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MAKING CITIES CIRCULAR: EXPERIENCES FROM THE LIVING LAB HAMBURG-ALTONA

Abstract. The article argues that to reach circular economy goals urban regions need to identify and understand the challenges and opportunities originating from the differences in spatial settings, and to develop place-based solutions by adequately involving (local) stakeholders. Based on the case study that was conducted in Hamburg within the Horizon2020 project REPAiR, spatial specificities in five different urban areas shall be analysed and strategies that were developed in a co-creative process shall be explored. The results show that the spatial organisation of CE strategies depends on urban structures and stakeholders' interest and needs to be embedded in the (local) governance setting and a spatial planning system.

Key words: circular economy, urban regions, Multi-level governance, living labs, urban metabolism.

1. INTRODUCTION

This paper is mainly based on the results from the Horizon2020-funded REPAiR project. It aimed at supporting the transition of urban regions from a linear to a circular economy by specifically addressing questions related to the spatial organisation of possible circular economy concepts. This refers to recent studies in the field, such as the 'circular city' (Williams, 2019), that have drawn attention to the spatial implications brought by actions focussed on reaching circularity at the urban scale.

The paper aims is to analyse and indicate the differentiated requirements of the implementation of circular economy schemes and solutions in different types of urban neighbourhoods. The analysis was conducted in the REPAiR case study in the district of Altona in Hamburg. The thematic focus lies in the organisation of

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activities to achieve circular economy solutions that are linked to waste management (i.e. production, transport, consumption, and treatment).

The article investigates the main requirements that need to be addressed to develop, and preferably implement, CE schemes and solutions. These are namely changes in the governance structure and stakeholder constellation, and the subsequent modification of the urban tissue at the strategic level. After contextualising the working conceptual terms (Section 2), we shall present the case of Hamburg (Section 4) based on the methodological framework that is described in Section 3. This framework shall allow us to analyse and highlight the differences in the characteristics of the urban pattern of five areas representing different urban typologies in the district of Hamburg-Altona (Section 5). Here, the relationships between spatial configurations of the five neighbourhoods, the stakeholders' activities and the application of CE principles are explored. The conclusions on these relations shall be discussed in the final Section 6.

2. LINKING CIRCULAR ECONOMY AND URBAN METABOLISM WITH URBAN GOVERNANCE: SPACE MATTERS

At the base of the REPAiR project there is the exploration of innovative solutions for a shift towards a more circular economy (CE) in six European urban regions: Amsterdam, Naples, Ghent, Pécs, Łódź, and Hamburg (REPAiR, 2017a).

CE is a rather new paradigm that has been accepted and embraced at the level of the European Union, which currently demands for an inclusive and just transition towards circularity (EC, 2019). This concept is rooted in the broader concept of sustainability (EC, 2011) and, specifically, it draws upon the concept of Urban Metabolism (UM), which aims at describing cities as open systems which exchange flows with the environment (Kennedy, Pincetl and Bunje, 2011). While UM is mainly a descriptive paradigm, CE offers a conceptual framework for managing flows (Ghisellini, Cialani, and Ulgiati, 2016). This framework was translated into policy recommendations among others by the Ellen MacArthur Foundation (EMF) and largely adopted by the European Union in the EU action plan for the Circular Economy 2015 (EC, 2015; Obersteg *et al.*, 2019).

CE has mostly ignored one element, i.e. the accounting of the effects on the (urban) space of projects aimed at pursuing a shift towards circularity (Williams, 2019; Obersteg *et al.*, 2019). Further, scholars have argued that the spatial dimension cannot be underestimated when handling flows in cities, since every undertaken action implies inevitably a change on the land(use) (Girardet, 2015; Prendeville, Cherim and Bocken, 2018; Williams, 2019). In the current debate, it has been argued that urban planning as a discipline that studies the development of cities should incorporate CE perspectives (Petit-Boix and Leipold, 2018; Prendeville *et al.*, 2018; Obersteg *et al.*, 2019) and that

urban regions are "the most suitable scale to act for the concretization and spatialization of CE actions (Milligan and O'Keeffe, 2019)" (Obersteg *et al.*, 2019).

REPAiR positions itself inside this debate. Its ambition is to investigate the conditions which enable a shift towards circularity in urban regions. This approach includes the involvement of all relevant stakeholders in the activities concerning a specific material flow, the analysis of the urban pattern of five different neighbourhoods in Altona District, and the understanding of the implications of possible CE actions in such areas given a determined governance setting.

We assume that this shift can be pursued throughout a process (the analytical framework proposed in Section 3) that needs to be governed (Obersteg *et al.*, 2019). As governance is a rather blurry concept (Bressers and Kuks, 2003; Björk and Johansson, 2001; Rhodes, 1996), we shall define it here as multi-level, cross-sectoral and multi-actor or quadruple helix governance (Obersteg *et al.*, 2019). This approach has enabled us to "encompass a diversity of governing modes (e.g. Bulkeley and Kern, 2006; Nilsson, Eklund and Tyskeng, 2009) and multi-level interdependence (e.g. Hooghe and Marks, 2001; Newig and Fritsch, 2009)" to understand the transition (REPAiR, 2017b, p. 9).

Against this background, this article investigates the following theses: (1) to reach CE goals in urban regions it is necessary to identify and understand the challenges and opportunities in different spatial settings, (2) based on this understanding it is necessary to develop place-based solutions, and (3) the analysis process and the development of solutions need to be conducted adequately involving (local) stakeholders.

3. METHODOLOGICAL MIX: LIVING LAB APPROACH AND MATERIAL FLOW ANALYSIS

The REPAiR project approach to address CE-related issues in urban regions is built on a mix of methods that are grounded in natural science, social science, and economics: the analysis of material and energy flows provides background information as support for a series of five Living Lab (LL) workshops held in 2018 and 2019 and several smaller meetings, which enabled the real inclusion of local stakeholders' knowledge in the project results (Evans *et al.*, n.d; REPAiR, 2017a) organised in the following four main steps: (a) identification of the geographical boundaries and the governance framework setting, (b) definition of main problems in the case study area, (c) declination of the problems and objectives, and (d) design of solutions (not further elaborated in this paper). This framework was then adapted to face the specificity of the Hamburg context. Interviews were conducted with key stakeholders from the fields of urban planning and waste management which helped identify additional actors to be involved in further steps of the process (Reed *et al.*, 2009).

As a result, the local public authority and the public waste management company shared the interest to consider five different urban typologies: (1) a large housing estate at the urban fringe (Osdorfer Born), (2) a densely built-up urban area (Ottensen), (3) a new urban development area (Mitte-Altona), (4) a single-housing area at the urban periphery (Rissen), and (5) a single-housing area with second homes and weekend visitors (Blankenese). These five "sample areas"[1] were investigated through an extensive spatial analysis to deepen the understanding of land use, socio-economic, and physical structures, as delineated in REPAiR (2018a). A Material Flow Analysis (MFA) conducted by the public waste management company provided the basic information on the waste behaviours in the five areas (U.E.C., 2017). Further, the governance analysis investigated the constellation of stakeholders in place and their responsibilities, tools and decision-making processes in use. The collected information provided a clear picture of the examined area and formed the base for discussion with the local stakeholders through the aforementioned four steps in the LL. Within this process, a university project was conducted to further analyse the areas and to collect first ideas for solutions, the latter were further discussed in the workshops with the local stakeholders.

Fig. 1. The five sample areas in the district of Hamburg-Altona (REPAiR, 2020)

Source: own work.

[1] NB: The "sample areas" have artificial boundaries developed within the REPAiR project, they borrow the name of the quarters that encompass them. As an example, the name Ottensen refers to the sample area located within the Ottensen quarter.

4. SPATIAL PLANNING, ENVIRONMENTAL AND WASTE MANAGEMENT IN THE CITY OF HAMBURG AND THE DISTRICT OF ALTONA

The circular city concept is closely linked to the policy fields of spatial planning and environmental management. The Free and Hanseatic City of Hamburg as a city-state[2] itself is responsible for legislating on planning and environmental issues including waste management. The Ministry of Urban Development and Housing (Behörde für Stadtentwicklung und Wohnen – BSW) manages planning policies and processes. The preparatory land-use plan (Flächennutzungsplan) is the most important and superordinate planning document; it covers spatial planning for the whole city (REPAiR, 2017b, p. 27). This document describes the current land-use and the planned new development areas to fulfil the foreseeable needs of the city (Pahl-Weber and Henckel, 2008). The plan is updated to record new city developments (BSW, 2020a). On a more concrete planning level, legally binding land-use plans (Bebauungspläne) are drafted for specific sections of the municipal territory: this "sets out the legally binding stipulations for urban structure [...] concerning property" (Pahl-Weber and Henckel, 2008, p. 47). In Hamburg, these plans are developed mostly by the planning departments of the districts, e.g. Altona. Additionally, for larger new development areas often spatial concepts, like master plans, are established: these are not legally binding but rather they coordinate the various sectoral plans, providing common goals and inputs for further developments (Pahl-Weber and Henckel, 2008; REPAiR, 2017a). This was the case in the Mitte Altona development project (see Section 5).

Hamburg's Ministry of Environment and Energy (Behörde für Umwelt und Energie – BUE) is responsible for administrative and legislative duties regarding environmental issues, including waste management. It develops the waste management plan (Abfallwirtschaftsplan) and controls Hamburg's public waste management company Stadtreinigung (BUE, 2017). As stipulated in a law (Stadtreinigungsgesetz SRG, 1994), Stadtreinigung (SRH) manages the collection of household waste, street cleaning, winter services, and public toilets; at the same time, it manages twelve recycling stations throughout the city. The household waste fractions that are collected by SRH are residual waste and bio waste. The first fraction is incinerated to generate heat and electricity for the city, the latter is brought to a composting facility for obtaining biogas and compost (SRH, 2019). Packaging and paper fractions belong to the so-called dual system and are managed by the subsidiary company WERT GmBH (BUE, 2017). A major aim of the waste management plan is to connect as many private households as possible to the four-tons system (residual, bio,

[2] Hamburg is one of 16 federal states in Germany and more specifically one of three so-called city-states (besides Berlin and Bremen). As a city-state Hamburg is a federal state and at the same time it incorporates competences and duties of a municipality. Parts of the municipal competences and duties are transferred to its seven districts. Each district has its elected council (Bezirksversammlung) and administration (Bezirksamt).

packaging, paper) to enhance recyclables rates. However, not every unit has all four bins, especially in areas with a dense building structure (cf. Section 5).

On the level of the Altona district administration, the department for urban and landscape planning is responsible for drafting binding land-use plans, in accordance with the preparatory land-use plan (BSU, 2011, p. 3; BSU, 2013). This department also steered the development of the Altona climate action plan that includes objectives, strategies and measures for climate mitigation in Altona. The plan was developed in a participatory process. Two of the plan's major topics are sustainable consumption and improved waste behaviour (Bezirk Altona, 2019a; Bezirk Altona, 2019b).

5. THE SAMPLE AREAS IN HAMBURG-ALTONA: SOCIO-ECONOMIC AND SPATIAL ANALYSIS AND IDENTIFICATION OF SPECIFIC PROBLEMS, OBJECTIVES, AND SOLUTIONS

As mentioned in Section 3, during the case study area analysis, a list of general problems was established in reference to the entire district of Altona, which then was refined at the sample area level. The following Table 1 presents the list of problems for Altona with respect to CE principles.

Table 1. List of problems identified for the entire district of Altona in order of importance for the local stakeholders

Ranked General Problems
P1) 38% of biowaste is disposed of into the residual waste bin and incinerated instead of being used for biogas and composting.
P2) When planning buildings, waste management is hardly considered, as it is not required by law.
P3) Urban planning and waste management do not communicate and cooperate sufficiently.
P4) The residents do not include waste management in their routines.
P5) With the growing collection of biowaste, there is a risk that quality will be compromised by plastic pollution.
P6) The separation of bio-waste has a bad image with many citizens ("bio-waste stinks") and they prefer to throw it into the residual waste bins, although those also stink.
P7) The financial incentives given to citizens to separate their waste are not clear or not high enough.
P8) Some public containers are not placed in the optimal position for users.
P9) Social pressure on the residents of housing estates is not sufficient to force them to separate waste properly.
P10) Older people and people with disabilities do not have access to some of the public containers.
P11) At schools and kindergartens, children do not learn enough about waste problems.
P12) Garden waste from public green spaces is generally not passed on to the waste management company for compost and biogas production.

Source: own work based on REPAiR, 2018a.

Further, the sample areas of Osdorfer Born and Ottensen are presented in detail, while the characteristics of the other three areas are only mentioned as supporting the main argument. This choice reflects also the interest of the main stakeholders involved in the process, who are currently concentrating their efforts in these two areas. Therefore, after an analysis of the socio-economic and urban physical structure, there follows – based on the work with the local stakeholders – an overview of the identified problems, objectives and first ideas for solutions. Table 2 provides an overview of all five sample areas at the end of the section.

5.1. Osdorfer born: a large housing estate at the urban fringe

Located in the northern part of the Altona district bordering Schleswig-Holstein, Osdorfer Born was the first large housing estate project in the history of Hamburg, which nowadays offers 4,750 housing units for a total of 10,263 inhabitants (Statistik Nord, 2017). Built in the late-1960s, Osdorfer Born was the result of the housing boom program after the Second World War. It was meant to be a modern and liveable place, with access to a big park area. The planned connection to the metro system was not fulfilled as a consequence of the economic crisis in the 1970s, a fact that contributed to the poor accessibility of the neighbourhood that lingers until today (Schubert, 2005). As a result, a rather disadvantaged share of Hamburg's population lives in this area: according to the social monitoring of Hamburg, Osdorfer Born is considered a neighbourhood affected by multiple types of ailments (i.e. low income, high unemployment rate – see Table 2), as well as a considerably high share of foreign population (26.4% compared to 17.3% in the Altona district). Due to its characteristics, Osdorfer Born is considered to have a "very low status" (BSW, 2019b, p. 16) and, therefore, is defined as a possible funding area receiving support for urban regeneration[3]. In this context, the city has been funding neighbourhood management and projects with its framework integrated urban development program 'Rahmenprogramm Integrierte Stadtteilentwicklung' (BSW, 2019a). Additionally, the public and cooperative housing companies in the area have set up a neighbourhood management to enhance social inclusion and requalify the built and natural environment (Osdorfer Born, 2020).

Based on the analysis and the statements of stakeholders during the living lab process, 1) socio-economic related issues, and 2) spatial-related issues were identified. Among all socio-economic issues, the language barriers are the most often indicated problem in the area, one which causes difficulties in explaining correct waste behaviour and involving citizens in CE activities within the neighbour-

[3] Since 1999, the federal government of Germany has been supporting the stabilisation and upgrading of urban, economic and socially disadvantaged and structurally weak urban districts and neighborhoods with the Social City "Soziale Stadt" urban development program (BMI, 2019).

hood. Lower levels of education and income also contribute to an often-limited awareness on environmental related issues (and waste behaviour consequently).

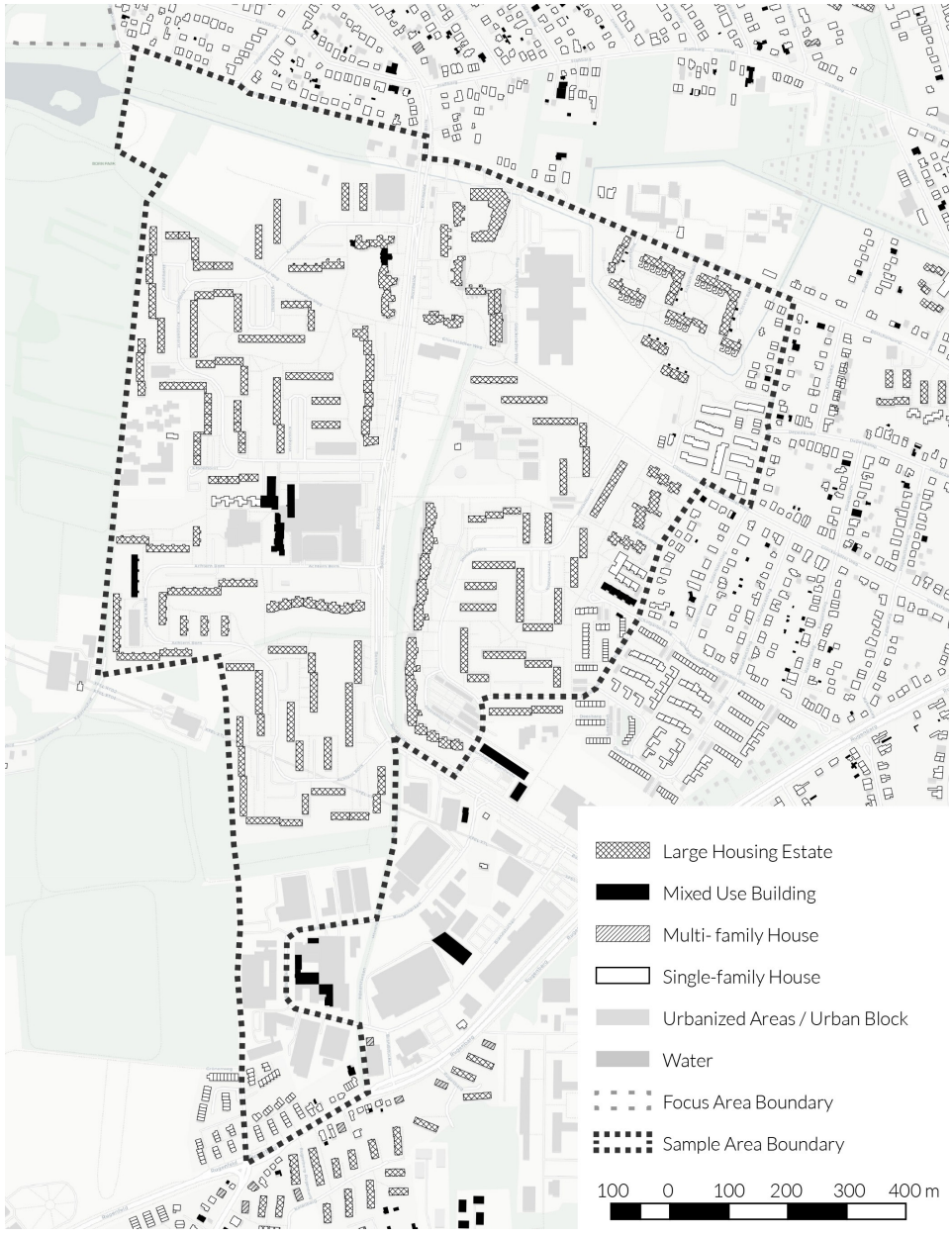

Fig. 2. Residential building types in the sample area Osdorfer Born

Source: own work based on RERAiR, 2020.

Concerning the spatial-related issues, the stakeholders stated that the anonymity of high rise buildings and the longer distances from the flats to the waste collection points on the street level lead to worse waste separation and generate littering in public spaces, especially concerning bulky waste. Moreover, the apartments' usually small kitchens do not allow residents to have all four bins for waste separation (Bauverein der Elbgemeinden, 2020). Finally, some waste collection points are not adequately accessible, especially for the elderly and disabled persons.

Therefore, the objectives defined by the local stakeholders for this area were related to enhancing social inclusion, improving environmental awareness, and at the same time providing knowledge on waste and life cycle. As space for waste separation inside the flats is scarce, alternative solutions, which enable a different way of separation, were explored (e.g. community composting, innovative forms of waste collection, like cargo bikes). To achieve these objectives the stakeholders concluded that a strategy that involves different groups of citizens is necessary to co-create solutions. Furthermore, possible tangible benefits for the citizens, like lower costs for waste management and improved cleanliness and quality of spaces, were regarded as necessary elements to be communicated. The stakeholders decided to develop this strategy using the existing network of local institutions (like housing companies, sport and neighbourhood associations) in the area. The neighbourhood management together with SRH would organise the process of strategy development and project implementation involving the local institutions.

5.2. Ottensen: a densely built-up urban area

The Ottensen neighbourhood is part of the historic centre of the district of Altona, which historically was an independent city and today functions as a centre for retail and services for the whole district. Its built environment is characterised by a rather dense structure mainly with 19th century buildings and narrow streets. Due to this high density, there is a high competition for space, especially for public land. As a consequence, it is difficult to dedicate spaces, either private or public, to waste collection, e.g. for the placement of tons or containers inside and outside of the buildings. In some parts of Ottensen, due to this insufficiency, residual and packaging waste is still collected by means of waste collection bags that are placed by households on the sidewalk (Sackabfuhr).

This bag collection causes problems of littering, bad smell, and negatively influences the aesthetic image of the area. Furthermore, a separated collection of organic waste cannot be conducted using the bag system, as it might cause hygiene-related problems. Although SRH conducted pilot projects to build underfloor containers for separated waste collection on public ground, there are still many streets where bag collection persists.

The population of Ottensen has an income close to Altona's average and is comparably well educated and young. Environmental sensitivity is rather high which is mirrored by the presence of many socio-cultural centres, initiatives and shops with an pro-environmental focus (e.g. zero packaging). Furthermore, several community gardening projects are active in the neighbourhood.

Despite these favourable conditions, the waste analysis performed by SRH has shown that the separation behaviour in this area is not better than in other parts of Hamburg even in households that potentially have the four bin system and could, therefore, separate fractions.

Further, the lack of (public) space to implement an improved waste infrastructure (especially an underfloor system) also generates conflicts of land with other possible uses of (public) space, e.g. parking spaces for cars or bicycles, and charging stations for electric vehicles.

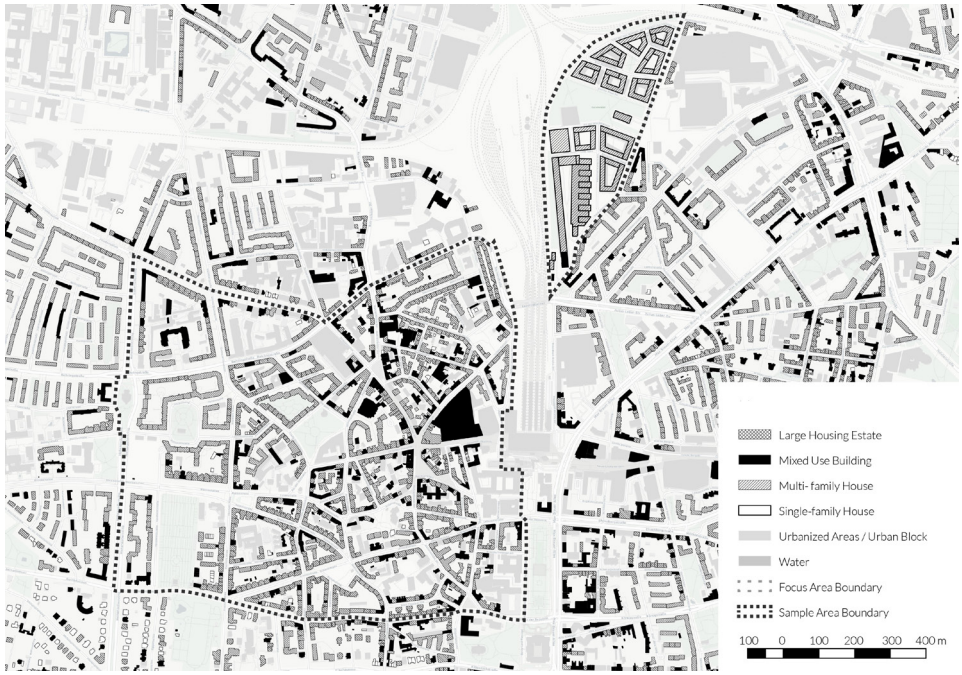

Fig. 3. Residential building types in the sample areas Ottensen and Mitte-Altona
Source: own work based on RERAiR, 2020.

The two main objectives for this area are described as follows. First, to reduce the bag collection and to improve the situation in the waste areas by implementing underfloor containers; to achieve this, creative solutions need to be developed. Second, to improve the waste separation and collection of bio waste in households that already have the four-bin system.

5.3. Mitte-Altona: a new urban development area

Mitte-Altona is the second largest urban development project in Hamburg after HafenCity. It is situated close to the historic centre of Altona Nord and Ottensen. The project is being developed on a disused railway freight station. Its master plan is composed of two areas: the first part will largely have been finished in 2020, while the second is planned to be completed in 2023 (Hamburgische Bürgerschaft, 2012a; Hamburgische Bürgerschaft, 2012b). Mainly apartment buildings are built in the area in order to face the need for new housing in Hamburg. The planning process started in 2007 comprising different steps, like a masterplan, a legally binding land-use plan, an urban design and architectural competitions, and participatory elements as foreseen by the German planning law. A part of the first development section was completed in 2018. The area can be considered as a future-oriented residential model with a mobility concept aiming to reduce car use and offer a planned mixture of social and free market housing. The residential buildings, which are predominant in the area, are characterised by a particularly high proportion of perimeter blocks with a common courtyard. The heights of the buildings follow the ones of the surrounding structure, while the density of the area is relatively high. The development of the second part of Mitte Altona area will start in 2026 (BSW, 2020b).

Despite the innovative planning with regard to the social mixture and mobility, the stakeholders indicated during interviews and workshops that the topic of waste management was not treated in an innovative way. Actually, the topic was rather neglected. Unlike in other newly planned areas, here no underfloor containers were implemented and even too little space was provided for waste bins to be well handled during collection days. This leads to conflicts with other uses of spaces, e.g. with car parking and the use of sidewalks and streets.

5.4. Rissen: a single-housing area at the urban periphery

This neighbourhood borders Schleswig Holstein, and is located around forty minutes by local train from the city centre of Altona. This area features a low density settlement with a high share of green areas, including big parks and vegetation on streets and backyards. Single-family houses are the main housing typology besides some four to five floor buildings in the centre of the neighbourhood close to the train station, where also local supplies are located. The low density of the built area offers sufficient space both inside and outside the properties for placing bins and containers for the waste separation. However, the waste separation analysis of SRH (U.E.C., 2017) has shown that the bio waste bins are mainly filled with garden waste, while kitchen waste is mostly disposed of in the residual waste bins and with it consequently incinerated. Therefore, a considerable amount of kitchen waste is lost for further treatment in the bio waste plant, where it would be anaero-

bically digested and then fermented to produce biogas and compost. The objective in Rissen is to improve the separation behaviour. As the infrastructure (four bin system) is already in place, solutions will have to focus on education, information and incentives (REPAiR, 2018a).

Fig. 4. Residential building types in the sample area Rissen
Source: own work based on RERAiR, 2020.

5.5. Blankenese: a single-housing area with second homes and weekend visitors

This neighbourhood features a hilly topography (around 70 metres of altitude) leading to the river Elbe (REPAiR, 2020). This area is famous for its nice paths on stairs (circa 5,000 steps) and small streets with single-family houses, many for weekend vacation. This means that the population here is not stable, and it varies considerably during the week.

Due to the topography, bins cannot be easily carried. Therefore, to a large extent, bags are used for residual, packaging and paper waste collection. In interviews and workshops this has been indicated as problematic, as it causes hygienic problems and makes the area less attractive for visitors. As in areas with bag collection, kitchen waste cannot be separately collected and has to be disposed of with residual waste. Like in Rissen, households with a bio waste bin mainly use it for garden waste. The main objective in Blankenese is to reduce bag collection. Solutions will have to tackle the lack of space and the topography.

Fig. 5. Residential building types in the sample area Blankenese
Source: own work based on RERAiR, 2020.

Table 2. Summary of the main spatial and socio-economic information for each sample area

INDICATORS	Osdorfer Born[a]	Ottensen	Altona-Nord	Blankenese	Rissen	Altona District
Population [n]	10,263	35,370	22,137	13,407	15,192	273,263*
Population density [inh/sq. km]	11,591	12,654	9,981	1,733	909	3,469*
Population over 65 years old [%]	18.0* (22.6)	13.4*	10.1*	27.2*	30.6*	18.0*

Table 2 (cont.)

INDICATORS	Osdorfer Born[a]	Ottensen	Altona-Nord	Blankenese	Rissen	Altona District
Foreign population [%]	26.4* (17.3)	13.1*	18.8*	8.3*	7.3*	16.1*
Population with migration background [%]	63.8* (39.2)	26.0*	36.0*	17.1*	16.9*	32.0*
Annual average income per taxpayer [€]	17,480 * (43,177)	40,830*	29,901*	117,139*	65,855*	48,620*
Unemployment rate (between 15 and 65 years old) [%]	11.8* (6.6)	4.4*	7.2*	1.9*	3.5*	5.9*

* These details were found in Statistik Nord (2017) related to the quarter level in the year 2016.
[a]For Osdorfer Born, the details at the neighbourhood level were found and are shown here compared to the quarter level (in parenthesis): according to the Hamburg Social Monitoring, Osdorfer Born functions as a "very low status" neighbourhood. Other details have been derived from the HCU Transparent geoportal and related to the year 2016. The comparison with the district of Altona is shown in the last column. These numbers have been calculated from the Datasets in the Transparent Geoportal Hamburg, GIS.

Source: own work, 2020.

6. DISCUSSION AND CONCLUSION

In the attempt to address the topic of circularity, the European Union is demanding a more inclusive and just transition by addressing all levels of governance. Our research concentrated on the local level and investigated the effects of CE activities on the socio-economic aspects and the consequences that affect the spatial organisation of the urban structure (as stated in Williams, 2019). Hence, the understanding of specific spatial conditions has proven important for the development of solutions that respond to local problems and meet stakeholders needs. As highlighted in Section 5, the mosaic of urban structures composing the five different areas raises unique problems specific for the local situation.

The analyses of the two most contrasting examples, i.e. Osdorfer Born and Ottensen, have shown that socio-economic and spatial aspects generate similar (but not equal) problems which require the development of a sound local strategy by involving stakeholders in place.

In Osdorfer Born, the current situation demands addressing societal challenges to overcome cultural and language barriers to reach a better waste separation at source. However, Osdorfer Born also faces problems in the built environment related to a lack or bad quality of space dedicated to waste-related activities. Additionally, spaces dedicated to waste collection and separation are not always well configured, ranging from a lack of understandable information to a suboptimal location.

In Ottensen, adequate physical waste infrastructures are present only in some parts of the area, with the Sackabfuhr (i.e. poor source separation) system currently being the most relevant practice. Additionally, even though the inhabitants of the neighbourhood have generally proven to be aware of environmental issues[4], this is not reflected in their waste separation behaviours (U.E.C. 2017).

The differences in the two areas demand distinctive strategies to achieve circularity at the local level. In Osdorfer Born, the involvement of institutionalised stakeholders (e.g. the neighbourhood management), who are already present in the area, could foster and guide the sensitisation campaign of the citizens through systematic engagement and rewarding or fining mechanisms. In Ottensen, a possible strategy should aim to create a network to connect those stakeholders who are already active in the neighbourhood (e.g. environmental and social associations) to foster local initiatives and projects.

In summary, it is argued that the strategic component to support locally tailored actions towards CE should consider the collection of a sufficient amount of data (qualitative and quantitative) to support the decisions by the stakeholders involved in the process. These should embrace a spectrum of both local (bottom-up) and institutionalised (top-down) stakeholders, as for the cases of Ottensen and Osdorfer Born. Furthermore, not only the vertical dimension, i.e. the levels of governance but also the integration between different sectors on a horizontal level plays a relevant role. Actually in Altona-Hamburg the Climate Action Plan (see Section 4) saw the participation of local (e.g. zero-packaging shops) and super-local stakeholders, such as the local waste management company and the municipality. In fact, the results have shown that in Hamburg there is a demand for a more decisive intervention of the public authorities to guide such a process, implying a narrower collaboration between the urban planning division and the waste management sector.

Reflecting on the methodology, the mix of data-based (Material Flow Analysis) and qualitative (stakeholder involvement in living labs) methods has proven to be useful for the research on circular economy and cities. Spatial, material-flow, governance and stakeholder analyses created the base for an informed discussion to address circularity in such local contexts.

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[4] As can be interpreted by the high voting results of the Green party in the latest Hamburg regional elections in February 2020 (Statistik Nord, 2020).

The involvement of local stakeholders has helped identify problems, understand peculiarities, and discover the challenges that prevent the achievement of circularity at the local level. Moreover, although the involvement process has been time and resource consuming, it could assure an innovative way of defining suitable solutions for specific problems and raising the chances for actual implementation.

The mixture of different stakeholders enabled various views as well as new insights for the participants themselves. The observation from different angles led to a richer and more balanced analysis of the problems and the exchange of a variety of arguments set the ground for the development of new strategies and solutions.

Nevertheless, the identification, the involvement and the mixture of stakeholders in a living lab is challenging and contains risks that could strongly affect the process and outcome. Therefore, the usage of the living lab method related to circular economy and city approaches should be further examined in research, although currently being highly recommended.

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