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Cradle to cradle implementation in business sites and the perspectives of tenant stakeholders

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Abstract

This study investigates the cradle to cradle philosophy, which is a paradigm changing innovative platform for achieving positive ecological impacts in the built environment. With focus on business sites, a preliminary survey is conducted to interrogate tenant stakeholders' preferences towards cradle to cradle attributes. Training, employment and use of local skills (social diversity) as well as realisation of highly flexible and easily adaptable spaces (conceptual diversity) were revealed as the most important attributes whilst integration of biodiversity was of least importance. This suggests therefore that business needs drive their preferences and as such must be reflected in C2C implementation strategies.

Keywords: Business sites; cradle to cradle; eco-efficiency; eco-effectiveness; tenant stakeholders.

1. Introduction

The sustainability vision remains one of the most vibrant forces that is reshaping the delivery of construction projects. To a large extent, sustainability approaches being driven in the built environment are based on eco-efficiency targets, with goals such as achievement of low or zero carbon, zero waste and zero emissions very popular within the built environment. Cradle to cradle (C2C) is however a more ambitious paradigm that proposes an

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alternate vision of not only designing products and projects that are sustainable (eco-efficient), but also contribute net positive ecological, social and economic impacts. C2C goals are set in the eco-effectiveness vision where the ambition is to make net positive contributions to the built environment. It is an innovative platform for realising ecologically intelligent and environmentally restorative designs [1-3]. Yet the deployment of C2C strategies in the built environment has been much slower than anticipated, with many built environment stakeholders unaware of the underlying philosophy of the concept, its guiding principles and how they can be implemented on their projects. To make any meaningful progress in promoting C2C amongst built environment stakeholders, it is important to understand their preferences and how these relate to C2C value propositions. The aim of this study was mainly to get a preliminary idea of C2C related attributes that stakeholders of business sites in the UK could connect with in order to prepare the ground for the main study to commence. It was envisaged that such preferences would reveal stakeholders' interest and what they were likely to be already familiar with in relation to uptake of C2C approaches in their development. The study focused on business site developments due to the particular benefits that C2C can contribute to clustered development schemes where different organisations are co-located together to undertake their various activities.

The next sections present discussions on the C2C philosophy and its underlying principles, business sites and the potential for C2C to impact positively on clustered development schemes. This is then followed by a discussion of the methodological approach and then results from the study.

2. Cradle to cradle philosophy

C2C is an innovation platform for generating positive impacts by improving the quality of products, systems and services [4]. This is achieved by designing positive economic, cultural and environmental qualities into materials, buildings, neighbourhoods and regions. Unlike conventional sustainability approaches that are dominated by eco-efficiency targets, C2C articulates a conceptual shift that integrates eco-effective targets [5]. Whilst eco-efficiency focuses on minimization of negative impacts, eco-effectiveness focuses on the creation of positive footprints [6, 7]. The aspiration of C2C for the built environment is thus to promote intelligent designs that have a positive synergetic relationship 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 wastes from biogeochemical processes undergo biological metabolism to create food for other biological processes. McDonough and Braungart [8] 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.

With the 'waste is food' principle, designs should be created so that materials (bio-degradable and non-biodegradable) can serve as technical or biological 'nutrients' (resources) for other processes at the end of their life span or use periods. The design aspiration should be to prevent any loss of material value (temporal material degradation) that would result in gradual material downcycling rather than true recycling – particularly with the technical material cycle. This means that biological and technical materials become necessary resources that feed into technical and biological metabolism cycles/pathways. As such, use periods of materials and components and their appropriate pathways would have to be pre-specified, products and components would have to be designed to facilitate material disassembly and materials would have to be intelligently pooled with their integrity still intact after their service life [8]. The 'product as service' concept also fits into this principle as technical materials and components are only sold to users to provide a specific service whilst the manufacturer retains ownership of the product after its service life or specified use period. The 'waste is food' principle further incorporates the issue of material toxicity, with the ambition to ensure that materials used in production of components are not just less toxic but non-toxic and non-hazardous. This is to prevent any long term health risks to end-users which would still exist even when materials still emit little amounts of toxic chemicals [9]. The aspiration should be to identify the toxicological and eco-toxicological characteristics of materials, find alternatives to toxic materials especially heavy

metals and where it is impossible to get non-toxic replacements, steps should be taken to maintain toxic materials in a closed continuous loop. Materials used in products and components should also have self-cleansing properties so that they clean and purify the surrounding air. This would make such products and components contribute a net positive impact on the environment because of their positive effects.

The second C2C principle concerns the use of current solar and gravitational income or other renewable forms of energy that are primarily driven by the sun's radiation – wind, geothermal, hydro and bio energy. The aspiration is for buildings for example to be designed as energy production rather than energy consumption hubs. That way, such buildings would contribute to a net positive ecological footprint because they are producing renewable energy. Presently, renewable energy technologies mostly provide intermediate-load energy supply whilst conventional energy sources: coal, nuclear and other fossil fuels are relied upon for base-load energy. Further technological advancements and innovation is required to ensure that the aspiration of total dependence on renewable energy sources can be realised.

The third C2C principle concerns the celebration of diversity. The vision is to realise 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 [8]. To integrate bio-diversity, flora and fauna would have to be factored into development schemes, for both the indoor and outdoor environment. Socio-cultural diversity can be achieved through mixed use designs that support a seamless interaction between users of a facility and the natural environment as well as designs that promote/enhance the health and social wellbeing of users through its aesthetic and spatial qualities. Conceptual or intellectual diversity can be achieved by promoting highly adaptable and flexible designs that can support multiple purposes and uses. These three C2C principles can be applied to the design and operation of built asset to create a positive ecological footprint, particularly in clustered development schemes like business sites.

3. Business sites and cradle to cradle

The development of business sites is underpinned by the clustered development concept in regional planning [10, 11]. Clusters are an agglomeration of interlinked businesses and institutions [12] that can take advantage of common services which might otherwise be too costly for any single business. Business sites are therefore clustered development schemes where different organisations are co-located together to benefit from the same institutional framework - modern services, physical infrastructure and services of other local companies - for the mutual benefit of all. Some business sites also provide other support services such as new enterprise incubation and mentorship for small start-ups. Business sites have sometimes been categorized based on the core activity of organisations that are co-located on the site, with classifications such as science or technology parks, research parks, retail parks, light industrial areas, heavy industrial areas, export processing zones and office parks. These business sites can be used to overcome market imperfections by facilitating economic growth and development through innovation, learning and job creation [13]. In spite of these benefits, business sites have been associated with poor environmental management, pollution, traffic congestion and reduced quality of life [13]. Conventional business sites can be economically efficient in the short-term but are typically not productive or healthy for occupants, can remain disused at night or during weekends (lack of diversity), become derelict sites when they no longer meet their intended purpose, lose their tax base value for local governments over time and become demolition liabilities due to poor materials design [5]. Industrial parks for example consume considerable amount of energy which are mainly from non-renewable sources and generate a lot of waste materials from the production processes. This is because the development of conventional business sites align with linear end-of-pipe development models that focus on economic development at the expense of negative environmental and social impacts.

There are still on-going efforts to ensure that business sites, as economic growth hubs, can be designed to have positive impacts on the natural ecosystem and local community. In industrial ecology studies for instance, the focus has been to model industrial parks so that they can mimic and function harmoniously with natural ecosystems. This has resulted in the emergence of a generation of eco-friendly business sites termed eco-industrial parks (EIPs) or eco-parks. By applying the concepts of industrial ecology, EIPs seek enhanced environmental benefits through industrial symbiosis of material and energy flows between companies in an eco-industrial system. Lowe *et al.* [14]

posit that minimum ecological impact can be achieved in EIPs by creating inter-linkages between businesses to ensure that energy, water, and materials are managed sustainably. Companies can cooperate to minimise resource use, reduce waste, and collaborate with local research or higher education institutions to improve their products and production processes. Through industrial symbiosis, waste from one organisation can be used as a raw material resource for another organisation. However, the main drawback with these efforts is that they mostly focus on minimizing negative impacts through reduction in resource use (dematerialization), energy and pollution – eco-efficiency with Tudor *et al.* [15] suggesting that more emphasis should be on thinking beyond 'sustainability' in the design, development and operation of EIPs. It is in this regard that C2C could contribute towards the achievement of a truly positive synergetic relationship between business sites and the social, cultural and natural environment. As can be seen from Table 1, the environmental, economic and socio-cultural objectives of C2C have implications for business sites.

Table 1. Cradle to cradle quality dimensions and corresponding principle features in business sites.

C2C Quality dimension	Implications for business sites
Environmental objectives	
• To design materials products and systems so they are resources for other processes and products. • Ensure that energy is wholly derived from solar and other renewable energy sources. • Ensure that biodiversity is promoted	• Support the use of healthy and defined materials in the development and operation of business site. • Design individual building units so that they can easily be disassembled and recycled without reducing material value. • Cluster businesses/companies to support industrial symbiosis. • Design business sites to be wholly dependent on renewable energy sources. • Design individual units that can clean the surrounding air, generate energy, recycle water and serve as habitat for flora and fauna. • Design flexible and mix-use building units that can be easily adapted for different functions. • Create habitats for flora and fauna in the business site.
Economic objectives	
• Ensure that businesses are more profitable • Engender local and regional economic development • Increased commercial attractiveness of business site	• Exchange materials as nutrients across businesses to turn disposal costs into income from selling resources. • Operate the facility on solar and renewable energy sources to alleviate energy costs. • Treat and reuse water to alleviate water costs. • Reduce disassembly costs.
Socio-cultural objectives	
• To improve the quality of life of local community • To conserve local culture and heritage by promoting cultural diversity • To provide facilities and services to serve development needs of local community	• Integrate features that create livelihoods for local communities. • Use locally available materials for development as well as design to reflect local heritage.

To achieve these C2C quality dimensions, features such as bio-digesters, constructed wetlands, waste water treatment ponds, and helophyte filters can be integrated into the business site to extract or utilize biological nutrients for other useful purposes. Rainwater recycling and treatment systems can also be integrated to transform rainwater into a useful resource for the business site. The choice of self-cleansing and self-purifying materials for the building fabric and interior working and communal spaces could also create positive impacts as these materials would purify the surrounding air. The business site can also be spatially planned with all the necessary infrastructure to support symbiotic sharing of resources across the site that would otherwise have become waste. Also, buildings in the business site can be designed with demountable components to aid easy disassembly and recycling as well as easy reconfiguration of spaces for other purposes. The business site can be planned as a mixed use site that incorporates

diverse amenities. Other features such as fish ponds, bird feeders, roof gardens and nature trails can be incorporated into the site design to enhance biodiversity of the area. Furthermore, the business site can incorporate different renewable energy sources such as photovoltaic roofs and skylights, solar wall panels or stand-alone solar photovoltaic/solar thermal modules, wind turbines, biogas plants and geothermal plants. Through the incorporation of some of these features, employment and training opportunities can be created to support livelihoods of the local community whilst a carefully designed C2C business site in itself would have a positive impact on the health and wellbeing of its users.

4. Methodology

A quantitative survey approach was adopted for the study to gain some insight into the extent to which C2C value propositions could influence the choice of tenant stakeholders to operate from a particular business site. This was to gauge the importance of C2C attributes in terms of how a given business site would be patronized by tenants because it embraces C2C design approaches. To achieve this, C2C attributes that can be realised in business sites were assembled from the literature. Overall, 19 C2C attributes that encompassed the three C2C principles were derived from the literature. Six of these 19 items used in the survey were on the waste is food principle. These were on waste conversion, integration of self-cleansing surfaces, utilization of biological waste, material exchange, and on-site treatment of wastewater. Four items in the survey were on the use of current solar income. These were on support for solar powered transportation, renewable energy generation, integration of natural lighting and integration of smart meters and building management systems. Furthermore the survey had nine items on the ‘celebrate diversity’ principle. Of these, one item was on biodiversity integration, five items on cultural diversity (support for local employment, preservation of local heritage, training and employment opportunities, promotion of tenant collaboration and integration of communal areas/spaces) and three items on conceptual diversity (flexibility and adaptability of spaces, mixed developments, elegance and aesthetic appeal of design). A five point Likert scale was used in the questionnaire and respondents were required to rate the importance (from ‘no importance’ to ‘utmost importance’) of these 19 C2C attributes in terms of their choice to locate and operate from a given business site. The questionnaire was posted out to 500 organisations that operate from business sites across the UK. Two rounds of the survey were conducted, with 250 questionnaires posted out in each round to managing directors of these organisations as they were best placed to provide responses on attributes that are of importance when they are choosing to operate from a business site. Only 21 questionnaires were correctly completed and returned. The low response rate could have been because the target persons were managing directors of these organisations, who would have had to take time off their busy schedules to complete the questionnaires.

Whilst low response rates in surveys are often associated with non-response bias, the assumption that high response rates ensure data quality and smaller non-response bias continues to be challenged [16] particularly because data quality also depends on randomness of the sample from which the data was received. It has also been argued that 30 responses can provide acceptable accuracy, particularly if the target group is small, with very little variance in the responses and a willingness to accept very low accuracy of the results [17]. Although the number of respondents were relatively small, it needs to be emphasized that the questionnaires were distributed randomly across business sites in the UK, with the respondent organisations comprising of engineering and construction consultancies, financial institutions, IT organisations, accounting firms, scientific research organisations and a children’s crèche. Thus the responses were from a good mix of organisations that predominantly operate from business sites in the UK. Also, given that the objective of the survey was mainly to get a preliminary idea of C2C related attributes that business site stakeholders in the UK could relate to in order to prepare ground for a case study phase, a low response rate survey was considered acceptable. The questionnaire responses were analysed by computing mean and median scores as well as the standard deviation of the ratings using statistical software package SPSS. Similar scores were also computed after respondent ratings had been consolidated into the three main C2C principles.

5. Results and discussion

The results are discussed based on the median ratings of respondents given the small sample size and the ordered nature of the ratings (ordinal scale). The survey results in Table 2 revealed that the development of business sites that support training and employment, and use of local skills and expertise were rated as the most important C2C attributes (median score = 4.00). The integration of bio-diversity into a business site was given the least importance rating by the tenants (median score =1.00). Ratings on flexibility and adaptability of spaces, mixed use development schemes, elegance and high aesthetic appeal, open spaces and communal areas, integration of natural lighting and facilitates exchange of materials and services amongst users were moderately high (median score = 3.00). This reveals that respondents consistently rated items on 'celebrate diversity' as important to their decisions to locate on a business site given that flexibility and adaptability of spaces, elegance and high aesthetic appeal and open spaces and communal areas were items on the 'celebrate diversity' principle.

Table 2: Scores on the importance of C2C attributes to business site tenants (Scale ranges from 1= 'no importance' to 5= 'utmost importance').

C2C Attributes	Mean	Median	Std. Deviation
Conversion of waste to beneficial resource	2.10	2.00	0.94
Integration of self-cleansing indoor coatings and furnishes	1.90	2.00	1.09
Facilitates exchange of materials and services amongst users	2.43	3.00	0.93
On-site utilization of biological wastes	1.86	2.00	1.01
On-site wastewater treatment and rainwater harvesting	1.71	2.00	0.78
Support for solar powered transportation	2.00	2.00	1.10
Self-cleansing external features and facades	1.95	2.00	0.80
Integration of natural lighting	2.86	3.00	1.49
Renewable energy generation	2.05	2.00	1.12
Support for training and employment opportunities	3.19	4.00	1.33
Integration of smart meters and building management systems	2.38	2.00	1.07
Highly flexible and adaptable spaces	3.14	3.00	1.42
Mixed development	2.81	3.00	1.25
Preservation of local heritage and environment	2.48	2.00	1.29
Elegance and high aesthetic appeal	3.00	3.00	1.41
Supports use of local skills and expertise	3.29	4.00	1.45
Biodiversity integration	2.24	1.00	1.51
Charters and agreements to promote tenant collaboration	2.38	2.00	1.32
Open spaces and communal areas	3.14	3.00	1.42

To explore this further, the rated items (19 C2C attributes) were consolidated into the three (3) C2C principles to identify which principle respondents considered to be of more importance when choosing to operate from a given business site. The 'celebrate diversity' principle was however split into its three components i.e. biodiversity, cultural diversity and conceptual diversity to identify which diversity component was considered to be of more importance. Of all the C2C principles, conceptual diversity was considered to be of more importance in influencing tenants' choice to operate from a given business site (median score =3.33) as can be seen from Table 3. The integration of biodiversity was rated to be of least importance (median score = 1.00) with cultural diversity receiving a moderate rating (median =2.50). These preliminary findings reveal that tenants consider issues that relate to conceptual diversity as being of most importance to their decision to operate from a particular business site. This suggests that perhaps, to commence discourse with business site stakeholders in the UK on C2C, the integration to

C2C principles that relate to diversity, particularly conceptual and cultural diversity could be a good starting point. The dynamic nature of most business activities - particularly when these involve business incubation and mentoring of different business start-ups - suggests that it is important to design business sites that are highly flexible and adaptable for multiple purposes. Likewise the design of mixed use sites that integrate different amenities for example, nurseries, restaurants, gyms, office units and perhaps even some residential apartments.

Table 3: Scores on importance of C2C principles to business site tenants (Scale ranges from 1= 'no importance' to 5= 'utmost importance').

C2C Principles	Mean	Median	Std. Deviation
Current solar income	2.32	2.00	1.01
Waste is food	1.99	2.17	0.72
Biodiversity	2.24	1.00	1.51
Cultural diversity	2.80	2.50	1.12
Conceptual diversity	2.98	3.33	1.16

By applying C2C design approaches, these different amenities/facilities can be integrated together to function harmoniously with each other whilst enhancing the commercial attractiveness of the site. These design approaches can also contribute to future-proofing of buildings and area development schemes given the rapid changes and multiple uses that buildings and area developments can be subjected to during their lifecycle, particularly in an era of liquid modernity [18]. To achieve this, open floor plans and demountable partitions can be adopted to make spaces easily reconfigurable for different uses. Another added benefit of easily reconfigurable spaces would be the reduction of churn costs, which was estimated by the International Facility Management Association to cost $809 per move on average in the US [19]. Designing open spaces and communal areas into buildings that are elegant and have a high aesthetic appeal can also have positive effects on the health and wellbeing of business site users. Similarly the integration of natural lighting into buildings and working spaces can have a positive effect on users in terms of their productivity, occupational health and wellbeing [20]. Whilst these productivity and occupational health and wellbeing benefits are not easily quantifiable, Fisk [21] estimated that in the United States alone, improvements in quality of indoor environments could yield savings or productivity gains of $43b-$235b per annum. These productivity gains are derived from reduction in respiratory illnesses, asthma and allergies, sick building syndrome symptoms as well as improvements in worker performance as a result of changes in thermal environment and lighting [21-23].

The high ratings on 'support for training and employment opportunities' and 'supports use of local skills and expertise' could be because most businesses depend on availability of skilled workers preferably from the local area so that commuting to work can be easier. It would be meaningless to site any business in an area without appropriate workers from the local area as this can stifle business growth and operations. However, the respondents rated the integration of biodiversity into the business site as the least important attribute that influences their choice to operate from a given business site although this creates a positive impact on the environment. The environmentally related C2C attributes were generally given lower ratings by the respondents, which suggest that perhaps C2C approaches would have to be promoted to this stakeholder group based on economic and socio-cultural benefits. The items that have been rated to be of most importance to these tenant stakeholders relate more to socio-cultural objectives rather than economic or environmental objectives although at this preliminary stage of the study, any such inference is inconclusive and would have to be further investigated during the case studies. Nonetheless, these preliminary insights reveal a good sign particularly because pursuing any socio-cultural objectives on business sites can have considerable economic and environmental implications. Business sites would not end up as derelict brownfield sites because they can be continuously adapted to suite multiple uses and purposes. The health and social wellbeing of tenants and users would also increase productivity of the occupants which ultimately becomes of economic benefit to businesses that operate from the site [21, 23]. Whilst this might only be directly beneficial to the occupant rather than the developer or investor, it can contribute to an increase in commercial attractiveness of the site, uptake of

spaces and a willingness of tenants to pay more for their premises [24]. Addae-Dapaah *et al.* [25] found that substantial returns on investment (78.56%) could be achieved from indoor air quality improvements alone, whilst at the same time increasing property values by 1.28% to 3.85%.

Ultimately, from an operational perspective, all the most highly rated attributes reflect key ingredients required for business operations and growth. This implies that preferences are largely driven by business needs, and those attributes that respond most directly to business needs are those that must be prioritized in any C2C implementation strategy. Traditionally, sustainability has predominantly been driven based on economic and environmental benefits without overemphasising on the social, health and wellbeing benefits. For example, cost savings that result from integrating renewable energy and the environmental benefits of using renewable energy sources have been used to drive the sustainability agenda. Due to the relative ease of quantification, energy savings are often used to make a business case for integration of renewable energy technologies into buildings, with Kats [26] estimating that on average green buildings that embed renewable energy technologies use 30% less energy than conventional buildings (are 30% more energy efficient). But the preliminary findings here, whilst inconclusive due to the low response rate, reveals that promoting socio-cultural benefits of sustainability and other alternative paradigms such as C2C to stakeholders could be a better anchor for realising a truly positive coupling between socio-cultural, environmental and economic benefits.

6. Conclusion

This study was a preliminary investigation into the perspectives of business site tenants in relation to C2C principles and attributes that can be integrated into such development schemes to create positive impacts. The findings, whilst inclusive due to the low response rate, have revealed that the 'celebrate diversity' principle is considered to be of most importance regarding their choice to operate from a business site. The tenant stakeholders exhibited more preference towards aesthetically elegant designs that are highly flexible and easily adaptable for multiple uses whilst being mixed use sites with diverse amenities. The trends identified could have been because these tenant stakeholders were more familiar with, and could relate better, to the attributes that they rated higher. Perhaps an even more plausible reason could be that these are the attributes that have a direct bearing on their business operations and growth. These preliminary findings thus provide some basis for commencement of discourse with different business site stakeholders in the UK on C2C. The C2C principles that relate to diversity, particularly conceptual and cultural diversity, could be a good starting point for engaging stakeholders on how to create positive impacts, benefits and footprints on business sites by pursuing C2C aspirations and visions. There are however some limitations to this study's findings given the low response rate. Whilst no definitive conclusions can be made from these findings, the survey has yielded preliminary insights on C2C related attributes that business site tenants are more familiar with. The patterns that have emerged from this survey would serve as an initial starting point by providing important lines of enquiry that can be pursued during the main case study phase of the research, where different business site stakeholders would be interviewed. It would however be interesting to undertake a similar investigation using a larger sample of business site tenants, particularly across different EU countries to understand differences in preferences towards C2C attributes. Other studies could also replicate such a survey by targeting different stakeholder groups that are involved in the initiation, planning, development and operation of business site schemes. These further studies would enable better understanding of what is of value to different stakeholder groups within a wider context in regards to C2C and how the concept can be adapted to different markets in the EU member states.

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References

[1] M. Hunt, D. Beeden, B. Brink, B. Freck, A. McLean, J. Roelofs, P. Stouthuysen, Perspective study: Build theme, in, Cradle to Cradle Network, Netherlands, 2011.

[2] P. Out, P. Haane, P. Levels, H. Albering, B. Ouwehand, Perspective study: Area spatial development, in, Cradle to Cradle Network, Netherlands, 2011.

[3] K. Sips, P. Kuppers, A Journey from Cradle to Cradle. C2C Network Initiatives Guide, in, Cradle to Cradle Network, Netherlands, 2011.

[4] M. Ott, G. Winter, F. Hoffmann, C2C BIZZ - Guide to cradle to cradle (C2C) inspired business sites, in, C2C BIZZ, Luxembourg, 2014.

[5] C.A. Booth, A. Oosting, K. Tannahill, N.A. Ankrah, F.N. Hammond, C. Williams, H. Smolders, J. Braas, L. Scheepers, A. Kathrani, L. Virdee, T. Kadlecova, O. Lewald, M. Mess, B. Merckx, M. Renson, A. Cousin, T. Cadoret, R. Vercoulen, E. Starmans, A. Bertrand, A. Beloussova, L. Mathieu, J.M. Meulemans, J. Schroeder, Beyond sustainability: cradle-to-cradle business innovation and improvement zones in NW Europe., in: M. Pacetti, G. Passerini, C.A. Brebbia (Eds.) 7th International Conference on Urban Regeneration and Sustainability, Ancona, Italy, 2012.

[6] W. McDonough, M. Braungart, The next industrial revolution, The Atlantic Monthly, 282 (1998).

[7] W. McDonough, M. Braungart, P.T. Anastas, J.B. Zimmerman, Applying the principles of green engineering to cradle-to-cradle design, Environmental science & technology, 37 (2003) 434-441.

[8] W. McDonough, M. Braungart, Cradle to cradle: Remaking the way we make things, North point press, New York, 2002.

[9] M. Braungart, W. McDonough, A. Bollinger, Cradle-to-cradle design: creating healthy emissions–a strategy for eco-effective product and system design, Journal of Cleaner Production, 15 (2007) 1337-1348.

[10] S.A. Rosenfeld, Bringing business clusters into the mainstream of economic development, European planning studies, 5 (1997) 3-23.

[11] E.M. Bergman, E.J. Feser, Industrial and regional clusters: concepts and comparative applications, WVU Regional Research Institute, Morgantown, West Virginia, 1999.

[12] P. Deutz, D. Gibbs, Industrial ecology and regional development: eco-industrial development as cluster policy, Regional Studies, 42 (2008) 1313-1328.

[13] O. Memedovic, Europe and central asia conference on industrial parks as a tool to foster local industrial development, in, 2012.

[14] E.A. Lowe, L.K. Evans, Industrial ecology and industrial ecosystems, Journal of Cleaner Production, 3 (1995) 47-53.

[15] T. Tudor, E. Adam, M. Bates, Drivers and limitations for the successful development and functioning of EIPs (eco-industrial parks): A literature review, Ecological Economics, 61 (2007) 199-207.

[16] M. Fuchs, D. Bossert, S. Stukowski, Response rate and nonresponse bias-Impact of the number of contact attempts on data quality in the European Social Survey, Bulletin of Sociological Methodology/Bulletin de Méthodologie Sociologique, 117 (2013) 26-45.

[17] K. Dziekan, V. Riedel, S. Müller, M. Abraham, S. Kettner, S. Daubi, Evaluation matters: A practitioners' guide to sound evaluation for urban mobility measures, Waxmann Verlag, 2013.

[18] Z. Bauman, Liquid modernity, John Wiley & Sons, 2013.

[19] V. Loftness, V. Hartkopf, B. Gurtekin, Y. Hua, M. Qu, M. Snyder, Y. Gu, X. Yang, Building Investment Decision Support (BIDS™):Cost-Benefit Tool to Promote High Performance Components, Flexible Infrastructures and Systems Integration for Sustainable Commercial Buildings and Productive Organizations, in, Carnegie Mellon University Center for Building Performance and Diagnostics, Pittsburgh, PA, 2001.

[20] L. Edwards, P.A. Torcellini, A literature review of the effects of natural light on building occupants, National Renewable Energy Laboratory Colorado, USA, 2002.

[21] W.J. Fisk, Health and productivity gains from better indoor environments and their relationship with building energy efficiency, Annual Review of Energy and the Environment, 25 (2000) 537-566.

[22] W.J. Fisk, A.H. Rosenfeld, Estimates of improved productivity and health from better indoor environments, Indoor air, 7 (1997) 158-172.

[23] G. Kats, L. Alevantis, A. Berman, E. Mills, J. Perlman, The costs and financial benefits of green buildings, A Report to California's Sustainable Building Task Force, (2003).

[24] N.A. Ankrah, E. Manu, F. Hammond, K. Baffour-Awuah, N. Hingorani, P. Wood, The Valuation Tool User Guide: Monetizing Cradle-to-Cradle, in, C2C BIZZ, Netherlands, 2014.

[25] K. Addae-Dapaah, T.K. Wai, M.J. Bin Dollah, Y. Foo, Indoor Air Quality and Office Property Value, The Journal of Sustainable Real Estate, 2 (2010) 91-115.

[26] G. Kats, Green building costs and financial benefits, Massachusetts Technology Collaborative Boston, MA, 2003.