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Urban Planning and Industrial Symbiosis in Slovenia

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Abstract. In recent years the concept of industrial symbiosis has been recognized as one of the most effective principles of the circular economy, with a positive impact on the environment on one hand and contributing to economic benefit on the other. The major role of spatial planning is to guide and coordinate different interests in the physical space and direct them in accordance with spatial planning procedures and methods. In addition to engineering, spatial planning is also recognized as a political and governmental discipline, where physical space represents the “arena” for arrangements of different activities and actions. Spatial development plans represent the legal instruments enabling the development and integration of industrial symbiosis alongside other contemporary trends in cities. In Slovenia, the potentials of industrial symbiosis are recognized only on the national level as a development axis. However, there is a lack of integration of the concept into spatial development strategies, programs and plans on the regional and local level. The concept is developed only on the level of waste management, which is based on the recycling of general household waste and not based on the exchange of waste as raw material between different industries. The main aim of the paper is to develop a methodology for integrating industrial symbiosis into spatial development plans on the strategic level. Since the City of Ljubljana is highlighted as one of the drivers of the circular economy in Slovenia, the paper will present Ljubljana as a case study of the research. The methodology will be developed based on research of the relationships between industrial symbiosis and spatial development plans and analysis of spatial development strategies, programs and plans to find the potentials for integrating a new model, industrial symbiosis, into the spatial planning system in Slovenia, which could enable a platform for the development of the circular economy.

1. Introduction

In the last few years, the circular economy (CE) and industrial symbiosis (IS) have been two the most widely discussed topics among academic circles and experts from different professions as possible supporting models to foster sustainability in cities. The concept of the CE is one of economic models supporting competitiveness, innovation and job creation affecting the long-term resilience of cities. The transition from a linear to a circular economy does not just mean an adjustment toward reducing negative impacts on physical space due to inefficient management and use of resources. One of the latest definitions of the concept of the CE is as “a regenerative system where resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” [1]. The concept of industrial symbiosis (IS) is one of the most effective principles of the CE, with a positive impact on the environment on one hand and contributing to economic benefit on the other. IS is a part of industrial ecology (IE) engaging traditionally separate industries into a common



approach involving the physical exchange of materials, energy, water and/or by-products to achieve a competitive advantage [3].

Since the processes are taking place in physical space, spatial and urban planning conditions for successful implementation of the IS and other CE models need to be established. Spatial planning is a discipline responsible for guiding and coordinating different interests in physical space [3] and regulating them in line with spatial and urban planning procedures and methods. In addition to engineering, spatial planning is also recognized as a political and governmental discipline [4] where the physical space represents the “arena” for agreements of different interests. Spatial development plans represent legal instruments by which the state, region and municipalities set guidelines, define policies on land development, the range of possible interventions and in addition to the conditions, the criteria for their implementation. Spatial development plans are divided up according to the level/scale (state, regional, local) and the timeframe (long-term, short-term). In Slovenia, spatial planning legislation starting from 2007 was only on the state and the municipal level of planning. Due to the lack of the intermediate level, from 1 June 2018 it will again implement the regional level which will in a way cover the strategic part of Municipal Spatial Development Plans. In the last few years, spatial and urban planning in Slovenia has been facing challenges that require integration of new aspects into the spatial planning system. The Slovenian Spatial Development Strategy 2030 adopted in 2017 exposed the fact that the current trend of spatial planning in Slovenia did not provide much support for achieving the optimistic goals already set in the Spatial Development Strategy of Slovenia adopted in 2004 [5]. Spatial planning is a complex system and faces adaptability challenges in terms of integrating current trends. Today spatial development plans are underestimated and potentials are poorly researched. To support cities in achieving their ambitious goals, new innovative approaches, models, and tools need to be developed.

1.1. Background

One of the flagship initiatives of the major development strategy, the EU 2020 strategy [6] adopted in 2010, is to foster resource-efficient management. Excessive use of resources was the major reason that the European Commission (EC) in 2011 adopted the “Roadmap for a Resource Efficient Europe” [7] where IS is recognized as a tool to promote efficient production encouraging re-using of raw materials and where EU member states need to support companies to cooperate in the creation of an IS model. The EU Vision up to 2050 sets even more optimistic objectives, but what is important is that among all the resources that are planned to be sustainably managed alongside raw materials, energy, water, air and soil, land is also mentioned as a resource [7]. The CE is also supported as goal in the new EU Urban Agenda from 2016 [8] as an important document for the future development of cities.

1.2. CE and IS in Slovenia

The study “Efficient use of resources: on the way toward the Action Plan of Slovenia” from 2014 [9] highlighted that there is a lack of a holistic national vision and sustainable strategy for efficient use of resources which could support the integration of current development trends, which include the CE and IS. Based on this, the national government of Slovenia drew up supporting documents, including the Framework Programme for Transition to a Green Economy [10]. The program was adopted in 2015 and it recognizes the CE and IS as part of the green economy development goals.

Raising awareness about the CE and IS have been recognized also through events organized in the last few years in Slovenia. The Operational Programme for Implementation of the EU Cohesion Policy in the Period 2014-2020 is under the project framework “Slovenia is minimising CO₂: best practices” and in the process of drafting the Slovenian Development Strategy 2030, in 2013 organized the event “IS as an opportunity for Slovenia” was organized in 2013, in which the integration of the UK IS model NISP was tested in Slovenia. A year later the Association of Town Planners of Slovenia organized the conference in Ljubljana “Green industrial areas: innovative approaches in urban planning” devoted to

IS. The year 2017 was specially devoted to CE and IS topics, among which the most promoted in the media was the international conference “Toward circular cities” organized by EURO CITIES, an independent network of European cities. The Ellen MacArthur Foundation, established in 2010, has a role of ambassador for the promotion of the CE concept in Europe and invited the City of Ljubljana to become a member of the network.

2. Methodology

The methodology of the first part is based on the desk analysis of the latest development strategies and plans on the national, regional, and local level [11] in the spatial and economic fields. The methodology used pursued the following procedure. First, the latest version of documents was transformed into PDF format from their original sources, followed by scanning selected terms in Acrobat Reader software with the “find” tool in order to get information about the chapter, paragraph, and statement that contains the terms [12].

On the national level the following major national development strategies and programs were under review: The Vision of Slovenia 2050 (2016) [13], the Slovenian Development Strategy 2030 (2017) [5], the Spatial Management Act (2017) [14], the Slovenian Industrial Policy 2014-2020 (2013) [15], Slovenia’s Smart Specialisation Strategy (2015) [16] and the Waste Management Programme and Waste Prevention Programme of the Republic of Slovenia (2016) [17]. The National Environment Protection Action Programme was not taken under review because it is outdated, but it is a new one in the development process. On the regional level the review looked at the major development document the Regional Development Programme of the Ljubljana Urban Region, [18] adopted in 2015, and on the local level the latest important development document the Sustainable Urban Strategy of the City of Ljubljana, adopted in 2015 [19]. Both documents, the Regional Development Programme and the Sustainable Urban Strategy, are strategic documents prepared for the needs of EU funds absorption in the period of 2014-2020. Alongside the Sustainable Urban Strategy, the Municipal Spatial Development Plan of the City of Ljubljana, planned to be adopted in May 2018, [20] was reviewed. In line with the national Spatial Planning Act (ZPNačrt, 2007) [21], the City of Ljubljana decided to adopt the strategic and implementation plans separately. The review looked only at the Strategic Plan since the focus of the article is the strategic level. The Strategic Municipal Development Plan is a long-term spatial development plan defining the basis, objectives and concept of spatial development of the entire municipality, and it provides guidelines for the development of settlements and their complete renovation, landscape development, determining land use, it defines spatial conditions for implementation, the concept of the public infrastructure of local importance, areas of settlements and dispersed settlements. The Municipal Spatial Development plan is the basis for building permits for spatial interventions.

The major objective of the review was to identify if the concept of IS or the CE is already integrated into development strategies, programs and plans, whether they are partly integrated or are not integrated at all. For the needs of analysis, in addition to IS and CE, other terms related to CE and IS were also identified. They are *industrial ecology*, *eco industrial park*, *industrial ecosystem*, *urban symbiosis*, *environmental management*, *green management*, *green economy* and *synergy*. The selected documents were not reviewed just from the perspective of identification of the selected terms but also through the context of point of view.

The second phase of research was devoted to analysis of promoted CE cases on the local level implemented in the public sector of the City of Ljubljana, such as city administration, public companies, public institutions and local communities to identify if there are IS concepts already existing and how they relate to the Municipal Spatial Development Plan of the City of Ljubljana. Since the main spatial development concept of the City of Ljubljana is not changing and the Municipal Spatial Development Plan needed to integrate guidelines from the latest development documents on the national, regional and

local levels, the review looked only at the documents adopted after 2010. The cases involved analyses from the perspective of how and whether they contribute to changes of the Municipal Spatial Development Plan. They are the CHAIRity project - give him another chance, Using Fallopia Japonica as raw material for paper, Hygienic paper from packaging waste, Reuse Center and Repair Café on Povšetova 4, Assembled furniture and equipment in the RCERO administrative building, Re-use (waste) material, Point. For you. and raising visitors' awareness of reusing and sharing, Reuse of furniture, the Library of THINGS, Activities for promoting short selling routes / green supply chains, Against plastic bags at Ljubljana's marketplaces, Campaign Gloves up! - a project to prevent the spread of tiger mosquitoes, Bicycle sharing – BicikeLJ, Street cleaning with recycled water and rainwater, Re-use of damaged and worn traffic signs, Re-use of asphalt, Refurbishing of car tires, Refurbishing of vehicles, Updating pool technical systems in the Tivoli pool, (Co) energy production, Processing biological waste into compost, Examples of NGO projects of NGOs in the City of Ljubljana, Material recovery or recycling, Cabins Šerinjon, the first Slovenian e-library of ethical design pieces and fashion accessories and the APPLAUSE project dealing with exotic plant species from harmful to useful with citizen-led activities [22].

3. Results and discussions

An analytical review of national development strategies and programs is given in table 1, recognizing the concept of the CE and IS as an effective model supporting the transition toward a green economy. On the other hand, related terms like *industrial ecology*, *eco industrial parks*, *urban symbiosis* and *synergy* are not even mentioned in the reviewed documents.

The CE concept is supported by three major general strategic development documents, the Vision of Slovenia 2050 (2016), the Slovenian Development Strategy 2030 (2017), Slovenia's Smart Specialization Strategy (2015) and by one sectoral one, the Waste Management Programme and Waste Prevention Programme of the Republic of Slovenia (2016). The first two general strategies emphasize the CE as a development goal, the Vision of Slovenia 2030 through commitment to sustainable development based on raw material self-supply, and the Slovenian Development Strategy 2030 through the innovative model "low carbon CE", the CE model supported by the efficient use of infrastructure and energy in the mobility sector. The Waste Management Programme and Waste Prevention Programme of the Republic of Slovenia emphasizes the transition toward the CE only in the field of construction waste.

IS is mentioned in the Slovenian Industrial Policy 2014-2020 as a new concept supporting the transition toward a green economy, in Slovenia's Smart Specialisation Strategy as an opportunity for all industrial sectors and services and in the Waste Management Programme as a measure for the prevention of waste in enterprises for which the Ministry of the Environment and Spatial Planning established the IS platform in 2015.

The terms *environmental* and *green management* are terms not used directly but due to legislation they are integrated through the use of other terms in all national documents such as *sustainable management of natural resources*, *efficient use of energy*, *efficient production*, *efficient business management* and others.

The *industrial ecosystem* as a term is not used directly, except in Slovenia's Smart Specialisation Strategy (2015). The term is used in relation to the optimization of a supportive entrepreneurial-innovation ecosystem and emphasizing the development of IT platforms as ecosystems supporting the goals of smart cities and society.

The review shows that *eco industrial parks* are not recognized as innovative models which can be supported through the spatial development processes as a land-use sub-category. In practice there are

many terms used for different models of industrial parks, among which are *trade industrial zone*, *trade zone*, *economic zone* and others. The problem lies in a lack of definitions and criteria for each of them. Many reviewed strategies and programs support the development of technology parks.

A green economy represents the major development goal of three development strategies, the Vision of Slovenia 2050, the Slovenian Industrial Policy 2014-2020 and Slovenia's Smart Specialisation Strategy.

Table 1. National documents scanned based on keywords related to the CE and IS

documents	Vision of Slovenia 2050 (2016)	Slovenian Development Strategy 2030 (2017)	Spatial Planning Act (2017)	Slovenian Industrial Policy 2014-2020 (2013)	Slovenia's Smart Specialisation Strategy (2015)	Waste Management Programme and Waste Prevention Programme of the Republic of Slovenia (2016)
circular economy	Yes	Yes	No	No	Yes	Yes
industrial symbiosis	No	No	No	Yes	Yes	Yes
industrial ecology	No	No	No	No	No	No
industrial ecosystem	No	No	No	No	Partly	No
Eco industrial park	No	No	No	No	No	No
urban symbiosis	No	No	No	No	No	No
environmental management	Partly	Partly	Partly	Partly	Partly	Partly
green management	Partly	Partly	Partly	Partly	Partly	Partly
green economy	Yes	No	No	Yes	Yes	No
synergy	No	No	No	No	No	No

On the regional and local levels, an analytical review based on table 2 shows that none of the terms among which are *CE*, *IS*, *industrial ecology*, *industrial ecosystem*, *eco industrial park* and *urban symbiosis* are mentioned in strategies and programs. Due to EU and national legislation *environmental* and *green management* are, as they are on the national level, also integrated into documents on the regional and local levels in all topics. The term *green economy* is mentioned only in the Regional Development Programme of the Ljubljana Urban Region (2015) as a goal linked to changing production and consumption patterns to achieve greater sustainability, more efficient use of resources, development of green technologies and creation of green jobs, and in the Sustainable Urban Strategy of the City of Ljubljana (2015) as a green economy goal supported by green public procurements and projects linked to IT development. *Eco industrial parks*, like the finding on the national level, are not recognized on either the regional and local level. In the Regional Development Programme of the Ljubljana Urban Region and Sustainable Urban Strategy of the City of Ljubljana, technology parks are promoted as a driver of economic development while on the strategic level of the Municipal Spatial Development Plan the development of a low-carbon economy zone is promoted.

On the EU and national levels, the City of Ljubljana is promoted as one of the best-case cities with integrated concepts of the CE in the public sector. They are listed and analysed in table 3 according to location and types of CE and IS. Ten cases are implemented in the whole area of the city, ten are located in one place (micro location), three of them at multiple locations, one is virtual and for one the location is not specified. By topic, five of them are focused on reusing materials, four of them on using recycled materials, four of them on repairing, recycling and reusing materials, four recycling and reusing materials, two of them are just repairing and reusing materials, two are focusing on eco-production from exotic and invasive plant species, two cases are raising awareness about repairing, reusing recycling

things, one is focused on recycling materials and one on self-care through setting up places for selling local food.

Table 2. Regional and local documents scanned based on keywords related to the CE and IS

Documents	Regional Development Programme of the Ljubljana Urban Region (2015)	Sustainable Urban Strategy of the City of Ljubljana (2015)	Environmental Protection Programme of the City of Ljubljana 2014-2020 (2014)	Municipal Spatial Development Plan – strategic part (2018)
circular economy	No	No	No	No
industrial symbiosis	No	No	No	No
industrial ecology	No	No	No	No
industrial ecosystem	No	No	No	No
eco industrial park	No	No	No	No
urban symbiosis	No	No	No	No
environmental management	Partly	Partly	Partly	Partly
Green management	Partly	Partly	Partly	Partly
Green economy	Yes	Yes	No	No
synergy	Yes	Yes	No	No

Out of twenty-five, in four cases IS models are identified. They are implemented due to more restrictive environmental regulations influencing the waste and energy sectors. All reviewed CE and IS cases which needed a physical space had to be implemented in line with the spatial planning regulations defined in a legal instrument, the Municipal Spatial Development Plan of the City of Ljubljana.

Unfortunately, today spatial development plans are underestimated and mostly used as technical instruments for implementation even for partial interventions or based on the initiative of various investors for updating the state of the art in the field and not as a tool for long-term planning of development in cities.

Table 3. Cases from the public sector of the City of Ljubljana promoted as best examples of the CE on the local level

	CE example	location	CE type	IS type
1.	CHAIRity project - give him another chance	micro location	repairing, recycling reusing material	-
2.	Using Fallopia Japonica as raw material for paper production	micro location	eco-production	-
3.	Hygienic paper from packaging waste	whole city	using recycled material	-
4.	Reuse Center and Repair Café	micro location	repairing, reusing material	-
5.	Up-cycled furniture and equipment in the administrative building of the RCERO	micro location	repairing, recycling reusing material	-
6.	Re-using (waste) material	whole city	reusing materials	-
7.	Point. For you. and raising visitors' awareness of reusing and sharing	whole city	raising awareness	-
8.	Reusing furniture	whole city	reusing materials	-
9.	The Library of THINGS	micro location	reusing materials	-
10.	Activities for promoting short selling routes / green supply chains	multiple locations	self-care	-

	CE example	location	CE type	IS type
11.	Against plastic bags at Ljubljana's marketplaces	multiple locations	using recycled material	-
12.	Campaign Gloves up! - a project to prevent the spread of tiger mosquitoes	whole city	using recycled material	-
13.	Bicycle sharing - BicikeLJ	whole city	reusing material	-
14.	Street cleaning with recycled water and rainwater	whole city	using recycled material	-
15.	Re-use of damaged and worn traffic signs	whole city	repairing, recycling reusing material	-
16.	Re-use of asphalt	whole city	recycling, reusing material	-
17.	Refurbishing of car tires	micro location	repairing, recycling reusing material	-
18.	Refurbishing of vehicles (LPP)	micro location	repairing, reusing material	-
19.	Upgrading pool technical systems for Tivoli swimming pool	micro location	recycling, reusing material	internal use
20.	(Co) energy production	multiple locations	recycling, reusing material	internal and external use
21.	Processing biological waste into compost	micro location	recycling material	internal and external use
22.	Examples of NGOs projects of NGOs in the City of Ljubljana	whole city	raising awareness	-
23.	Material recovery or recycling (Energetika Ljubljana, CČN, RCERO)	micro location	recycling, reusing material	internal and external use
24.	Cabins Šerinja, the first Slovenian e-library of ethical design pieces and fashion accessories	virtual	reusing material	-
25.	Project APPLAUSE - Alien Plant Species from harmful to useful with citizens' led activities	not specified	eco-production	-

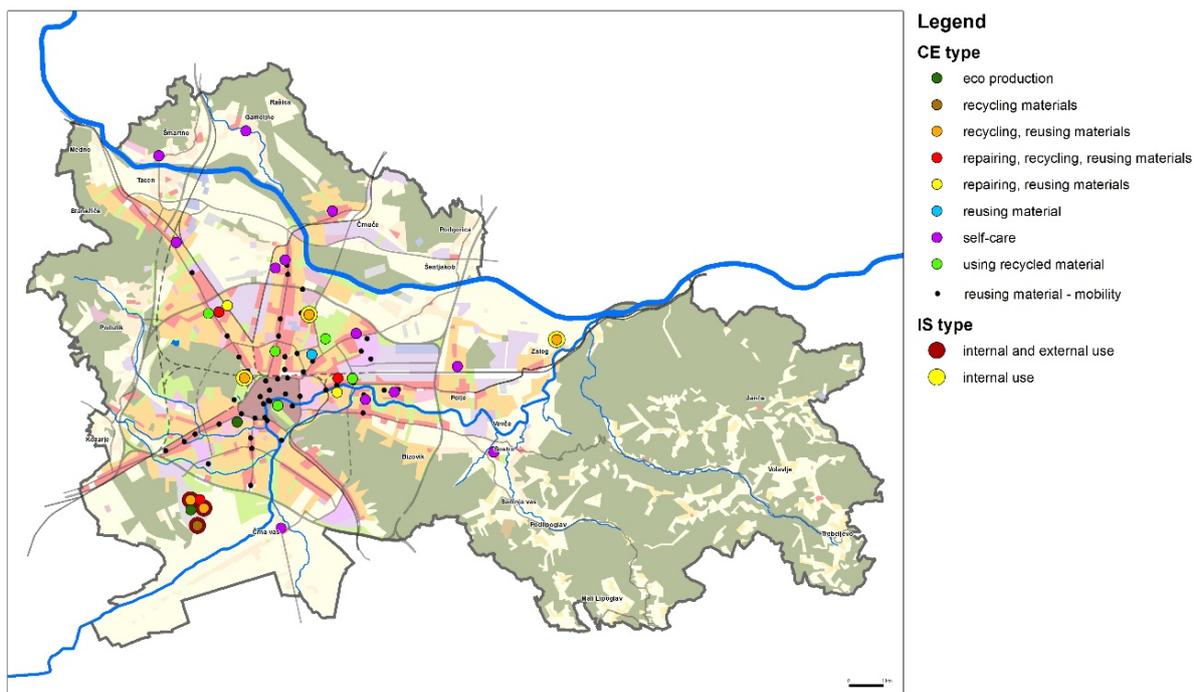


Figure 1. CE and IS types across the entire City of Ljubljana

4. Conclusions

Based on the existing Slovenian development strategies, programs and plans, there are potentials for integration of IS and other related models of the CE. Since they are recognized only on the national level as a development axis, reflection needs to be established also on the regional and local levels. The CE and IS concepts are developed only in waste and energy management due to the restrictive environmental regulations. The paper shows that integration of the CE and IS model is not possible if conditions in the Municipal Spatial Development Plans are not established. Thus, for successful implementation, the CE and IS concept need to be integrated into spatial development plans and other related development strategies, programs and plans as a development goal, both on the local and the regional level. Since local authorities play a major role in decision-making processes, especially in the process of preparing documents such as the Municipal Spatial Development Plan, it is important that they adapt and integrate CE and IS concepts and implement them also in other sectors. An important role in spatial planning processes is also played by potential key players for implementation of the IS and other CE models. They need to be identified and involved at the beginning of the process of preparing Municipal Spatial Development Plans in order to identify and define the possibilities offered by the physical space.

In future research, there is a need to implement other CE models which need a physical space and consequently a legal platform, among which are Spatial Development Plans on all administrative levels.

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