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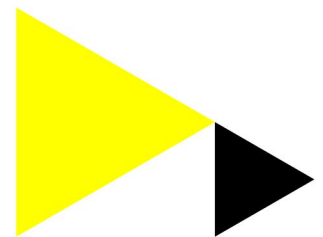
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Collaborative Value Creation and Learning in Innovation Projects for a Circular City

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Over the last decade, the concept of a circular economy, an industrial economy that is restorative or regenerative by intention and design, has gained increased attention of policy makers, industry and academics. Recently the number of innovation projects, set up by local governments, communities, non-governmental organizations and businesses, to experiment with new sustainable technologies for a circular city, has increased substantially. This paper aims to explore how in this emerging field different stakeholders collaboratively create value and develop a viable sustainable business model. We do so by building on business model literature and literature on innovation networks and combining these with insights on value outcomes and learning from strategic management.

For this study we take a qualitative research approach, building on four innovation projects for a circular city, characterized by collaboration of a wide variety of stakeholders, each being initiated and coordinated by a different stakeholder type. The findings show an emphasis on technical and organizational learning, influencing expected and unexpected value outcomes. The main contribution of this paper is a conceptual framework to analyse value creation and capture within the context of open partnerships through different learning types. Learning proves to be an effective mechanism in innovation networks to create and capture more economic, environmental and social value than initially aimed for.

1. Introduction

Over the last decade, the concept of a circular economy, has gained increased attention of policy makers, industry and academics to this topic. A circular economy can be defined as “a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops” (Geissdoerfer, Sayaget, Bocken and Hultink, 2017). There is a growing body of literature on circular economy, from the micro-level addressing firm-centric design of products and services and business model strategies for a circular economy (e.g. Bocken, de Pauw, Bakker and van der Grinten, 2015; EMF, 2012), to the macro-level discussing policies and strategies for the transition of cities or regions to a circular economy (e.g. Su, Heshmati, Geng and Yu, 2013; Ghisellini, Cialini and Ulgiati, 2016). At all

levels, the literature stresses the importance of new business models and collaboration with a variety of stakeholders. We take a meso-level perspective focussing on collaborative innovation projects that are set up to experiment with new sustainable technologies and working methods to advance the transition towards a circular city, a phenomenon that augmented in recent years.

Prendeville, Cherim and Bocken (2017) define a circular city as “a city that practices circular economy principles to close resource loops, in partnership with the city’s stakeholders (citizens, community, business and knowledge stakeholders), to realize its vision of a future-proof city”. They propose that implementation of circular city practices benefit from a combination of top-down interventions by local governments (e.g. facilitate collaboration with all urban stakeholders, experimentation and business support) and bottom-up change through

initiatives and entrepreneurial activities by communities, NGOs and businesses. With this paper we aim to explore how in this emerging field of circular city innovation projects, different stakeholders collaborate in value creation and how they create, share and capture multiple value through experimenting and learning.

Sustainable business model literature makes clear how a multiple value and multi-stakeholder perspective is necessary for sustainable business models (e.g. Lüdeke-Freund, Brent, Massa and Musango, 2016; Yunus, Moingeon and Lehmann-Ortega, 2010). A circular business model, creating, delivering and capturing value from waste can be seen as a specific type of sustainable business models (e.g. Bocken et al., 2016), that are by nature networked (e.g. Antikainen and Valkakori, 2016), require experimentation and learning (e.g. Buelque and Aggeri, 2016) and include value sharing among a large variety of stakeholders including local communities (Bocken, Short and Rana, 2014; Antikainen and Valkakori, 2016). The literature further shows that innovation in emerging fields of technology, for example in living labs, are co-created by (open) innovation networks consisting of businesses, public organisations, NGOs, knowledge institutes and users (e.g. Leminen, Westerlund and Nyström, 2012; Möller and Rajala, 2007).

In this paper we combine these insights with strategic management literature on value outcomes and learning to explore how innovation networks developing and testing technological solutions for a circular city, collaboratively create and share value for all stakeholders. Based on four innovation projects, each initiated and coordinated by a different type of actor and aimed at contributing to the transition towards a circular city, we find that learning is an important mechanism in innovation networks to create and capture more economic, environmental and social value than initially was expected and aimed for.

In the following section we present the theoretical background of this paper, followed by the research method, the case selection logic and the method for data collection and analysis. Next we describe the findings based on a within-case and cross-case analysis and end this paper with discussing the results and presenting our contribution to research and practice.

2. Theoretical background

In this section we first explore the literature on sustainable business models and circular business models and explain the concepts and definitions we use as a basis for this study. Next we explore the literature on innovation networks and how this contributes to our study. Finally we explain the insights on value creation and learning from the strategic management literature we use for our analysis.

2.1 Sustainable and circular business models

A business model can be defined as a conceptual representation of the organizational and financial “architecture” of a business, and articulates the logic and

architecture of how value is created, delivered and captured (Teece, 2010). Although this generic business model concept is firm-centric, it can be considered a boundary-spanning activity system (Zott and Amit, 2010), that can act as a market-device “to explore a market and to bring their innovation – a new product, a new venture and the network that supports it – onto existence” (Doganova and Eyquem-Renault, 2009, p. 1560). New business models are widely recognized as conditions for implementing sustainability-oriented innovations (Boons and Lüdeke-Freund, 2013; Schaltegger et al., 2012) and are considered important in the transition towards a CE (e.g. EMF, 2012; Geissdoerfer et al., 2017).

According to Lüdeke-Freund, Bocken, Brent, Massa, and Musango (2016), sustainable business models differ from generic business models in three ways. First they view business as an engine of societal progress, businesses having the potential, resources, and capabilities to develop innovative solutions that turn environmental and social issues into market opportunities. Second, they include a broader notion of value resembling a triple bottom line approach integrating people, planet, and profit, and the concept of shared value. Third, they take a multi-stakeholder, system-level perspective on value creation embracing not only customers but also other stakeholders.

To incorporate this broad notion of value and multi-stakeholder perspective, we combine Schaltegger et al. (2016) and Yunus et al. (2010) and propose the sustainable business model consists of: (i) a “value proposition” providing ecological and/or social value next to economic value to its customers and other stakeholders, (ii) a “value creation and delivery”, explaining how the value is created and delivered by the company and its partners for all stakeholders, and (iii) “value capture” maintaining or regenerating natural, social and economic capital beyond its organizational boundaries.

A circular business model creates, delivers, and captures value by slowing and closing resource loops (Bocken et al., 2016) and can be seen as a specification of a more general sustainable business model (Lüdeke-Freund et al., 2016; Bocken et al., 2016). Bocken et al. (2014) developed a framework with eight sustainable business model archetypes, of which several types are relevant for the transition to a circular economy. One of these business model archetypes is ‘creating value from waste’, by Bocken et al. (2014) defined as eliminating the concept of ‘waste’ by turning waste streams into useful and valuable input for other production cycles, closing material loops and making better use of under-utilised capacity. Often combinations of archetypes can be made, in the case of ‘creating value from waste’ for example with ‘adopt a stewardship role’ (i.e. proactively engaging with all stakeholders to ensure their long-term health and well-being, for example by better engaging the consumer with the full story of production and the supply chain) and/or ‘repurpose for society/environment’ (i.e. prioritizing delivery of social and environmental benefits rather than economic profit maximisation, through close integration between the firm and local communities and other stakeholder groups).

Specific characteristics of circular business models, mentioned in the emerging literature, include the

following: (i) Circular business models are by nature networked (Antikainen and Valkakori, 2016) as they require collaboration within complex networks, that include actors across industry boundaries and from other sectors (Bocken et al., 2014; Buelque and Aggeri, 2016; Antikainen and Valkakori, 2016), and integration with local communities and other stakeholder groups (Bocken et al., 2014). (ii) Circular business models require experimentation processes and collective learning, creating the information required for building the new business model on the way (Buelque and Aggeri, 2016). (iii) Circular business models appropriately share value within the value system (Buelque and Aggeri, 2016), balancing self-interest and value for all stakeholders involved (Antikainen and Valkakori, 2016).

As the literature on circular business model is premature, and empirical research on collaborative innovation projects in the field of circular economy is limited, many questions remain open. Which networks and cooperative arrangements are involved in the creation of business models for sustainability (Schaltegger, Hansen and Lüdeke-Freund, 2016). How can networks translate social and environmental value creation into economic profit and competitive advantage to build a viable sustainable business model (Bocken et al., 2014)? Especially, how can non-profit organisations, often depending on external donors, realise long-term economic viability (Bocken et al., 2014)? And how do actors collaboratively create and share value for all stakeholders, including the participants of the network?

2.2 Innovation networks

Interorganizational innovation networks are increasingly important for innovation in emerging technology fields (Powell, Koput and Smith-Doerr, 1996; Valk, Chappin and Gijsbers, 2011), however studies on networks as a whole are scarce (Provan, Fish and Sydow, 2007). We follow Provan et al. (2007) who see a network as a group of organizations linked through multilateral ties and connected to achieve a common goal and use the network-level as the main unit of analysis for our study.

According to Möller and Rajala (2007), innovation networks is one of the management mechanisms for emerging value systems that are necessary for radical change, such as the transition towards a circular city. In innovation networks, the challenges faced by the actors creating new technology and business models, are profoundly different from those in stable business networks as they are confronted with ample uncertainty about the technological possibilities and the activities and actors necessary to seize its value potential (Möller and Rajala, 2007).

A particular form of innovation networks is a living lab, a (physical) experimentation environment where public organisations, private companies, knowledge institutes and (potential) users collaborate to create, prototype, demonstrate and validate new technologies, services, products and systems in real life contexts early on in the innovation process (Ballon, Pierson and Deleare, 2005; Leminen et al., 2012). Based on open innovation principles,

all actors are considered equal, including (potential) users, and co-create and test innovations creating value as a network (Leminen et al., 2012). As the network is open to enter and leave the initiative, there is a need to capture value on an individual level as well to sustain continued participation and support of the initiative (Chesbrough and Appleyard, 2007). This is in concord with the characteristics of circular business models presented earlier, however how collective value is created and shared amongst the actors of the emerging value system remains unclear.

According to Leminen et al. (2012) the purpose, value creation logic and possible outcomes of a living lab, may depend on the actor that drives the network's innovation activities. Leminen et al. (2012) therefore propose four types of living labs: (i) Utilizer-driven living labs are launched by companies, focussed on developing and testing new products and services, by knowledge (co-)creation with others in the network of the living lab. (ii) Enabler-driven living labs are initialized by enablers (e.g. public-sector actors, NGOs, municipalities), with the aim to pursue societal improvements. (iii) Provider-driven living labs are launched by a provider organization (e.g. educational institutes, universities or consultants), with the purpose of generating useful knowledge and information for everyone in the network. (iv) User-driven living labs are initiated by users or build around a user community, and is focussed on solving users' every-day problems. Other actors in the network participate by supporting the users in with knowledge, equipment, resources or guidance.

However, the composition, organization and leadership of the innovation network may change over time, influencing the expected outcomes as the process is more important than the intended end result (Leminen et al., 2012). A living lab approach for example, facilitates experimentation and learning by developing context specific insights on development and acceptance processes, informing about possible conditions for the societal embedding of technology, and generating images of potential societal impacts of the innovation (Ballon et al., 2005). This may influence the value that is created: "the resulting outcome is being shaped while collaborating and can ultimately take a completely different form than originally anticipated" (Leminen et al., 2012, p.10). How learning influences the value outcomes remains unclear.

2.3 Collaborative value creation and learning

Trial-and-error learning is considered an important ingredient of business model innovation for sustainability to create (Chesbrough, 2010; Schaltegger et al., 2016; Sosna, Trevinyo-Rodríguez and Velamuri, 2010). Also in open innovation there is a trend towards more iterative and interactive probe-and-learn processes (Gassmann, Enkel and Chesbrough, 2010) and especially in situation where the actors and their knowledge are disparate and the technologic development path is unknown, learning in networks emerges (Powell, 1996).

To explore how innovation networks collaborative create and capture value for all stakeholders, we propose to look at the purpose or value creating aim of the innovation project or living lab (i.e. intended value) and the value outcome (both expected and unexpected value), and study learning as the mediating variable explaining how the value outcome differs from the intended value (see Figure 1).

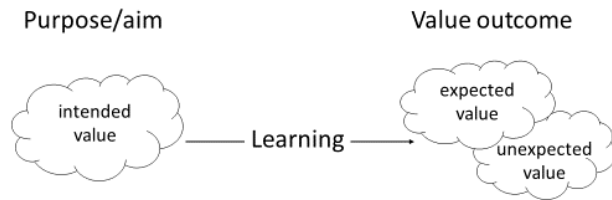


Figure 1. Value creation: aim, learning and value outcome.

From the perspective of circular business models, the intended value and the value outcome does not only concern the initiating firm or organization, but also concerns other stakeholders as beneficiaries, while sustainable business models combine economic value with benefits for society (e.g. Schaltegger et al., 2016; Yunus et al., 2010). We therefore distinguish economic, environmental, and social value, that may include both tangible and intangible benefits (Allee, 2009). For sustainable business models related to the transition towards a circular city, these benefits may include (derived from Bocken et al., 2014): (i) economic value, e.g. creating value from what currently is perceived as waste, using underutilized capacity; (ii) environmental value, e.g. reduction of waste to landfill, reduction of continuous demand for virgin materials, reduction of emissions, sustainable growing and harvesting of food and other crops, bio-diversity protection and regeneration; (iii) social value, e.g. secure livelihood, community development, improved education, creating awareness, improved health and welfare.

For assessing learning we build on the classification developed by Bossink (2017) for demonstration projects, which we adapted to the sustainable business model archetypes from Bocken et al. (2014) related to the

transition towards a circular city: (i) technical learning to develop and produce new technical solutions, working methods or prototypes for creating value from waste; (ii) organizational learning to cooperatively organize the development, testing and implementation process of new solutions for a circular city; (iii) policy learning to develop regional or city policy measures that stimulate and facilitate development, production and implementation of circular solutions; (iv) market learning to bring prototype-based products made of waste and technical or organisational solutions for reuse, recycling or using under-utilized capacity to the market and its potential impact.

3. Research design

For this explorative study we take a qualitative research approach, using case study methodology in order to capture as much detail as possible and create in-depth insight in the phenomena (Eisenhardt, 1989; Yin, 2003). To improve the external validity a multiple case study design is used (Yin, 2003).

3.1 Case selection

The phenomena we study are collaborative innovation projects, set up to experiment with new sustainable technologies to advance the transition towards a circular city, combining the sustainable business model archetype ‘creating value from waste’, with ‘adopt a stewardship role’ and/or ‘repurpose for society/environment’ (Bocken et al., 2014). We selected four projects using a sampling logic based on theoretical replication (Yin, 2003), based on the categorization of living labs by Leminen et al. (2012). Each innovation project is initiated and coordinated by a different stakeholder type (business, NGO, consultancy and user), providing theoretical variation in the starting conditions that may influence the answers to the research questions. See Table 1 for an overview of the selected projects.

Table 1. Selected circular city innovation projects

	Locally Grown Paint	WASTED	Cleantech Playground	Buurtcompost
<i>Rationale</i>	Local growth of flax and line seed for sustainable paint on uncultivated land	Neighbourhood laboratory for plastic waste upcycling	A living lab for sustainable and regenerative technologies	Local composting of household swill with worm composting
<i>Living lab type (Leminen et al., 2012)</i>	Utilizer-driven	Enabler-driven	Provider-driven	User-driven
<i>Initiative and coordination</i>	Business (SME)	Non-governmental organisation	Consultancy agency	User
<i>Start of the project</i>	2012	2013	2010	2015
<i>SBM archetype (Bocken et al., 2014)</i>	Creating value from waste Adopt a stewardship role	Creating value from waste Repurpose for society/environment	Creating value from waste Adopt a stewardship role Repurpose for society/environment	Creating value from waste Adopt a stewardship role Repurpose for society/environment

The projects are based in the Amsterdam Metropolitan Area and are examples of bottom-up initiatives with goals to collectively create shared value from waste. They are characterized by collaboration of a variety of stakeholders (e.g. private companies, public organisations, non-governmental organisations, knowledge institutes and citizens), and at least include involvement of a municipality. The projects started between 2010 en 2015 and are still progressing. Although all projects have been started with the aim to contribute to create shared value and have the desire to create a viable sustainable business model to be able to continue the project, this stadium is not yet reached for every projects as they are still continuing

3.2 Data collection and analysis

The data collection consists of 8 in-depth retrospective interviews (face-to-face) with initiators and key project partners. For triangulation purposes 57 additional data sources are studied (Yin, 2003), consisting of 14 publications (reports and other professional publications), 4 project websites, 15 project descriptions on partner websites, 19 news bulletins and 5 video's. An inductive research approach is followed starting with a within-case analysis, writing up detailed case-study reports to explore the unique patterns of each case (Eisenhardt, 1989). We focus on the intended value and the expected and unexpected value outcome for the network as a whole, as well as at value capture by individual partners. A cross-case comparison is conducted focussing on the learning influencing the value outcome by exploring cross-case patterns, looking for similarities and differences between cases, strengthening the internal validity and the generalisability of the results (Eisenhardt, 1989).

4. Findings

We first present the individual case study-reports, followed by a cross case comparison focussed on learning effects and their interrelation with value outcomes.

4.1 Casestudies: from intended value to unexpected value outcomes

Four case-study reports describe the origin and aim of the project, what actors are involved in the value creation and learning process and what economic, environmental and social value is created and captured.

4.1.1 Locally Grown Paint

Locally Grown Paint is initiated by an small- and medium-sized enterprise (SME) called Rigo Paint to locally produce eco-friendly paint based on line seed oil and flax, locally instead of abroad. The initial motivation of the firm was the desire to make the sustainability of

the paint, being produced based on renewable sources instead of oil, visible and tangible to the consumer. Other purposes are shortening the logistic supply chain drastically and stimulating the local circular economy.

By collaborating with municipalities, conservancies and the local airport, new use is given to local wasteland and uncultivated grounds. By close collaboration between these actors and with local SMEs for seed supply, farming and milling, the possibilities for local production were explored without any additional funding. Tangible results are the renewed use of waste land for growing crops for the production of the eco-friendly paint but for other crops as well. Many new partners joined the project, including wind mills for grinding the line seed, that previously had to buy materials to run their mills for educational purposes and that now are being used for their original purpose again. See Table 2 for an overview of the main economic, environmental and social value, both expected and unexpected.

Table 2. Locally Grown Paint: expected and unexpected value outcome.

	<i>Expected value outcome</i>	<i>Unexpected value outcome</i>
<i>Economic value</i>	Delivering sustainable paint for a competitive price	Reduction of maintenance and other costs through allocation of (temporarily) uncultivated land
<i>Environmental value</i>	Local (less transport) and environmentally friendly (no use of fertilizers) growing methods Use of underutilized capacity (land)	Replication of the working method for other crop and in other geographical areas Use of environmentally friendly production methods (using wind mills)
<i>Social value</i>	Increased local employment Increased awareness	Educational value of using wind mills for their original purpose

The learning in this case is mainly organizational and concerns learning how to cultivate flax and other crops locally and how to collaborate without funding and share the financial costs and gains through open book keeping. For land owners the working method proved to be cost effective while growing flax reduces maintenance and other costs, was an unexpected outcome, paving the way for using their grounds for other crops as well. Other unexpected value outcomes are replication of the working method by similar firms as the initiator abroad through sharing of the working method, and the fact that the sustainable paint is now also used by some of the land owners and partners involved in the production process.

Although it started as a demonstration project, the project scope has grown towards a way of working that is adopted by several of the network actors for various purposes, increasing the amount of uncultivated land that is used this way year by year.

4.1.2 WASTED

WASTED is a local pilot project aimed at increasing the separation rate of plastic waste, whilst creating public awareness among citizens of our global plastic waste problem and to stimulate to be part of the solution. The project was initiated by a NGO called CITIES inspired by their previous project, Farming the City that was paying attention to food waste and wasted packaging material. A research study on plastic waste management and governmental waste policies was the starting point for the WASTED project. In collaboration with creative entrepreneurial firms and local organizations, a neighborhood laboratory is realized, where local citizens get rewards (coins) for separately collected plastics waste, that can be used for benefits at local business or cultural organizations. Initially the plastic waste was projected to be used as facing material for a new building in a neighboring park, but for practical reasons this idea was replaced by producing building blocks out of the waste that, for example to be used for street furniture.

The initial project is located in the North of Amsterdam in a neighborhood and the project was initially supported financially by the municipality and another NGO, but aims to find a viable business model to run without funding in the near future. Learning in this project is mainly organizational learning. Many of the original ideas did not work as effective as expected, and were redeveloped through trial-and-error. For example, reaching citizens to participate proved to be quite difficult, but educational programs at local schools brought a new way to reach citizens through their children. When collecting the waste by bicycle proved to be too time consuming, collaboration with the municipality was set up to include the plastic waste collection in existing routines.

The value outcome is mainly social as the actual separation rate and actual reuse of the plastic is limited. The main tangible results are currently a social community between residents and local SMEs. Unexpected outcomes are for example an educational program for creating awareness amongst children that was developed based on additional governmental funding and a working method for setting up a wasted laboratory, a reward system and community building, available through open source documentation, and already being applied in several cities around the world. See Table 3 for the main economic, environmental and social value outcomes. The initiating NGO CITIES is currently exploring the possibilities to start a similar project in another neighborhood, realizing the context specific conditions that have to be taken into account.

Social value	Community building between citizens and local entrepreneurs Increased awareness and behavioural change	Education of school children on our waste problem Open source working method for setting up a WASTED lab
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4.1.3 CleanTech Playground

Cleantech Playground is a living lab for developing, testing and demonstrating regenerative technologies and technological solutions for closing material, energy and water cycles, situated at De Ceuvel, as part of a temporary community-driven creative breeding place at a former ship wharf.

A group of young architects, planning to realise a sustainable floating neighbourhood, came up with the idea to search for an area where they could live and work in an environmentally sustainable way, and that could serve as inspiration and pilot testing place for their plans for the floating neighbourhood. They received funding from the municipality to develop a creative breeding place at location DeCeuveel, in which the Cleantech Playground living lab was included. The Cleantech Playground was initiated by Metabolic, a cleantech consultancy agency, together with the group of architects, with the aim to develop, test and demonstrate regenerative technologies for full recycling of local resources and at the same time cleaning the heavily polluted soil of the area.

The learning in this case is mainly technical learning and organizational learning. By collaborating with various knowledge institutes different technologies have been developed, implemented and tested, reusing waste materials and closing materials loops, an example being the production of fertilizer based on urine collected at the local café. By building a community of volunteers it has become a renown inspirational circular city example.

Expected value outcomes are the cleaning of the heavily polluted soil of the former ship wharf, reuse of discarded houseboats and closing of different resource loops, generating knowhow concerning the feasibility and acceptability of different sustainable solutions at a local scale. Unexpected outcomes are the educational and inspirational value of the project and the community that is built around it. See Table 4 for the main economic, environmental and social value outcomes.

Table 3. WASTED: expected and unexpected value outcome.

	<i>Expected value outcome</i>	<i>Unexpected value</i>
Economic value		Economically viable educational program
Environmental value	Increased separation rate of plastic waste (although limited result)	Replication of the project and its result internationally

Table 4. Cleantech Playground: expected and unexpected value outcome.

	<i>Expected value outcome</i>	<i>Unexpected value</i>
Economic value	Insights in the economic viability of tested solutions	
Environmental value	Closing of resource loops (e.g. water, urine) Use of renewable energy Cleaning polluted soil Reuse of waste streams (e.g. discarded house boats)	Initiation of additional technological research projects (e.g. biogas boat)
Social value		Community building Inspirational and educational value for visitors (citizens and professionals)

4.1.4 Buurtcompost

Buurtcompost is initiated by an Amsterdam resident, who is eager to compost his fruit and vegetable waste, as swill is not collected door to door by the municipality and gardens are scarce. He first started at home, in a closet, by vermicomposting, a composting process using earthworms to turn organic wastes into very high quality compost. Because of practical reasons, he took the initiative to compost collaboratively at the corner of the street. Together with a designer he built a worm cabinet, and asked his neighbours to join him. The initiative was supported by the municipality and soon several similar neighbourhood initiatives followed his example.

With the help of Buurtcompost and facilitated by the municipality several worm cabinets were build and placed at several locations in town, a number that is still growing as it is stimulated by the municipality. Each streetcorner composter has approximately 20 users who regularly deposit their fruit and vegetable waste together with leaves and leftover carton. Thanks to the enzymes and bacteria produced by the worms a high quality compost is created, that can be used by the users for their garden or balcony.

Because in winter it is too cold for vermicomposting at street level, Buurtcompost pitched an idea at the municipality to use vermicomposting in an underground container. Supported by the municipality a prototype was developed, placed and tested. The solution proved to be able to digest a larger volume of organic waste (of approximately 200 residents) and create high quality compost without smell or other problems as vermin. Because of the volume reduction capacity of vermicomposting, the container needs to be emptied only once or twice a year, which makes underground vermicomposting a potentially very efficient solution for the municipality.

The value outcome is substantial and divers (see Table 5). Current tangible results are the placement of growing number of street corner composters and establishment of associated neighbourhood teams, a prototype of an underground container, but also the organisation of work safari's and composting workshops

to inspire and educate new users. Environmentally the solution delivers high quality compost through a local solution, reducing waste and transport. This expected outcome is duplicated with each reproduction of the initiative. Unexpected value outcome is the contribution of street corner composting to social cohesion in the neighbourhood. The opening of a new streetcorner composter is often the first time that residents meet and the atmosphere in the neighbourhood is said to be improved. Other unexpected value outcome is educational value. Economic value is created as the residents do not need to buy compost, whereas upscaling underground vermicomposting may be a fruitful solution for waste reduction for the municipality as it is local reuse of waste, reducing transport costs.

Currently Buurtcompost is collaborating with a university, for example to add a shredder to the underground container as a means to further increase the processing capacity and to assess the effects of local composting on social cohesion in neighbourhoods.

Table 5. Buurtcompost: expected and unexpected value outcome.

	<i>Expected value outcome</i>	<i>Unexpected value</i>
Economic value	No need to buy compost Reduction of waste transport costs	New cost-effective method for collection/reuse of organic waste Development of new products (e.g. different composter types)
Environmental value	Local upcycling of organic waste and use of the resulting compost CO2 reduction through less transport of waste	Replication of the initiative
Social value		Increased social cohesion in neighbourhood Educational value

4.2 Value outcome and learning effects

The data reveal that, regardless the initiator and starting point, the projects are mainly environmentally and socially driven with an aim to innovate, demonstrate sustainable solutions and inspire others to contribute to the transition towards a circular economy. Especially actors such as NGOs and users prioritise maximising societal and environmental value, rather than economic value. The SMEs involved in the LGP case show a more entrepreneurial mind-set, additionally trying to realise economic advantage for the actors in the network. Based on a cross-case comparison we analysed how the intended value is effected by the four types of learning and what the expected and unexpected value outcome is.

4.2.1 Learning effects

The data show an emphasis on organizational learning for all case studies. For all four types of living labs (i.e. utilizer-, enabler-, provider- or user-driven, organisational learning proves to be an important factor

in collaborative value creation. In all cases learning how to organize the development, testing and implementation of solutions for a circular city are vital to capture its environmental value potential. Learning to activate users and learning to build and moderate communities prove to be important to improve social value outcomes in all cases, except for the utilizer-driven case Locally Grown Paint. This may be due to the fact that in this particular case citizens are not directly involved as users of the sustainable paint. Organizational learning lacks a focus on economic value in most cases, although in the utilizer-driven case the actors learn how to share financial costs and gains among the innovation network.

Profound technical learning is only found in the Cleantech Playground, as it is its main purpose in this provider-driven living lab. Not only the initiator/coordinator is a technology-driven consultancy agency, also many other actors involved are knowledge institutes or organizations have an interest in the feasibility of the sustainable technologies. Although the focus in this case lies on technical learning related to the environmental value of the solutions, an economic perspective is important as well for various actors as they learn about the financial viability of decentralized application of the sustainable technologies. Technical learning, although low-tech, is also found in the other cases. In the Buurtcompost case, for example, various technical solutions are being developed and tested, in collaboration with SMEs and knowledge institutes, to improve the quality of the compost (environmental

value) and to make it easier for citizens to use the solution (social value) and for municipalities to operationalize the solutions (economic value).

Policy learning is found in those cases where the municipality plays an active role. This is the case in WASTED, where the municipality is involved in collecting the plastic waste bags at the pilot location, and in Buurtcompost, by for example facilitating the experimentation with the underground composter. However, policy learning in these cases is hardly a preconceived goal and it is hard to find concrete examples of possible policy learning effects on economic, environmental or social value outcomes.

Market learning is underexposed in all case studies. Clear viable business models are absent in all cases studied, but the interviewees do acknowledge the importance of a viable business model and a sound financial business case for continuation or upscaling of circular solutions successfully tested in the project, especially the projects that received external funding at the start (the enabler-driven case WASTED and the provider-driven case Cleantech Playground). Although assessing economic, environmental and social impact is regularly mentioned in the interviews it has not resulted in using or developing assessment methods or in taking concrete measures to enlarge the potential impact.

In Table 6 we give an overview of examples of how each type of learning may contribute to creating economic, environmental and social value.

Table 6. Examples of how learning may contribute to creating economic, environmental and social value.

Learning effect	Economic value	Environmental value	Social value
<i>Technical learning</i>	How to develop technical solutions or working methods that are economically viable	How to develop technical solutions for closing resource loops How to develop and implement solutions for reusing and recycling of waste streams or using underutilized capacity	How to develop technical solutions or working methods in such a way that they are acceptable for users
<i>Organizational learning</i>	How to share financial costs and gains of the solution	How to organize the development, testing and implementation of solutions	How to create awareness and activate (potential) users How to build and moderate communities
<i>Policy learning</i>	How to decide upon supporting initiatives (in kind or financially)	How to change the conditions necessary to facilitate development, testing and circular solutions	How to stimulate bottom-up initiatives for circular solutions
<i>Market learning</i>	How to assess economic impact of circular solutions How to create brand value based on environmental and social value	How to assess environmental impact of circular solutions	How to assess social impact of circular solutions

4.2.2 *Expected and unexpected value outcomes*

Similar to the aim of the projects and its intended value, the value outcome that is collaboratively created, is largely non-financial and mainly encompasses sound environmental benefits (e.g. material reuse or recycling, reducing CO2 emissions, closing resource cycles) and social benefits (e.g. education, creating awareness, community building). This value outcome is clearly influenced by the type of learning, as the technical, organizational and policy learning found in the cases appear to mainly focus on increasing environmental and social value. Market learning that may have a larger focus on increasing economic value, is underexposed in

all case studies. Nevertheless, some economic value is also found, although in a lower degree, through technical, organizational and policy learning.

The environmental value can largely be considered expected value outcome as developing, testing and implementing solutions for the transition towards a circular city is the main goal of each case studied. However also unexpected environmental value is found, based on not foreseen spin-offs of the project (e.g. replication of the working methods developed by WASTED and Locally Grown Paint in other countries), and extra technologies being tested (in the case of the Cleantech Playground).

Unexpected value outcomes are primarily found based on organizational learning, particularly related to social value outcomes, as creating awareness, activating (potential) users and building and moderating communities proved to be vital, challenging and rewarding for this particular type of projects.

5. Discussion and conclusion

The main contribution of this paper to the literature is adding learning as a perspective to analyse value creation within the context of open partnerships, effecting the value outcome for the network as a whole as well as individual stakeholders. Learning proves to be an effective mechanism in innovation networks to create and capture more economic, environmental and social value than initially was expected and aimed for.

5.1 Contribution

The results adds to both innovation network and business modelling literature by providing a conceptual framework to analyse how learning may influence the value outcome, by looking at different types of learning (i.e. technical, organizational, policy and market learning) and their effect on different types of value (i.e. economic, environmental and social value).

To the sustainable business modelling literature the study provides proof of how a learning perspective can help translate environmental and social value creation to realising economic benefits (Bocken et al., 2014). It shows how different learning types influence value creation and alters the value outcome, by indicating what types of individual and common value may be captured in the case of circular business models such as 'creating value from waste'. The results further show how different types of innovation networks are involved in creation business models for sustainability (Schaltegger et al, 2016) and add to our understanding of how different partner types may contribute to the initiation and development of sustainable business models.

In relation to the innovation network literature, the results confirm the finding of Leminen et al. (2012) that, the process is more important than the intended end results, and add that through staying open, the networks are able to incorporate ideas and resources that prove to be necessary, enabling new learning experiences and capturing additional and unexpected value.

5.2 Practical implications

To practice the empirical evidence indicates an emphasis in circular city innovation projects on technical and organisational learning, but lacks a focus on capturing economic value next to environmental and social value. Market learning is underexposed in the cases studied and policy learning, although present, could benefit from a more structured approach.

For practitioners involved in collaborative sustainable innovation projects, the different types of learning may serve as guidelines to focus the value creation process and increase the value outcome in reconciliation with the demands of different stakeholders. Our study suggests that by deploying learning processes smartly, it is possible to collaborate across organizational boundaries and create not only financial, but also environmental and social value.

5.3 Limitations

A limitation of this study is related to the number and the scope of the projects evaluated. The case studies were selected from a limited number of available projects, as circular economy is an emerging theme in development of cities. The results could benefit from verification of the conceptual framework with a larger number of case studies and in different areas of sustainable innovation.

Another limitation concerns the timing of data collection. The case studies are still running and the analysis and findings are based on the available data at a certain point in time. A longitudinal research approach, revisiting the case studies at different future moments for additional data collection, may enrich the results, and provide new avenues for further research as well. Further research could for example include the changing roles of actors in the network and their influence on value creation and learning, or could focus on identifying different stages to propose a process model for value creation and learning.

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