 1990 and 2018	Chamber of Commerce (Figure 12)
	Tourists flows	Trend of tourist flows in Syracuse	Tourist Office Syracuse (Figures 13 and 14)
	Real estate market value in Ortigia	Trend in the real estate market in Ortigia (Rent and market value)	Agenzia delle Entrate—Osservatorio del mercato immobiliare, Real Estate Observatory Available online:(accessed on 11 September 2018) (Figure 15)

In order to check that our analysis concerning the state of conservation of house stock is not affected by change in income, we compared data on the quality of buildings and the per capita income in the panel of the nine Sicilian towns. Figure 7 reports on the abscissa the change in per capita income and on the ordinate the following ratio: $[(W_{2011}/W_{2001})/(D_{2011}/D_{2001})]$, where W_t is the incidence of well-preserved buildings at time t and D_t is the incidence of decayed buildings at time t . No statistically significant correlation emerges from the data.

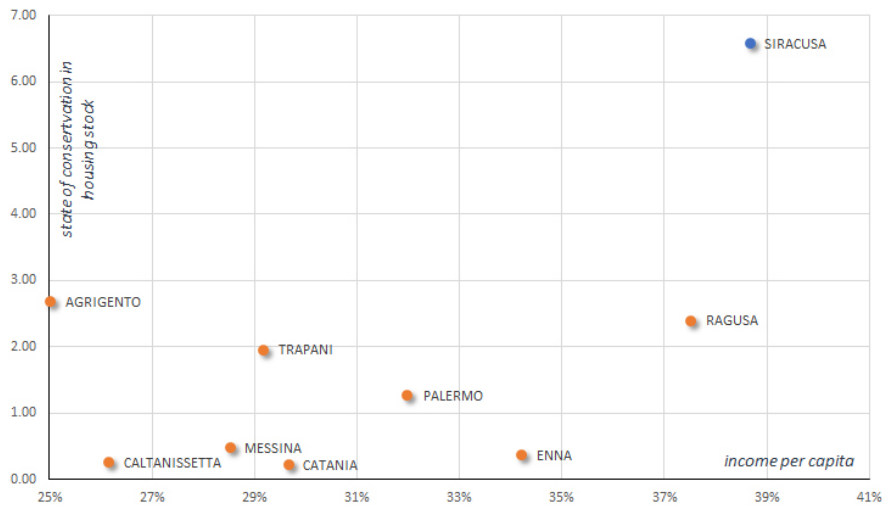


Figure 7. Change in per capita income and change in the state of conservation of housing stock in Syracuse vs. other cities of the Sicily Region (data source: National Institute of Statistics—ISTAT, Census 2001–2011).

Figure 8 shows data concerning building regulation approvals for maintenance and restoration on privately-owned buildings in the last twenty years, between 1997 (year in which the Faculty of Architecture was inaugurated in Syracuse) and 2017. The increase in the number of approvals between 1997 and 2003 is consistent with the urban renewal process linked to the investments in higher education. The data shows a peak in 2005, which can be explained by the inclusion of Ortigia in the UNESCO World Heritage List. The decrease between 2007 and 2010 can be due to the 2007 global economic downturn. In the last seven years the number of applications has been consistently growing. Between the end of the 1990s and the beginning of the new Century financial incentives offered by the Sicilian Region effectively influenced building rehabilitation and maintenance and this explains the increased number of applications’ authorizations. In the following years, the regeneration process activated by grants and promoted by the Local Authority become a catalyst triggering more interventions on the building stock (Figure 8).

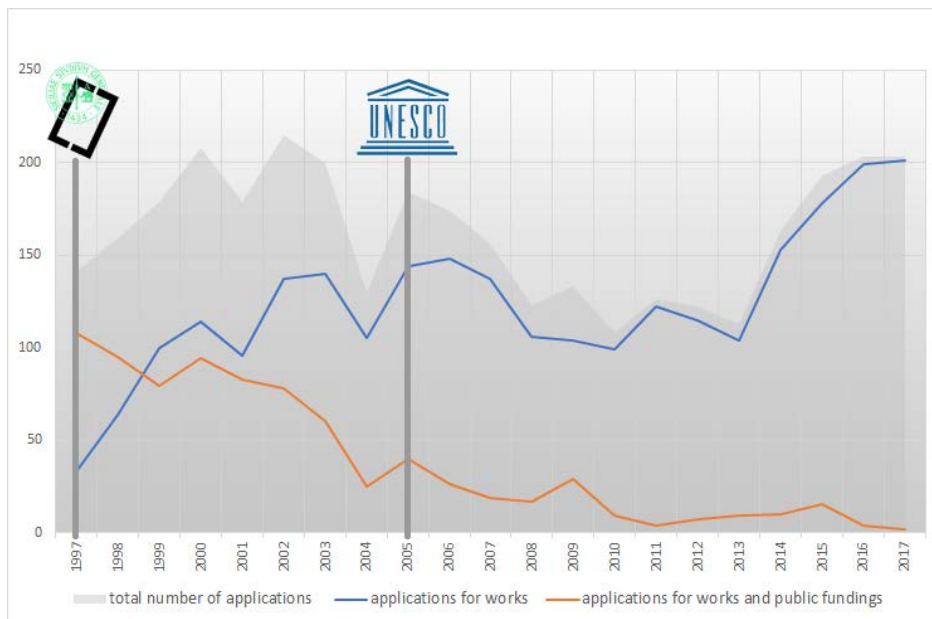


Figure 8. Building regulation approvals for maintenance and restoration on private-owned buildings in Ortigia (data source: Municipality of Syracuse).

Another clear impact of the localization of the faculty of Architecture in Ortigia is given in Figure 9, which highlights the high and ever-growing number of architects registered in the Province of Syracuse that has graduated from the Syracuse campus of the University of Catania. The establishment of a new faculty in a city that did not have a university is meant to attract young people from the area who cannot afford to study far from home. However, the impact of the presence of the university as knowledge provider is also highlighted by an increase in social awareness around cultural issues, such as the growing number of non-profit organizations dedicated to arts and culture. While Figure 10 compares Syracuse with Ragusa and Messina for the number of non-profit organizations versus number of inhabitants, Figure 11 compares the non-profit sectors of interest within each city.

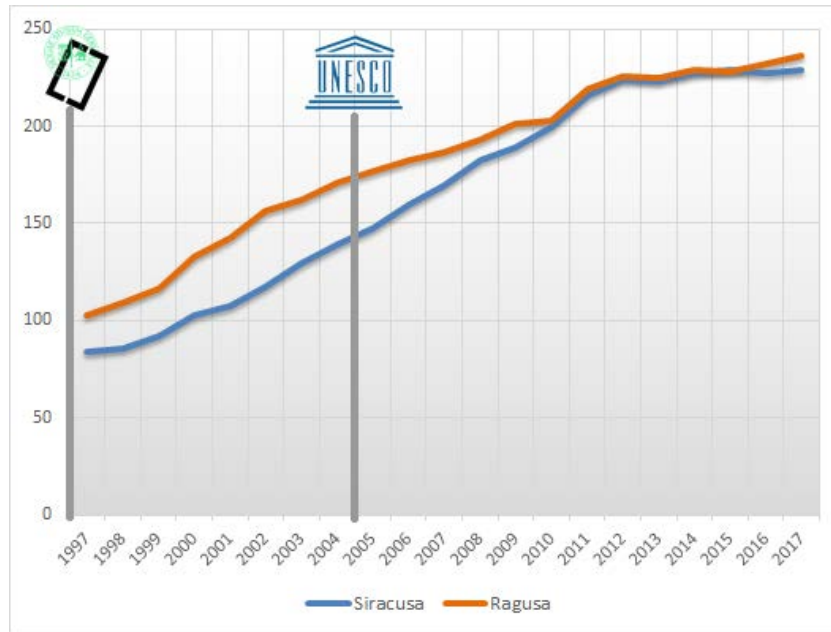


Figure 9. Number of Architects registered in the Provinces of Syracuse and Ragusa vs. number of inhabitants (data source: Architectural Registration Board of Syracuse and Ragusa).

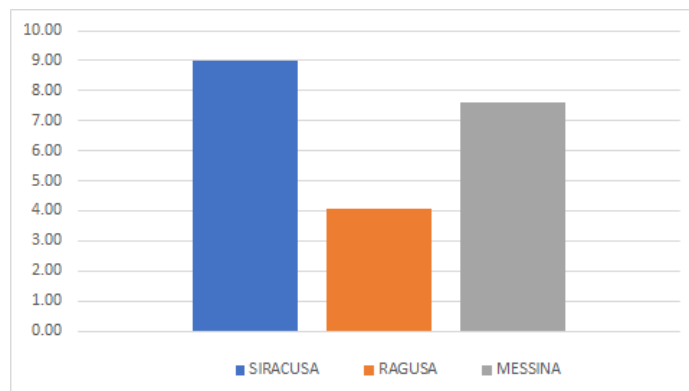


Figure 10. Number of non-profit organizations per 100,000 inhabitants in Syracuse, compared to the other Sicilian towns (data source: Non-profit Organizations Website).

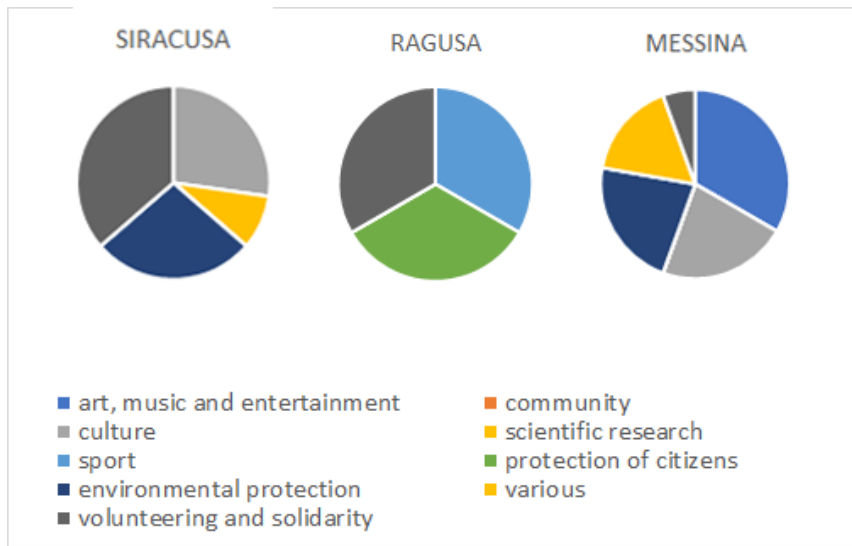


Figure 11. Comparison between the non-profit sectors of interest in the cities of Syracuse, Messina and Ragusa (data source: Non-profit Organizations Website).

As discussed, the changing cultural landscape in Syracuse has brought about the rehabilitation of the historic centre and an increased demand for cultural events and activities. In return, this has increased the attractiveness of the site and encouraged tourism flows as well as tourist related entrepreneurship. Figure 12 shows the increase in tourist accommodation in the period of analysis (1990–2018), which witnesses a sharp increase in the number of bed and breakfasts. Figures 13 and 14 describe tourist trends indicating the increased site’s attractiveness. The growth in the site’s attraction power is confirmed by the progressive increase of foreign residents: 6.1% in 1991, 13.4% in 2001, 26.7% in 2011.

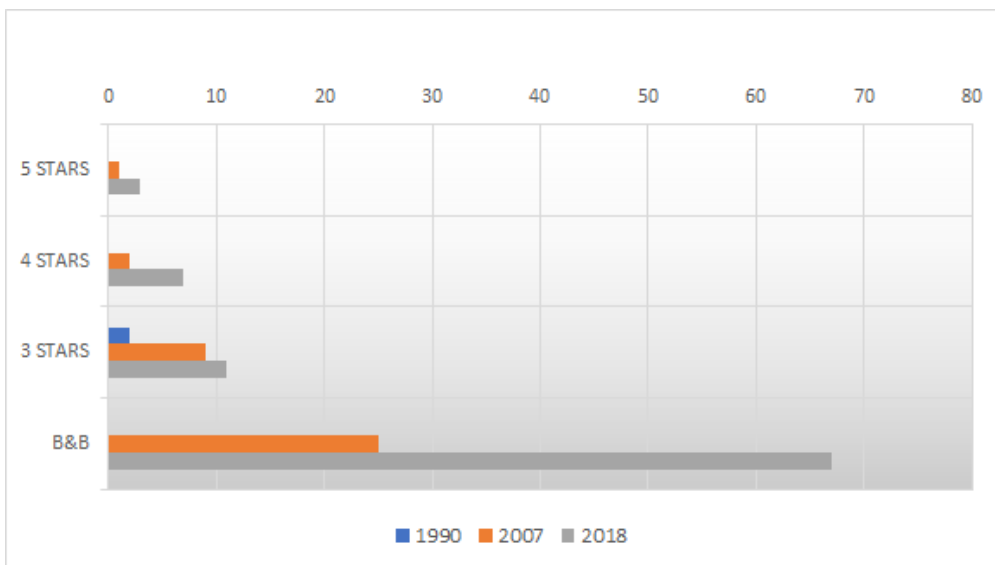


Figure 12. Increase in the number of accommodation facilities in Ortigia between 1990 and 2018 (data source: Chamber of Commerce of Syracuse).

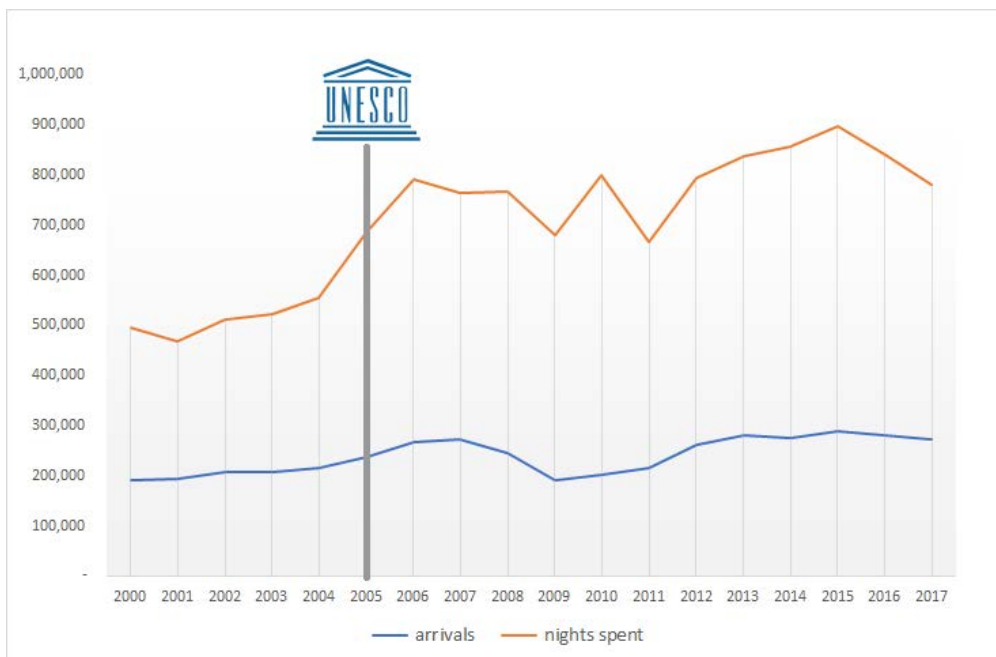


Figure 13. Trend of tourist flows in Syracuse (data source: Province of Syracuse—Economic development section).

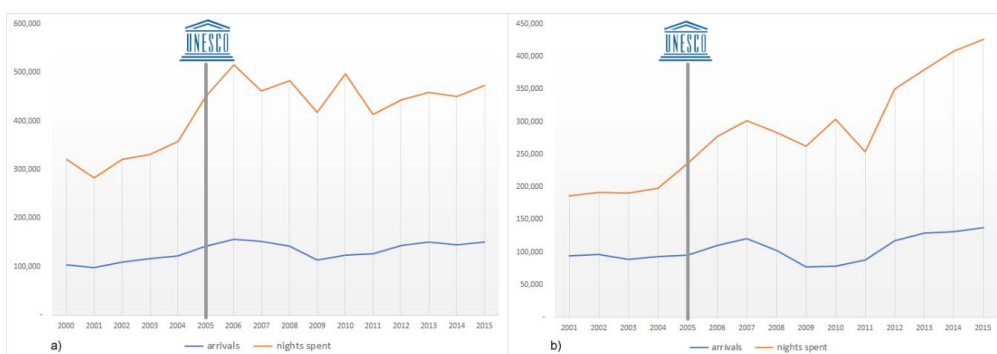


Figure 14. (a) Italian tourist flows in Syracuse (data source: Province of Syracuse—Economic development section); (b) Foreign tourist flows in Syracuse (data source: Province of Syracuse—Economic development section).

The substantial economic investments of local authorities in higher education facilities had a rapid effect of regenerating the historic centre. Many buildings were redeveloped to house students and teachers, stores and warehouses on the buildings' ground floor were reused for new users' services (shopping, restoration, coffee shop, partly for housing, etc.). This had a clear, positive impact on the real estate market in Ortigia, as shown in Figure 15. "At first, during its immature stage, this heterogeneous market has been attacked by a massive trading wave affected by the gap and inconsistency between local owners who were looking backward and foreign buyers who were looking forward [. . .]. The second phase (2005–2009) has been characterised by the success of the brand of Ortigia that confirmed it as one of the most promising real estate markets [. . .]. The third stage (since 2010 until now) [. . .] has been characterised by the lack of liquidity, due to the crisis of credit" [75]. A general improvement of the physical and functional condition of this real estate can be ascribed to this evolution, as the filtering of the local population and the concentration of the property because of some massive investments made by professional investors or groups of real estate investors.

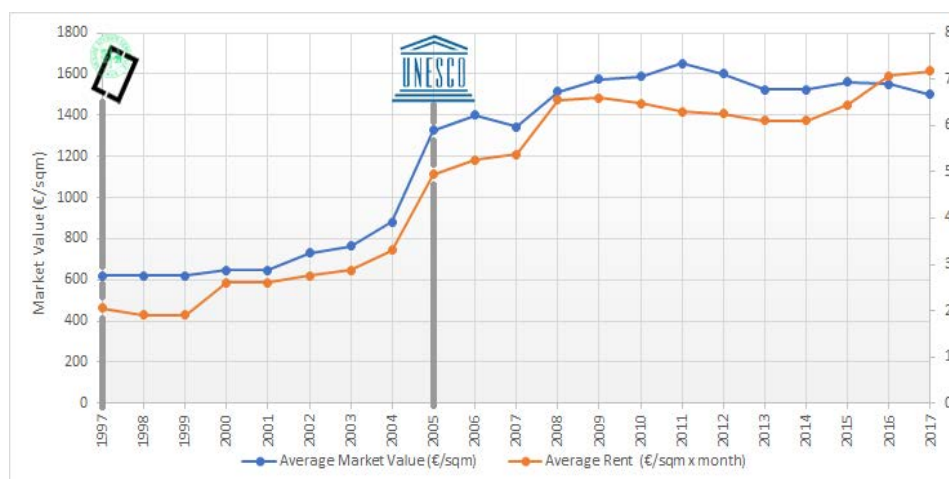


Figure 15. Trend in the real estate market in Ortigia (data source: Agenzia delle Entrate—Osservatorio del mercato immobiliare, Real Estate Observatory).

In this section, we have identified the main performance indicators for the three overlay environments defined by our adaptation of the Triple-Helix Model. The analysis of the related secondary data confirms our hypothesis of the pivotal impact that the localization of the University in Syracuse has had on the urban regeneration of the area and on the consequent level of attractiveness of the site.

5.2. External Trajectories

In this section we discuss about the external trajectories activated in Ortigia by each helix upon the other. Such trajectories can be traced back to:

- Strategic decision-making between Local Authorities and Higher Education (or more in general, knowledge innovation hubs). The activation of this trajectory takes place following a political choice: the local authority invests financial resources to allow the establishment and growth of the University and enhance local culture. The data here presented shows how the support received from the territorial entities played a catalyst role in the regeneration of Ortigia. In 1996, the Regional Province of Syracuse and the Municipality signed an agreement with the University. The Province guaranteed 4,200,000 Italian liras for instrumental resources and quotas for teaching staff resources as well as technical-administrative personnel (1997–2003). The Municipality provided the monastery of San Domenico, as well as other properties, to temporarily host the University.
- Knowledge transfer between Higher Education and Cultural Heritage Entrepreneurship. In this case, it is the University that activates the trajectory. In Ortigia, Higher Education played the fundamental role of culture promoter by training local professionals. The consequences of the activation of this trajectory can be seen in the ever growing percentage of architects registered in the Province of Syracuse and graduated in Syracuse. These architects acquired specific skills on local building techniques, building types and materials. The university promoted professional schools, specialization courses and cultural initiatives widening the training offer in the historic building sector.
- Stakeholders' engagement, between Cultural Heritage Entrepreneurship and Local Authorities. The ability of cultural heritage to attract public and private funding triggers the trajectory thanks to the interest of stakeholders to invest both on built heritage and related industries. The exemplification of the trajectory is traceable in the impacts of the National and Regional laws for Ortigia and the consequent awarding of the World Heritage Site status by UNESCO, which attracted further public funding. In particular, the PRU and URBAN projects contributed to

finance urban and building renewal and improve services for citizens, involving the Municipality, private entrepreneurs and other public organizations, such as the Independent Institute for Social Housing (IACP), the Ministry for Public Works, the Ministry of Infrastructure and Transport, the Regional Authorities for Cultural Heritage Preservation and the University itself. Furthermore, the implementation of the laws n. 70/1976, n. 34/85 and n. 25/1993 (concerning measures for productive employment in Sicily, which allocated 4000 million Italian liras in Ortigia) financed works on facades, roofs, staircases and courtyards of buildings used for housing, commercial and handcrafted activities.

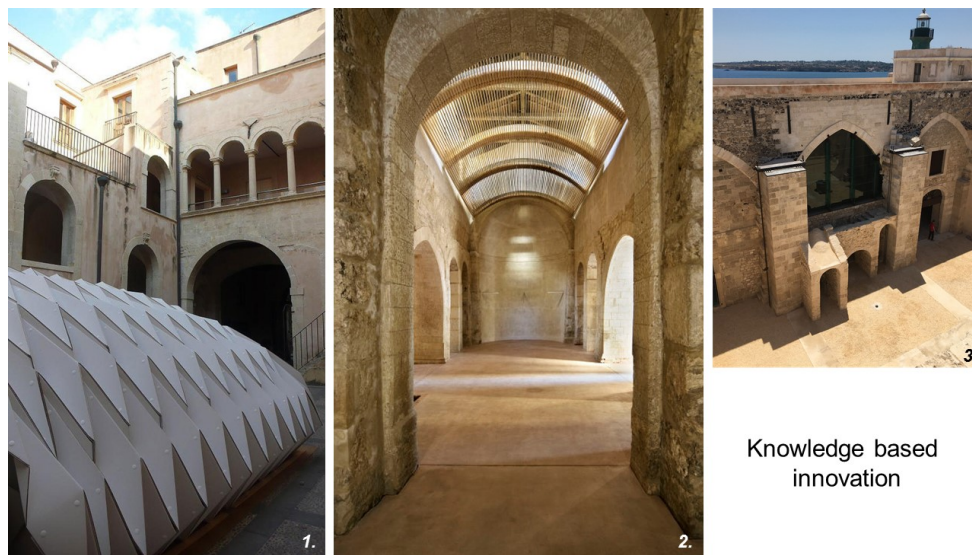
5.3. From Strategic Decision Making to Place Making in Ortigia: The Innermost Trajectories

In this section, we briefly present some examples of how the Local Authority decision making strategy had impacted on the shaping of the urban space in Ortigia. Since 1997 some important restoration and enhancement activities have been carried out on buildings or public spaces, with the advice or direct involvement of university professors (Figure 16). We have selected the examples of urban interventions shown in Table 2 and in the following pictures, as exemplary outputs per each of the identified trajectories:

- Knowledge based innovation (Figure 17); 1. Cardboard Pavilion (2012), 2. Paleo-Christian Basilica of San Pietro (2008), 3. Maniace Castle (2016);
- Culture-led economic development (Figure 18); 4. Ancient market (1997), 5. Dwelling for students at the Giudecca (2010);
- Commitment in resources management (Figure 19); 6. OribePavillion (2006), 7. Impact Hub (2013).



Figure 16. Ortigia Island: location of the sample cases.



Knowledge based innovation

Figure 17. Knowledge based innovation in Ortigia: 1. Cardboard Pavilion (2012), 2. Paleochristian Basilica of San Pietro (2008), 3. Maniace Castle (2016).



Culture-led economic development

Figure 18. Culture-led economic development: 4. Ancient market (1997), 5. Dwelling for students at the Giudecca (2010).



Figure 19. Resources management: 6. OribePavillion (2006), 7. Impact Hub (2013).

Table 2. Restoration and enhancement examples in Ortigia.

	Buildings	Designer/Consultants	Client	Year
Knowledge based innovation				
1	Cardboard Pavilion	Luigi Alini International Paper (Catania), studio Aion	University of Catania	2012
2	Paleochristian Basilica of San Pietro	Emanuele Fidone	Municipality of Syracuse	2008
3	Restoration and seismic reinforcement of Maniace Castle	Aldo Spataro Roberto De Benedictis, Giuseppe Cocuzza, Nicola Impollonia, Caterina Felicita Carocci	Regione Siciliana, Assessorato dei Beni Culturali e dell'Identità Siciliana	2016–2017
Culture-led economic development				
4	Reuse of Ancient market	Emanuele Fidone	Municipality of Syracuse	1997
5	Rehabilitation of Dwelling for students at the Giudecca	IACP Syracuse	ERSU	2010
Resources management				
6	Oribe Pavillion	KengoKuma& Associated Luigi Alini, Massimo Perriccioli	University of Catania and University of Ascoli Piceno	2006–2007
7	Impact Hub	Municipality of Syracuse University of Catania	Municipality of Syracuse	2013

Figure 16 shows the localization of the examples within Ortigia, whilst Figures 17–19 show pictures of the architectural/urban interventions.

The above projects are representative of the innermost trajectories, triggered by the interaction of three helices/environments: University-Local Authority-Cultural Heritage Entrepreneurship.

Several of these projects won awards for best practice and all of them changed the way people lived in the city. It was out of the scope of this paper to go into details about the value and the importance of each of the already widely published selected urban interventions [76–78]. In fact, in our theoretical discussion, they represent only the outputs of the circular process whose final and crucial outcome is the overall increase in civic engagement as well as site attractiveness. However, the above pictures show the quality of the interventions, which are a clear testimony to the enhancement of local skills and best practices in the heritage conservation construction industry.

The transition towards circular economy took place in Ortigia thanks to a cultural project aimed at empowering the civil society. A coherent co-evolution is achieved thanks to the interaction

between several stakeholders who commits to cooperation and long-term planning. In this scenario, the University not only promotes capacity building in the professional and scientific fields by attracting and forming new talents but also by raising citizens' awareness on the importance of their choices, their responsibility about their shared culture, making them custodians of heritage. The consequent urban alterations due to tourist flows can be assumed today as the new challenges that the cultural regeneration project is called to face (Figure 20).



Figure 20. Tourist flows and urban alteration, new challenges for Ortigia.

6. Conclusions

The aim of this paper was to demonstrate how the integrated actions of knowledge transfer, strategic decision-making and stakeholders' engagement could foster successful heritage-led urban regeneration. In particular, we argued that local administration, higher education and cultural heritage entrepreneurship could be the main pillars of a virtuous circular project aimed at empowering the civil society through built environment's reuse and enhancement.

The paper proposes the adaptation of the Triple Helix theoretical model to explain the dynamics of the urban regeneration process within a circular economy paradigm. The discussion has focused on the key features of regeneration, describing the role and commitment of three main stakeholders, which promoted and drove the urban regeneration processes: Higher Education, Cultural Heritage Entrepreneurship and Local Authorities. The theoretical model is validated through secondary data analysis, which describe the three external trajectories activated and the related overlay environments. Per each of them, a set of performance indicators describing the regeneration impacts are identified: skills specialization, funding opportunities, site attractiveness. Finally, we show some design examples, as expression of the outcomes of the three innermost trajectories, to describe the regenerative impact of knowledge based innovation, culture led economic development and resources management.

The data analysis confirms the importance of the delicate balance among heritage conservation, innovation promotion and civic engagement. Breaking such a delicate equilibrium would be likely to determine new critical issues for the future of Ortigia, possibly threatening the acquired knowledge and the recognition of cultural heritage values. In fact, since 2005, Ortigia has been interested by a progressive exploitation for tourism and leisure activities' purposes. This has had a strong impact on the historic urban landscape, where now commercial and artisanal activities are mainly targeting tourists, with the consequent decrease of neighbourhood shops and the lack of services for children and for the elderly population. The combination of the theoretical TH model with the empirical assessment against performance indicators might help monitor such a delicate balance and make sure that the University could still play its fundamental role in the urban renaissance of the assigned territory.

The transition towards a circular economy in Ortigia is taking place thanks to a cultural project, expression of a coherent co-evolution process aimed at empowering the community. The results are relevant for the current literature debate on circular economy and historic urban landscape conservation. Even though the model requires to be further tested in other urban contexts, the findings of our analysis confirm our hypothesis that strategic decision-making and investments in research and knowledge transfer, combined with the reuse and valorisation of historic urban landscape has the potential to trigger successful socio-economic processes. The adapted triple helix model might help disentangle the implications that such processes have for urban planning and new form of

private/public partnerships. For sure, such a theoretical model could help the impact analysis of the circular processes occurring in historic urban landscapes.

The conclusions reached by the paper can be summarized as follows: the circular economy paradigm, initially focused on ways to improve productivity and efficiency, now could help identify successful cooperation mechanisms. The culture of cooperation is a fundamental of the civic culture, being the culture of relationships, of synergies, of complementarities. When we move from a linear to a Circular Economy paradigm, cooperation becomes convenient not only within the economic dimension but also within the ecological and social dimensions. The culture based on cooperation encourages each actor to take their own responsibilities, in the understanding that any right is linked to a duty. In this way, the Circular Economy model goes beyond the traditional economic model based on the maximization of individual utility (*homo economicus*), embracing the idea of individuals with many other dimensions (*homo socialis*, *homo ecologicus*) [79].

Within this framework, the paper shows how the concepts of circular economy, circular city and citizenship, are closely related and how Universities have the potential to promote the circular model, not only for the associated economic benefits but also to foster new forms of citizenships.

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