

Implementation of Cradle to Cradle diversity principles in business site development schemes

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Abstract

The conventional linear 'end-of-pipe' approach to development of business site schemes is associated with high energy consumption, waste generation, air pollution and land contamination. These schemes are also not always sufficiently diverse to meet changing future needs, resulting in the legacy of derelict brownfield sites at the end of their service life. It is argued that by applying the diversity criteria of Cradle to Cradle (C2C) design

philosophy to business site development, positive contributions can accrue to the natural and human environment, whilst maintaining flexibility and adaptability to meet changing future needs. This study investigates the development and integration of C2C diversity criteria on two pilot case study business sites, using an action research strategy. The study finds that essential ingredients for successful integration of C2C diversity criteria are co-creation, innovative procurement practices, good governance and willingness to accept risk. These parameters inform guidelines for achieving diversity on business sites.

Key words: Brownfield sites, business sites, Cradle to Cradle, diversity, greenfield sites

1.0 Introduction

From an urban planning and development perspective, business sites are an agglomeration of interlinked firms and institutions that are co-located to take advantage of common services which will otherwise be too costly for any single business (Deutz and Gibbs 2008). Apart from agglomeration benefits of sharing common services and infrastructure, the business site concept has also been driven by other location factors, such as proximity of markets, proximity of suppliers and services, government influence and environmental objectives. The environmental drivers have been evidenced by the development of environmentally-friendly eco-parks and sustainable business parks (Pellenbarg 2002). Whilst these development schemes can facilitate economic growth and development through innovation, learning and job creation, they have mostly been associated with poor environmental management, pollution, traffic congestion and reduced quality of life (Memedovic 2012). These negative impacts of business sites have been attributed to the adoption of linear 'end-of-pipe' development models, which focus on economic

development at the expense of environmental and social impacts (Ankrah et al. 2015). In the long-term, such sites also lose their tax base value for local governments, become demolition liabilities due to poor design and choice of materials and terminate as derelict brownfield sites that no longer meet their intended design purpose (Ott et al. 2014). The realisation of diversity in the design and operation of business sites can, however, contribute significantly towards ensuring that such development schemes meet economic objectives and both social and ecological objectives throughout their life-cycle and beyond (Ott et al. 2014). Business site schemes that have been designed to embrace and celebrate diversity can serve multiple social, economic and ecological functions throughout their life-cycle, ensuring that they do not ultimately become derelict brownfield sites.

Although the diversity concept continues to gain popularity as a guiding principle in urban planning and design, it is subject to variable interpretations and meanings (Fainstein 2005), making its practical implementation problematic. Within the urban planning and design context, the multiple meanings of diversity include varied physical designs, mixes of uses and support of multiple social groupings (Fainstein 2005; Putnam and Unum 2007). This study adopts a Cradle to Cradle (C2C) perspective on diversity, in which the celebration of diversity is one of three founding principles, the other two being 'waste is food' and 'use of current solar income' (McDonough and Braungart 2002). According to C2C philosophy, there are three dimensions of the 'celebrate diversity' principle that can be implemented on business sites. These are biodiversity, socio-cultural diversity and conceptual diversity (McDonough and Braungart 2002; Mulhall and Braungart 2010). However, there is little robust research that demonstrates how such diversity criteria can be leveraged on business sites to achieve positive social and ecological impacts. How can these three aspects of diversity be incorporated on business sites, and what would be their actual impacts on

social, ecological and economic goals? It was to interrogate some of these issues that this research was undertaken. This paper focuses on the first question of the approaches for developing and incorporating the C2C diversity criteria on business sites. The main research question was: How can the C2C diversity principle be practically realised in the design and development of business sites?

The next section discusses the C2C concept before delving deeper into the concept of diversity, with particular focus on the C2C 'celebrate diversity' principle. The methodological approach for the study is then discussed before presenting the study findings, discussion and implications.

2.0 Cradle to Cradle

C2C is an innovation platform for achieving positive impacts, by improving the quality of products, systems and services (Ott et al. 2014). This is achieved by designing positive economic, cultural and environmental qualities into materials, buildings, neighbourhoods and regions. Unlike conventional development paradigms that are dominated by eco-efficiency targets, C2C articulates a conceptual shift towards the eco-effectiveness targets of being 'good' rather than 'less bad.' Whilst eco-efficiency focuses on minimization of negative impacts, eco-effectiveness strategies strive for the creation of positive beneficial footprints (McDonough and Braungart 1998; McDonough et al. 2003). The aspiration of C2C for the built environment is thus to promote intelligent designs that have positive synergetic relationships with the environment. This can only be realised by taking inspiration from natural flow systems, where the sun is the primary source of energy and where waste from biogeochemical processes undergo biological metabolism to create food for other biological

processes. As such, McDonough and Braungart (2002) formulated three C2C principles for achieving eco-effectiveness:

- Waste is equal to food: everything is designed as a resource for something else.
- Use of current solar income: the dependence on renewable energy sources.
- Celebrate diversity: supporting biodiversity, socio-cultural diversity and conceptual diversity.

The 'waste is food' principle articulates that waste should be conceived as a resource from the onset of design, such that materials (bio-degradable and non-biodegradable) can serve as technical or biological 'nutrients' (resources rather than waste) for other processes at the end of their life-span or use periods. Materials used in products and components should also have self-cleansing properties, so that they can clean and purify the atmosphere (Braungart et al. 2007). This ensures that materials contribute net positive impacts on the environment through their positive effects. The principle of use of current solar income advocates dependency on renewable forms of energy that are primarily driven by solar radiation: solar, wind, geothermal and hydro-energy. The aspiration is for built assets to operate as energy production rather than energy consumption facilities, contributing a net positive ecological footprint. The 'celebrate diversity' principle advocates designs that mimic healthy and complex natural ecosystems, where different organisms and plants function together for the collective good of the entire ecosystem. To achieve this, designs would have to create and support bio-diversity, socio-cultural diversity, and conceptual diversity (McDonough and Braungart 2002).

C2C has become firmly established as a design philosophy and a significant amount of research has been undertaken on different aspects of this philosophy. Much of such research has dwelt on its application in the industrial engineering and product design sector (see e.g. Lee and Bony 2007; Ioannou and Ody-Brasier 2011a; van de Westerloo, Halman and Durmisevic 2012; Ordouei and Elkamel 2017; de Macedo Guimar, Lia Buarque 2012; de Pauw *et al.* 2014; Braungart, McDonough and Bollinger 2007; Go, Wahab and Hishamuddin 2015; Bakker *et al.* 2010). Lee and Bony (2007) for instance provide a case study of how Herman Miller implemented C2C during the design of the Mirra chair, as well as the impact of the new protocol on their internal processes: design decisions, manufacturing, and supply chain management. Similar case studies are provided by Ioannou and Ody-Brasier (2011a;b) on Desso a Dutch manufacturer of carpet tiles and flooring solutions. Ordouei and Elkamel (2017) presented a study investigating and affirming the robustness of a composite sustainability index (CSI) for monitoring and troubleshooting the sustainability performance of a C2C designed chemical process, whilst de Macedo Guimar (2012) introduced a sociotechnical design method for achieving C2C outcomes in the clothing sector. An interesting case study research is offered by de Pauw *et al.* (2014) which provides empirical evidence of the importance of design philosophy by proving that 'design focus' leads to significant differences in product design, underscoring the need to embed philosophies like C2C in the consciousness of designers.

Its implementation in the built environment has however not been the subject of much empirical research. Theoretical papers such as McDonough and Braungart (2003) which advocated adoption of C2C for sustainable design of the built environment and McDonough *et al.* (2003) which reviewed the scope for applying the 12 Principles of Green Engineering to C2C design to optimize products, processes and systems, abound. However, the empirical

studies are rather limited. The prominent research include: a study cataloguing the experiences of nineteen professionals with implementation of the C2C principles in a building and what they considered as the main challenges (van de Westerlo, Halman and Durmisevic 2012); a survey by Ankrah, Manu and Booth (2015) that interrogated business site tenants' preferences of cradle to cradle attributes and found *inter alia* that training, employment and use of local skills (social diversity) as well as realisation of highly flexible and easily adaptable spaces (conceptual diversity) were more important attributes than the integration of biodiversity; and an audit of the integration of cradle to cradle principles in building practices in the Flanders region of Belgium that actually flagged the lack of guidelines for implementation of these principles as a critical weakness (Debacker, D'Haese and Vrancken 2012).

Certainly, in relation to its role in achieving diversity in the built environment, it is reasonable to conclude that there is a dearth of empirical C2C research.

3.0 Diversity in business sites: A Cradle to Cradle perspective

From an urban planning perspective, urban designers conceptualize diversity as the incorporation of mixed building types, urban planners focus on mixed-use schemes, whilst sociologists and cultural analysts envisage diversity as the achievement of class and ethno-racial heterogeneity (Fainstein 2005; Putnam and Unum 2007). Diversity is often used to depict the achievement of physical and social heterogeneity through mixed buildings that encompass multiple architectural styles and patterns, embrace different construction styles, are suitable for mixed uses, foster multiple interactions and that have a local character (Fainstein 2005). These aspects of diversity can improve creativity and the achievement of

social justice. From a C2C perspective, conceptual or intellectual diversity is similarly conceived as the promotion of highly adaptable designs that can easily be modified or reconfigured to serve multiple purposes (Mulhall and Braungart 2010). This is analogous to urban planning and design aspirations of achieving architectural heterogeneity through a mix of building types and styles and mixed use designs through juxtaposition of diverse facilities (i.e. retail, entertainment, residential and office developments) (Fainstein 2005). Indeed, the achievement of mixed use schemes can boost local economic prospects due to the seamless interactions across diverse individuals and organisations. This results in a form of economic or commercial diversity. C2C proponents also advocate cultural and social diversity to be promoted through mixed use designs, preservation of local heritage, support for livelihoods and promotion of healthy indoor environments and designs that enhance the health and well-being of users through their aesthetic and spatial qualities (Mulhall and Braungart 2010). Urban planning literature also recognises the need to achieving social diversity by accommodating the social unevenness that manifests through income and ethnic disparities, during the design and development process: urban heterogeneity and social justice (Sandercock 1997 2003; Putnam and Unum 2007).

Recent development schemes have sometimes been driven by imitation, which limits the achievement of social-cultural and conceptual diversity. Residential buildings, shopping malls, office buildings and other developments tend to look the same the world over, because of widely shared development strategies that are exchanged on a global scale (Fainstein 2005). Indeed a term 'duplitecture' has emerged (see e.g. Manley and Silk 2014) to characterise this development. It is noted that such imitation is driven by efficiency needs and pressure to derive quick return on investments and is not necessarily inimical to implementing diversity. However generally, such imitation inhibits the emergence of

organically-driven developmental forms and patterns that respond to local forces and reflect local heritage. Some development schemes tend to promote single-group neighbourhoods, resulting in social segregation and lost opportunities for achieving social heterogeneity and improved livelihoods for disadvantaged or less affluent socio-economic groups. The potential to use imitation as a creative process to synthesise the universe and nature into architecture and urban design (see e.g. Steil 2014) as required in biomimicry, unfortunately has not been realised in development schemes.

Whilst all these diversity conceptualizations from urban planning literature reflect aspects of conceptual and socio-cultural diversity, as proposed by the C2C 'celebrate diversity' criteria, they are deficient in terms of reflecting the need for bio-diversity integration in urban development schemes.

Biodiversity, which is the biotic aspect of the business site environment, consists of flora and fauna that can be integrated into the scheme: in both indoor and outdoor environments. This can be achieved through the incorporation of gardens, green roofs, fish ponds and other innovative facilities that support flora and fauna. A study on the preferences of tenant stakeholders towards integration of biodiversity into business sites revealed the low level of importance that business site tenants place on biodiversity integration (Ankrah et al. 2015). Biodiversity integration on business sites therefore had the least influence on tenants' choice to operate from such sites. However, Snep et al. (2009) found that the implementation of measures that enhance biodiversity in business sites may be acceptable to business site stakeholders if it is oriented towards the achievement of urban green functions, such as recreation, health and well-being and improved external appearance of the site. This tension between what is important and what is acceptable suggests, therefore,

that challenges exist with the practical achievement of biodiversity integration in business sites. Thus, whilst the C2C diversity concept and its application in business sites offers the prospect of maximizing economic, socio-cultural and ecological benefits in business sites, no tried and tested road-map exists in practise for defining the needs of business sites, identifying the combination of diversity criteria for optimum benefit, and the means by which they can be integrated into development schemes. Whilst achievement of any form of diversity, for example in this case of business sites, should be an organic and contextualized process, a viable innovative strategy is required to successfully integrate biodiversity, socio-cultural diversity and conceptual diversity criteria in such development schemes. These innovative strategies need to be incorporated into the design, development, management and governance processes of business sites to realise any added economic, socio-cultural and ecological value. This study, therefore, investigated strategies for incorporating the 'celebrate diversity' aspiration into business sites through a methodological approach that involved multiple stakeholder engagement.

4.0 Methodological approach

The research adopted 'action research,' which is a social research strategy that aims to achieve social change in the process of generating data for scientific knowledge production (Greenwood and Levin 2006). Action research designs involve the participation of local stakeholders (e.g. organisations, communities and networks, in conjunction with expert and professional researchers, working together from the onset of problem definition to achievement their social change agenda (Greenwood and Levin 2006). Thus, action research involves the constant interplay between theory and practise (Gustavsen 2001). Brydon-

Miller et al. (2003) define action research as a participatory, democratic process that is grounded in a participatory worldview, and aims to develop practical knowledge in pursuit of worthwhile human purposes. Action research can be viewed as a two-fold process of acting to improve practice and at the same time providing new understanding, generating new knowledge about how and why the improvement or change happened (Mcniff and Whitehead 2011). The opportunity to contribute to new practices through action, and the contributions to theory, new knowledge or ideas, are intertwined in action research.

This research formed part of a wider transnational project called the C2CBIZZ Project involving nine north-west European countries. The C2CBIZZ project involved the implementation of actions that aimed for change in the diversity criteria that can be embedded into the master planning of area sites. This change implementation agenda provided the ideal environment for an action research strategy to be adopted to generate an account of any new knowledge, ideas, or theory on how the change was achieved and the implications of actions that were taken. The selection of this research strategy was informed by the close involvement of the researchers in the interventions to transform the selected area sites. It was considered that action research would offer the best vehicle for the reflective process required to extract the lessons on best practice for C2C diversity implementation during the interventions. McNiff and Whitehead (2011) have differentiated between interpretive action research, which involves the study and reporting of what practitioners are doing by an external researcher, and the self-study or living theory action research, whereby practitioners themselves can offer explanations about their own actions. The self-study action research approach was adopted in this instance as all the practitioners involved in development and implementation of the C2C diversity guidelines were at the same time engaged in the reflection and documentation of these actions, the changes that

were achieved, how and why the change happened and the implications for promoting the C2C diversity criteria on business sites. The action research strategy was applied to two pilot case study business sites, with the aim of understanding developmental and implementational issues surrounding the integration of C2C diversity criteria. Given the transnational focus of the study, these two pilot sites were located in France and Germany, thus presenting different geographical, institutional and cultural contexts for studying diversity implementation in business sites. Ultimately, it was envisaged that through this action research study, new solutions and guidelines would be developed for implementing C2C diversity criteria in business sites across Europe and beyond.

4.1 Data Collection and Case Studies

The first pilot site was a brownfield site (La Lainière site) located in the European Metropole of Lille (MEL). An important objective for MEL was to enhance City assets, particularly as they were undergoing a period of economic uncertainty. It was considered that the concept of diversity, as defined under C2C philosophy, and its application offered the prospect of achieving this objective through the future-proofing it offers and the economic, socio-cultural and ecological benefits that accrue to the local community. A brownfield site located in the MEL that urgently needed to be redeveloped (La Lainière) was used as a pilot site for testing the processes and resultant tools.

The second pilot site was a greenfield site (Strawberry Field site) earmarked for future development in Bielefeld, Germany. Strawberry Field is a 23 hectare site that is being considered for development. The area, which is currently agricultural land, will be developed over several years to become to a C2C-inspired business site capable of being returned to its initial state after its task of commercial use is completed.

In trying to address the main research issue of how the C2C diversity principle can be practically realised in the design and development of business sites, it was necessary to establish what tools and processes would facilitate its implementation and what barriers would have to be overcome in the course of its implementation. Consequently, two sub questions were posed with particular reference to these two case studies as follows: i) what are the most effective tools and approaches for deriving diversity criteria for the planning and development of these pilot business sites; and ii) what are the critical barriers/challenges to implementation of diversity principles on these pilot sites and how can these be overcome by stakeholders? The research was undertaken from early 2011 to early 2016, and the researchers, who had received extensive training on the C2C concept, worked in the capacity of project partners in conjunction with local stakeholders, to develop diversity implementation plans for the two pilot sites.

Research at the La Lainière site involved seminars, workshops, bilateral meetings and brainstorming sessions amongst C2C experts and partners from across north-west Europe (Figure 1). The aims of these sessions were to identify and share ideas and intentions about diversity. There were also competitive dialogue sessions that involved members of local communities. These sessions were advertised in local newspapers, so that citizens could contribute to the development of diversity criteria for the La Lainière site, alongside the appointment of delivery partners. The final stage of the research embraced the implementation of the emergent co-created diversity vision on the pilot site and analysis of lessons learnt.

[INSERT FIGURE 1 HERE]

Figure 1: Methodological approach for developing and implementing diversity criteria on La Lainière site.

Research on the Strawberry Field site also incorporated a series of workshops, which were open to all interested citizens, companies, built environment professionals, politicians and students from the Bielefeld University (Figure 2). To facilitate full public engagement, lectures were given by specialist C2C consultants, as well as flyers that informed local people about C2C philosophy and the plans to realize C2C diversity criteria on the Strawberry Field site. A critical difference between the Strawberry Fields and La Lainière projects was that the development (and research) process for the former site ended at the master planning stage, whereas for the latter, there was partial implementation of the vision on site with the construction of a prototype facility (Maison de la Project).

[INSERT FIGURE 2 HERE]

Figure 2: Methodological approach for developing diversity ambitions on the Strawberry Field site.

In both cases, data were gathered from observations of the process of developing and implementing the diversity plans. These observations were documented in memos kept by researchers. Interactions with all stakeholders were also recorded electronically and by note-taking. The fora for such interactions were workshops and seminars at which stakeholders brainstormed and collaborated to develop 'road-maps' for integrating diversity in the proposed business sites (Figures 1 and 2). Observations of developments on the pilot sites, specifically at La Lainière site, also provided useful data which informed the findings presented below. The methods of data collection, using the descriptions of Johnson (2011) thus encompassed 'conferences' (workshops, seminars, and brainstorming sessions), field

observations (including site visits), research journals and documentary analysis. Data gathered included field notes, digital recordings of the conferences, promotional documents and other artefacts created during the interventions. On the La Lainière project there were six 'conferences' at the planning stage and seven at implementation stage. On the strawberry fields project there were five 'conferences' at the planning stage and development of an experimental masterplan. This combination of methods provided "a series of quick looks taken at different times and in a variety of ways" (Johnson, 2011) at C2C diversity implementation.

Thematic analysis was undertaken by coding and categorizing the key concepts that emerged from the memos and recorded information. Findings in relation to the efficacy of the process, the resultant tools and lessons learnt are shared below in relation to the three broad phases of project progression: planning, procurement and execution.

5.0 Research Results

5.1 Diversity on La Lainière Site

As applied to business sites, diversity is conceived as making business sites open and permeable areas, which are living areas for companies, employees and residents, and which fit perfectly into their environment and city. In turn, this makes the site an area for all types of economic activities, developing a diversity of urban and economic functions integral to the operation of the city. La Lainière, therefore, was perceived as an opportunity for the MEL and all signatory partners to combine their efforts in order to achieve the objective of economic regeneration through the creation of an open and permeable business park on

the existing brownfield site. At the heart of this vision was a requirement for: (i) the development of a 'Diversity Charter;' (ii) procurement of a supply chain; and (iii) delivery of a pilot project.

5.1.1 Development of the Diversity Charter

Two key findings emerged from the process leading up to the development of a diversity charter outlining key diversity principles that all stakeholders were willing to be signatories to. This phase was fundamentally about the identification, sharing and reconciliation of multiple and sometimes conflicting intentions and interests in relation to the achievement of diversity. The involvement of all key stakeholders was, therefore, necessary. To achieve that, the project team utilized an assortment of channels and media to secure maximum engagement. These encompassed a series of seminars, workshops, public consultation meetings and other bilateral meetings with the local authority, local businesses and local community partners (Figure 1). The intention was to achieve collective co-creation of the diversity vision and an agreed road-map for its delivery. It was found that this co-creation approach, rather than a top-down, one party or even third party imposition, contributed significantly to the successful outcome, which was the development of a charter called the 21st Century Business Parks Charter (Lille Métropole 2014). The Charter provided a common and qualitative approach for the design of business parks, shared by the most important stakeholders and which proved to be the key governance tool for the entire project.

A second critical finding was the need for creative lateral thinking to underpin the strategy set out in the road-map. In this case study, this was achieved by the involvement of external consultants and experts to promote 'thinking out of the box' and provide new perspectives. This, together with the early selection and involvement of the site developer to spearhead

the entire process, resulted in some innovative strategies and solutions that informed requirements specification for the prototype project to test the effectiveness of the Diversity Charter.

The key points reflected in the final version of the Charter were:

- (1) A business park should be an integral component of the urban unit (town or city) in its diversity and quality. There is a need to raise citizen awareness citizen on the importance of developing the city's economy and businesses.
- (2) The governance and diversity of stakeholders and the need to adapt the governance to each step and each actor.
- (3) Consensus among the stakeholders is critically important.
- (4) Consensus around the necessity of increasing biodiversity, developing biological corridors and choosing local plants to ensure continuity.
- (5) The modularity of buildings and uses of land have to be able to respond to changing business needs over time.

5.1.2 Procurement of the Supply Chain

Two teams were procured for the implementation of the Charter: a design team and a works team. Significantly for both teams, the standard EU tendering methods of open or restrictive tendering proved unsuitable because of the complexity and innovation anticipated with the implementation of C2C diversity principles. Consequently, the competitive dialogue approach had to be deployed. Under this approach the procuring authority enters into a dialogue with bidders, following an 'Official Journal of the European Union' (OJEU) notice and a selection process, to develop at least one suitable solution(s) for its requirements and on which chosen bidders are invited to tender. EU procurement rules

impose a requirement for this procedure to be used only in exceptional cases with procedures being designed to ensure that genuine competition is maintained. An important lesson emerging from this phase of the process was that even the adoption of competitive dialogue did not prove entirely appropriate, as tendering suppliers were not fully conversant with the concepts and ideals the Project was implementing. The dialogue, therefore, had to be designed to integrate elements of C2C training and engagement with the co-creation activities of the planning phase.

The outcome of this procurement procedure was a masterplan for the site (a former industrial site) and the design and specification of a prototype/test building named La Maison de la Project (House of Project). This masterplan was to be delivered through a concession contract (€64 million contract over 12-years) for the renewal of a total of three sites – La Lainière, Peignage Amédée and Pennel et Flippe sites (located in the towns of Roubaix and Wattrelos in northern France). La Lainière to provide 70% commercial and 30% housing. The Project also aimed to create and restructure public spaces, the road system, various networks and soft links for pedestrian/cycling travels, the housing of urban/parcel services, small and medium production and logistic activities, and their related tertiary activities (offices). The Project also proposed a balanced and diverse housing programme to enable the meeting of needs of the territory, by embracing a wide range of service provisions and prices with a mix of public rental housing, home ownership at a controlled price and free access to property. These mixed functions accorded with the Charter and C2C diversity principle, and the designs were strongly anchored on the need to retain and spread the memory of the site and the need for local employment development, trade, services to respond to local needs, business hotels, and shared services such as nurseries and restaurants. Within this wider context, the House of Project was to be implemented to

provide an open friendly place that facilitates the creation of relationships between residents and workers. It was to be used as a venue for conferences, meetings, exhibitions and other inclusive events that allow resident participation (e.g. photo exhibitions, sporting activities, community restaurants and discussion cafés for citizens).

The C2C House of Project was also to be site for the governance of the future business park.

The main design features of the House of Project were:

- (1) Respect of biological and technical cycles.
- (2) Reuse of on-site materials.
- (3) Retention of site's memory as key element in material selection.
- (4) Design for disassembly and reuse of the main structure.
- (5) Multi-functional spaces, notably for exhibitions.
- (6) Innovative heating system through the roof in feather cushion.
- (7) Adaptability and flexibility to change the initial function of the building to reflect the evolution of the site users' needs (i.e. future-proofing).

In accordance with the Charter, biodiversity featured strongly. The Business Park was to serve as a biodiversity tool. The Project was thus designed to enable the creation of ecological added value. The design of public spaces was to improve the ecological continuity of the blue and green belts identified on the site, and by so doing ensure their colonization by local species. The water management system was also designed to limit disposal to the public sewerage system.

5.1.3 Implementation and realization of the House of Project

The two storey House of Project building was the first physical structure built on the site. It offered ample opportunities for the research team to identify significant challenges

associated with on-site implementation of complex (and sometimes abstract) concepts, such as C2C diversity. Figure 3 provides a collage of the House of Project under construction, showing its site context, aspects and interior.

[INSERT FIGURE 3 HERE]

Figure 3: La Maison de la Project (House of Project), Lille.

Several critical lessons emerged from the delivery process on what worked well, what did not work well, and the key challenges encountered. These lessons are discussed below.

Co-creation proved integral to successful realization of project ambitions. This was necessary and important because the knowledge on C2C has not diffused enough within the construction and property sector and, therefore, is insufficiently engrained in the minds of designers and contractors. This knowledge *lacuna* was even more severe at the level of the works team, and further down the supply chain. The unfamiliarity of C2C to the contractors resulted in an over-pricing of risks. This implied that the budget was under severe strain, even before the start of works on site given this lack of full understanding of the risks and requirements of this innovative project. As highlighted previously, even the adoption of competitive dialogue did not allow this gap to be bridged fully. Indeed the project manager remarked that “*maybe there should have been no public tender.*” Secondly, it quickly became apparent, as particularly noted by the design team and project manager, that having “*a brave client*” was instrumental to the success of this project. It was acknowledged that as with all other types of projects, there were trade-offs to be made between *quick* delivery, *cheap* products and *good* quality. It took a brave client to make tough, but correct choices, especially as this was an innovative project with no defined roadmap for implementing diversity principles.

The third key lesson related to the importance of time sufficiency for such innovative projects. The House of Projects was severely time constrained by funding conditionalities. Results, in terms of the physical assets, had to be delivered by an immovable deadline which implied that stakeholders were compelled to make some sub-optimal choices in Project delivery.

A related issue that also contributed to the sub-optimal choices was the know-how/skills deficit that made the procurement of some building elements particularly challenging. An example of this was given by the project management team, as the original specified building fabric was earth-wall, to reflect local styles and use of local materials (to achieve cultural and social diversity). However, this specification had to be changed to timber cladding because of the lack of skills in earth-wall construction.

The existence of a Charter brought much clarity to the delivery team, in terms of the aspects of diversity that had to be prioritized. In this House of Project case, the main diversity criteria specified was flexibility (conceptual diversity). There was a requirement for flexible spaces that could be easily reconfigured as needed to ensure future-proofing and longevity. The Charter was also particularly important because of the coherence it brought to the integration of diversity features, many of which will need to be integrated on a piecemeal basis as the site is progressively developed.

The ambition of this project required significant changes to sourcing and buying patterns of the works contractor. The contractors had to procure C2C certified products or products that had been tested to ensure compliance with C2C requirements. Thus, they had to deal with completely new and unfamiliar suppliers. The Project Manager also expressed the view that convincing contractors to change their approach to suit project requirements was a

significant challenge. This was compounded by the incompatibility of the design/specifications with legal requirements and the cost of adaptation required to satisfy such requirements (e.g. connection to sewer systems, security and fire safety).

5.2 Diversity on Strawberry Field Site

The integration of diversity in the vision for the Strawberry Field site was both a function of the process adopted and process outcomes. These are summarized in Figure 2 and briefly elaborated in this section under the headings: (i) collection of ideas; and (ii) site design, to enable lessons to be extracted from relevant experiences.

5.2.1 Collection of ideas

Phase 1 was the planning phase involving the collection of ideas from critical stakeholders in the site development process (Figure 2). To this end, a project team was formed to organize workshops and a series of events (five in total) under the broad theme ‘Planning the Future¹.’ The Project team consisted of the Commissioner for Climate Protection, the Engineer for Transport Planning, the Consultant for Economic Development, and three Project Managers (all three were from the City of Bielefeld). These were the Manager for Sustainability at the Schüco Company, the Project Manager for Sustainability at the Goldbeck Construction Company and the Head of Energy Generation at Stadtwerke Bielefeld. This high level-support proved to be a key driver of project success.

Each ‘Future planning’¹ event started with a workshop, followed by lectures delivered by invited speakers and finishing with a panel discussion on the relevant topic. Significantly, these events involved both the Project team and the general public. Thus, the process of

¹With an appropriate sub-theme such as: ‘The C2C BIZZ Project;’ ‘Innovative building concepts;’ ‘Energy management on business sites;’ ‘Building as a ‘resource-stock;’ and ‘Results of the C2C BIZZ Project.’

integrating C2C principles of diversity involved both expert input and broad-based public consultation.

The ideas and concepts drawn from these activities informed the design brief for the planning and design of the Strawberry Field site. In collaboration with the University of Applied Sciences of Bielefeld, a team of eight from the Architecture School was assigned the task to create an experimental *“master plan for a business site, inspired by C2C.”* This team comprised students from the Architecture, Building Engineering and Project Development disciplines. The brief given was as follows: *“You are in 2030. Develop a C2C-inspired business site. All materials used in the area for the buildings, the sewage and the waste are in circular run. The energy supply is as far as possible from renewable sources. After the abandonment of the business site (or individual properties), the site is to be restored to its original state without residue.”* The students were invited to translate ideas and concepts from the ‘Future planning’ events into a site development plan. This phase of the process allowed the critique of earlier assumptions and propositions regarding the planning of business sites and the principles of C2C, leading to re-definition of the key concepts of business site, plot, building/arrangement of buildings, companies, transport/mobility, energy supply, water, nature/biodiversity, and social aspects. It also led to the realization that development of a *“vision of a perfect C2C inspired Business Park”* was required, with Strawberry Field being the pilot site for testing the feasibility of this vision. The outcome of this process was a tentative framework for diversity guidelines which also informed the production of a brochure for wider dissemination of the vision for Strawberry Field. Throughout this process, there was close co-operation with the project team at the La Lainière case study.

5.2.2 Site design

The first step in the development of the vision was initiating a dialogue with all stakeholders interested in planning of new business sites and buildings in Bielefeld. An integral part of this was the production of a brochure 'Business + Build' for the purposes of securing the involvement of relevant local companies.

Having defined the main topics and using the input of the consultation with the companies, the project team contracted external experts familiar with the C2C philosophy to develop and test the vision. Parties that contributed to the study were City Förster (Architecture and Urban Design), Drees and Sommer (Advanced Building Technologies) and Streitbürger/Speckmann Bielefeld (Lawyers). The experts worked on three themes that were part of the vision: legal restrictions; defining the most interesting industry mix; and creating diversity (incorporating social components, such as common areas and facilities).

The end result was a masterplan document on how C2C can be incorporated at the level of land use planning. The Masterplan 'Vision of a Perfect C2C Business Park' not only described the vision but also defined the road-map for navigating the barriers towards realization of the vision. It included the designs for a structure plan, developed by City Förster (Architecture and Urban Design) and the Office of Landscape Planning ('Urbane Gestalt').

The key elements of the vision were:

- (1) Conception of the total available area for the implementation of C2C activities.
- (2) Presentation of material cycles for buildings, open space and infrastructure.
- (3) Showing the concept of C2C business site as 'Divide and borrowing' instead of owning; that is communal facilities for all companies
- (4) The synergies that can be created in industry by active co-operation between companies and combining efforts to optimize material flows.

- (5) Intelligent building design to promote energy efficiency and renewable energies.
- (6) Representation of diversity: integration of the business site within their environment.
- (7) Biodiversity.
- (8) To open the business park to the public and encourage their use of facilities and equipment and recognizing the contribution of the active participation by local citizens in promoting the socio-economic and environmental regeneration of the business park. These facilities include sports and leisure facilities, a restaurant and a public kindergarten. These positive developments will help to ensure that the business park functions as an integral part of the entire urban space.

The feasibility study that sought to implement these elements on the Strawberry Field pilot site confirmed the following, which are considered essential ingredients for achieving best practice in the development of C2C diversity principles on such a greenfield site:

- (1) A mix of industries is extremely important.
- (2) In Bielefeld, economic activities are predominantly manufacturing industries and the sector servicing these industries. Many of these enterprises are highly suitable for location within a C2C business park.
- (3) It is possible to use all expendable materials in a continuous loop system (water, energy, temperature and waste).
- (4) The materials used for the infrastructure and the buildings must be without residue and capable of re-naturalization (deconstruction). Ideally, these must be kept in a closed loop.
- (5) An important key to success for implementing continuous material loops is the trust and willingness of all stakeholders to co-operate in these networks.

- (6) Overall site management is needed to optimize material flows.
- (7) The site needs innovative infrastructure to facilitate the C2C managed business site.
- (8) Land use planning will influence the implementation of C2C inspired business sites.

However, the C2C principles are difficult to translate in legally binding stipulations at this level. Other legal structures can help in a later phase, for example C2C converted into sales contracts.

A key result of these processes was the recognition of synergies amongst stakeholders and the constructive and positive way in which the ecological, social and cultural aspects were discussed. All major stakeholders appreciated this approach, with the main effect being expressed as the commitment of Bielefeld politicians to carefully consider the C2C dimension while developing future business sites.

6.0 Discussion and strategic implications

Whilst the literature clearly expresses the need for diversity in urban planning and design (Fainstein 2005; Mulhall and Braungart 2010; Sandercock 2003; Snep et al. 2009), what is less clear is how this can be achieved. Impediments include limited resources, profit maximization motivations of developers and operators, disparate/discordant stakeholders (extensive fragmentation) and planning restrictions. Consequently, this study sought to establish what the most effective tools and approaches for deriving diversity criteria for the planning and development of business sites are. The two case studies showcase some of the essential ingredients towards a road-map for achieving diversity within a C2C framework in urban planning.

The adoption of a consultative approach in both case studies proved very instrumental in overcoming some of these challenges, by facilitating the development of the shared vision of these projects, and securing the support and commitment of stakeholders. This is strongly supported by change and transitions management literature (Sclove 1995; Kemp et al. 2007; Upham et al. 2015). Although how to meaningfully achieve effective participation remains an on-going concern (Mulgan 2015). Increasing public participation is a long-standing agenda item in urban and planning studies (Wellman 1978 in Upham et al. 2015), public administration (Parrado et al. 2013) and technological innovation studies (Sclove 1995). For instance, Sclove (1995) strongly advocates more authentic public participation in technological innovation, with Upham et al. (2015) further qualifying this desire by suggesting iterative, participative processes that utilize a myriad of methods and interventions, including opinion surveys. Consultative approaches provide a means by which the conceptual and socio-cultural diversity aspects advocated by Sandercock (2003) can be fully co-produced, by unlocking and balancing different viewpoints, and offering transparency. These benefits were very evident on both case studies. According to Suchman (1995) and other theorists (e.g. Upham et al. 2015), such transparency buys procedural and outcome legitimacy; an essential element of innovation processes (Upham and Dendler 2014). Other important benefits observed from the two case studies that also chime well with extant literature include joint problem framing and co-design, co-production and co-dissemination (Arnstein 1969; Mauser et al. 2013; Parrado et al. 2013; Voorberg et al. 2015). All these elements contribute to successful transitions management (Kemp et al. 2007).

In both cases, a clear vision was required that embraced all aspects of the diversity concept proposed by C2C philosophy. In the La Lainière case, this was captured in the form of the

Charter agreed by all development partners. Whilst non-binding, it was still a physical/tangible manifestation of common interpretations and meanings of the diversity concept (Fainstein 2005) and the commitments stakeholders agreed could then be used as a benchmark for assessing future actions/choices thus, providing greater incentives to commit to the vision. In the case of Strawberry Fields, whilst there was no such charter, there was a brochure that captured the vision and commitments of stakeholders, thus serving similar functions to the 21st Century Business Park Charter of La Lainière.

Translating the shared vision and stakeholder commitments into actual site development plans and physical structures also required co-creation (Parrado et al. 2013). Typically owners/developers make choices without reference to other stakeholders, based on their goals of maximizing profit from site development activities, rather than collective interest. However, lessons from these case studies provided evidence that achievement of collective diversity goals, alongside other client goals, is possible through the co-creation methodology.

Co-creation mitigated the risk of having suppliers without all the requisite knowledge and capacity by providing a platform for engaging all relevant stakeholders in project design and delivery. The procurement framework (competitive dialogue), whilst not the most ideal, allowed co-creation to occur in respect of defining the needs of the projects and joint/collaborative risk management. Some procurement approaches, such as open tendering, are not amenable to the co-creation approach and therefore this issue must be carefully considered during the planning phase. It was also evident in both cases that strong leadership was required and owners/developers had to be willing to accept a significant amount of risk.

With specific reference to diversity, the most significant element to emerge as necessary to achieve the C2C principles being championed in these projects was flexibility and adaptability. This fundamentally concerned the need to future-proof the development. All other elements revolved around this need to future-proof business sites (Fig. 4).

[INSERT FIGURE 4 HERE]

Figure 4: Elements of the C2C diversity principle implemented in the two case studies at Lille and Bielefeld.

The tools that facilitated these processes included: the Charter (or brochure in the case of Strawberry Field) that aided communication of the vision and securing buy-in of stakeholders; a C2C Knowledge Centre that connected designers and suppliers to C2C product manufacturers; external consultants who provided expertise and helped to define requirements; and the various platforms that were used to drive consultation and co-creation.

The study further sought to establish some of the specific issues emerging from these pilot sites as critical barriers to implementation of the diversity principles and how these can be overcome by stakeholders. Through the reflective process, some key challenges were isolated from the case studies. These challenges included:

- (1) The negative impact of time constraints, which in some cases led to sub-optimal solutions when trying to address identified diversity needs;
- (2) Legal impediments that influenced the selection of suppliers and design/planning choices. The specific legal impediments in this case were the EU procurement directives that mandated the adoption of open, restrictive or in exceptional cases competitive

dialogue procedures in the selection of suppliers. These procedures proved unsuitable for this innovative project as many suppliers were unable to engage with the C2C concepts.

- (3) Lack of awareness and knowledge among suppliers at an operational level which meant that the vision was not always translated into the finished product at site level, simply because site level operatives did not understand the vision; and
- (4) The need to change sourcing and buying patterns with the attendant disruption and cost increases likely from using new suppliers.

These challenges are very significant to the extent that they signpost some of the trade-offs that owners/developers will be confronted with in their quest to realize diversity in (business) site development projects. However, the case studies also showcased some effective response strategies. For instance, it was found that adopting new models of ownership and use of materials and components (e.g. using leasing arrangements) was an effective remedy to the sourcing and buying challenges. Similarly, embedding C2C training in the procurement processes helped to bridge the knowledge gap in the supply chain, albeit not fully. Other suggestions put forward by participants concerning these challenges included the need for more visibility of C2C projects and products to aid diffusion of C2C knowledge, the need for funders to allow greater flexibility in relation to project deadlines, and converting the C2C Charters into sales contracts thus elevating them from their non-binding status.

Significantly, there were no discernable differences arising from the fact that one of the sites was a brownfield site, whilst the other was a greenfield site. Arguably, there was greater emphasis on returning the site to its natural state at the end of its use as a business

site in the case of Strawberry Fields (the greenfield site), but this did not translate into notably different choices being made on the two sites. Similarly, there was no discernable pattern arising from the difference in nationality of the key stakeholders. This is not surprising, considering that the long-term challenges of climate protection and resource management that these projects seek to respond to are supranational and common to both states.² It is noted that both France and Germany operate civil law systems and whilst legal impediments were noted, these did not derive from the underlying legal systems of those countries. Both planning systems are characterised by a strong ethos of environmental management and mechanisms for integrating environmental concerns, and protection of historic, ecological and environmental concerns (Oxley et al. 2009). Not surprisingly therefore, both authorities were supportive of the C2C vision for the projects. The main legal issues that were particularly manifest in the La Lainière case because it progressed to implementation were the requirement to comply with building regulations and EU procurement directives. Significant modifications were required to the design to achieve compliance with requirements for safety of persons, hygiene and sanitary requirements. The issue with these modifications was the attendant costs to maintain the C2C attributes of the development. The procurement processes which also required compliance with EU procurement directives did not deliver satisfactory outcomes. It is noted that a new procedure (Innovation Partnership) has since the research been incorporated in the revised Public Contracts Directive 2014/24/EU to cater for such scenarios where procurement involves delivery of innovative products.

²See Hofstede's Culture Compass scores, which are high for both countries in terms of Long-Term Orientation dimensions: <https://geert-hofstede.com/countries.html> [accessed 01/12/16].

7.0 Conclusions and future work

Full integration of diversity criteria in development of business sites remains a key challenge, more so when the problem is framed from a C2C diversity perspective. This action research study has revealed that, regardless of whether brownfield or greenfield sites, essential ingredients for successful integration of C2C diversity criteria are inclusive public consultation, innovative procurement practices, co-creation, an appropriate legal framework, good governance and a willingness to accept some risk. The most overriding ingredient for defining and developing C2C diversity criteria for these sites was constant involvement of stakeholders' from the very onset. This 'bottom-up' approach allows for creativity and synthesis of diversity criteria that respond most effectively to local socio-cultural, economic and ecological needs. It further reinforces the view that C2C should be conceptualized as an innovative platform that allows for flexibility in defining applicable criteria; rather than a fixed and static development model. This approach to development was, however, not supported by some aspects of existing procurement practices, particularly the requirement to comply with public sector procurement regulations which generally provide rigid frameworks that are difficult to circumvent. The risks posed by unconventional project briefs also suggest that strong commitment and buy-in will have to be demonstrated by the developers/clients/promoters when seeking to promote C2C diversity criteria on business sites.

Findings from this study suggest that the achievement of C2C diversity criteria on business sites is still undergoing conceptual and operational evolution. Time will, therefore, be required to ensure that technical and legal frameworks and experimental cases such as those presented become fully aligned with C2C diversity aspirations/objectives. However,

the key messages that should be upheld by stakeholders interested in pursuing C2C diversity criteria on their sites remains preparedness to foster imagination and innovation, readiness for some experimentation and allowing considerable flexibility in their approach. Future research would be required to track the actual impacts that the C2C diversity guidelines developed for these sites had on social, ecological and economic goals. Knowledge gained by working on these case study projects is socially and economically beneficial, as it can be transferred across the construction industry for the benefit of other clients. In turn, this will contribute to the dissemination of the C2C diversity agenda in the construction supply chain and the creation of social value through development activities.

It is acknowledged that this article is based only on two pilot case studies one of which did not progress to implementation stage, resulting in findings that are not fully comparable. Whilst this limits the opportunity to generate more robust conclusions from a cross-case analysis, the insights they offer can still inform the approach taken to implementation of C2C diversity principles in other contexts.

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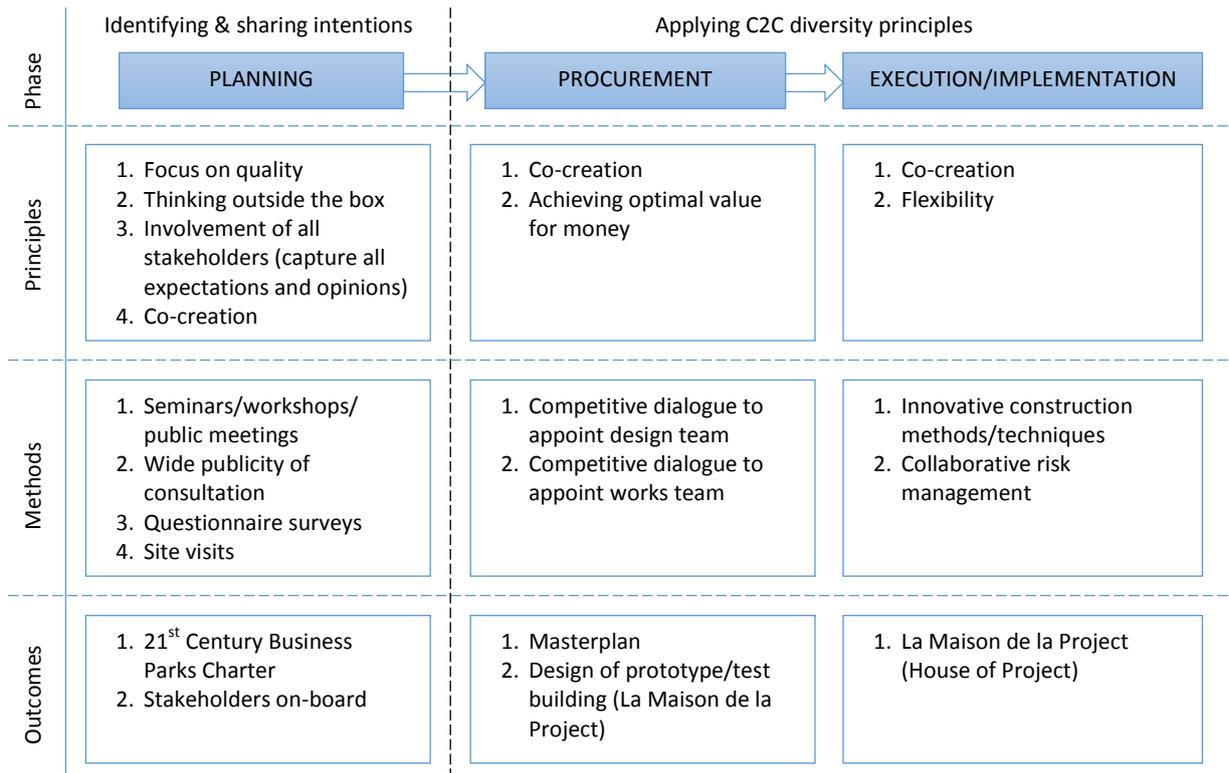


Figure 1: Methodological approach for developing and implementing diversity criteria on La Lainière site.

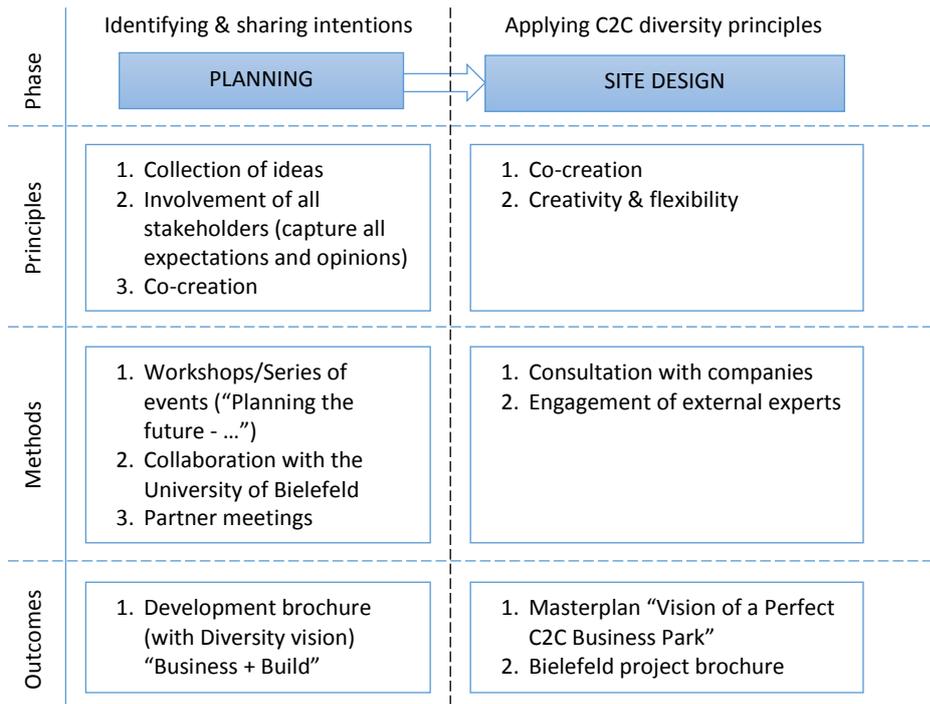


Figure 2: Methodological approach for developing diversity ambitions on the Strawberry Field site.



Figure 3: La Maison de la Project (House of Project), Lille.

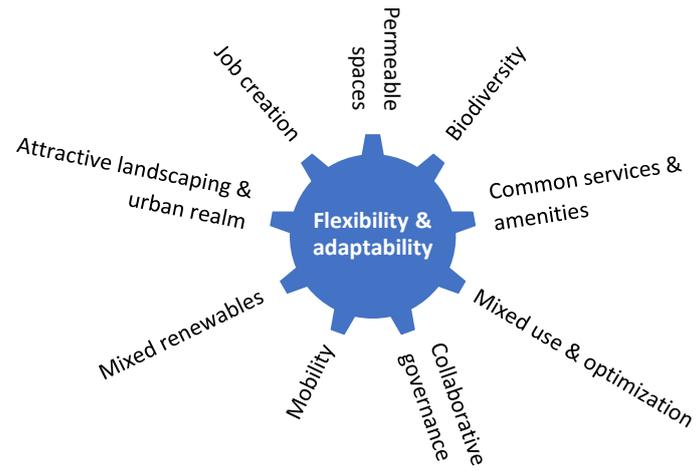


Figure 4: Elements of the C2C diversity principle implemented in the two case studies at Lille and Bielefeld.

Figure Captions

Figure 1: Methodological approach for developing and implementing diversity criteria on La Lainière site.

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