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Collective ‘action recipes’ in a circular economy – on waste and resource management frameworks and their role in collective change

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Abstract

This paper shows how to constructively engage with waste and resource management frameworks, by clarifying their role in the societal discourse on waste and resources, providing insight into their step-based structure, and how they draw on different definitions of ‘waste’ and ‘resource.’ Through use of the concepts of ‘frame,’ ‘collective action frame’ and ‘logics,’ a language and conceptual toolbox is made available that facilitates a constructive debate around such frameworks. Ten waste and resource management frameworks are included here, among which are the five frameworks that are part of the synthesis of the Ellen MacArthur Foundation’s Circular Economy framework: Cradle-to-Cradle™ by Braungart and McDonough, the Performance Economy by Walter Stahel, the Blue Economy by Gunter Pauli, Regenerative Design by John Lyle and the Industrial Symbiosis framework. A case is made for the careful consideration, creation, use and further development of such frameworks and directions are provided for the further development of the CE concept into a robust concept.

Keywords

Circular economy, resource productivity, collective action frame, societal change, waste, closed-loop, circular strategies

Highlights

- Conceptualises waste and resource frameworks as collective action frames (CAFs)
- Includes a discussion of 10 waste and resource frameworks
- Clarifies the role of CAFs in the societal discourse on waste and resources
- Provides insight in the step-based structure of CAFs
- Shows how CAFs draw on different definitions of ‘waste’ and ‘resource’

1. Introduction

The circular economy (CE) concept has caught the attention of businesses, policy makers and academics. The concept's core proposition is to move away from 'take-make-use-dispose' practices and replace these with material, part and product cycling and cascading, thus enabling resource preservation, efficiency and productivity. CE functions as an umbrella concept. This means that it groups a wide range of waste and resource management strategies and focusses the attention on their capacity to extend resource life, whilst generating value and preventing value loss and destruction (Blomsma and Brennan 2017). As such, the CE concept constructs and legitimises a space for the interrogation of the appropriate and effective use of such strategies.

Rising to the challenge posed by the umbrella concept, many frameworks have emerged that can be seen as proposals or visions of how a CE could or should operate through combining different ways to cycle, loop and cascade (Blomsma and Brennan 2017). In fact, the most well-known framework by the Ellen MacArthur Foundation – which can be summarised by its butterfly diagram and the ReSOLVE acronym – is itself a synthesis of a number of such frameworks (EMF 2013, 2015), specifically Cradle-to-Cradle™ (Braungart and McDonough 2002), the Performance Economy (Stahel 2006), the Blue Economy (Pauli 2010), Regenerative Design (Lyle 1994) and Industrial Symbiosis (e.g. Lowe and Evans 1995).

Frequently, the research community engages such frameworks in one of two ways – both unhelpful in catalysing societal change in the area of waste and resource management. In the first manner of engagement, a framework is taken as 'given.' That is: it is used as a framework for research, but not reflected upon, strengthened or further developed. In other words, the framework is applied uncritically.

A recent example can be found in Zhijun and Nailing (2007), who focus on CE in the Chinese context, but do not reflect on how a definition of CE grounded in the Industrial Symbiosis framework leads to initiatives focussed on the creation of eco-industrial parks, whilst omitting many other strategies. Another example can be found in Govindan and Hasanagic (2018), whose use the interpretation of CE by the Ellen MacArthur Foundation, and based on this proceed with their literature search and analysis without detailing or reflecting on the limitations thus built into their approach.

The second manner of engagement, in contrast, engages such frameworks over-critically. This is usually because the scope or context of the framework is overlooked or misunderstood, causing misinterpretation of (many of the) details or crucial elements of the framework. This can lead to premature dismissal of the examined framework.

See, for example, Allwood (2014), who equates the CE concept to a call for increased recycling and instead proposes a focus on the preservation and intensified use of materials, parts of products already manufactured. This leads the author to introduce a new framework – 'material efficiency,' ignoring the possibility to expand or adapt the emerging CE terminology to include an increased focus on energy aspects. Positioning such frameworks as non-complimentary risks potentially helpful ideas being put aside before they are further developed, resulting in the potential loss of momentum for change.

This paper shows how to appropriately and constructively engage with waste and resource frameworks that cover the level of industrial systems and economies in the academic domain. Through drawing on the constructs of ‘frame’ (Goffman 1974) and ‘collective action frames’ (Benford and Snow 2000) from sociology, and ‘logics’ from institutional theory (e.g. Thornton and Ocasio 2008), the purpose and structure of such frameworks is examined. This has three key outcomes. First, the societal function of such frameworks is elucidated. Second, it is shown how these frameworks construct high-level courses of action, based on their structure. That is: it is shown how such frameworks compile suggested collective ‘action recipes’ in the domain of waste and resource management. In addition to this, a key outcome is the development of the *waste and resources grid*, which can aid in assessing waste and resource frameworks through determining their relevance and suitability for use in particular contexts. In addition to this, this tool can also support the future development and synthesis of waste and resource frameworks, by serving as a means to verify coverage of relevant strategies.

Through this, a language and conceptual toolbox is made available that facilitates a constructive debate around waste and resource frameworks. The aim of this is to maintain and strengthen the current momentum around the CE concept, whilst improving upon current frameworks and developing them further. This supports the development of the CE concept into a coherent concept and one of truly transformative potential (Blomsma and Brennan 2017).

This paper is structured as follows. In the next section, the concepts of ‘frame,’ ‘collective action frame’ and ‘logics’ are introduced and their applicability to the waste and resource management discourse is discussed. Next, the methodology for selecting the 10 frameworks discussed in this paper is introduced, and an overview of the 10 frameworks is provided. In the following two analysis and results sections, the structure of the frameworks is examined in more detail, respectively through the lenses of ‘collective action frame’ and ‘logics.’ This includes the development of the *waste and resources grid*. This is followed by a discussion outlining the implications for synthesis efforts and further development of waste and resource frameworks. A concluding section provides a summary.

2. Theoretical background

2.1. *Frames, logics and change*

Frames and framing processes are central to understanding how meaning is constructed, maintained and challenged. *Frames*, according to Goffman, are cognitive devices that people use to determine how their world “hangs together” (Goffman 1974:440). *Framing processes* are the automatic and always on-going processes which generate meaning as and when events transpire. For example: the same sequence of events can be described as an experiment, a practice or a demonstration. Adopting either description results in a different assessment of what is ‘going on’ (Goffman 1974). Through the process of extracting meaningful clues present in the situation, it is determined which frame should be applied to a situation. As such, people perceive reality through the frames they apply and they use them to determine what is relevant and the manner in which to engage (Gitlin 1980:6, in:

Gray et al 2015). In other words: frames guide perception and steer action (Creed et al 2002:36).

Frames can draw on ‘logics’ to establish meaning: *logics*¹ are abstract cognitive concepts that consist of widely shared belief systems that provide meaning to the actions of individuals and organizations (Thornton and Ocasio 2008). Logics both determine and restrict the actions that are possible (Rao et al 2003): actors can draw and elaborate upon frames within the limits the underpinning logic delineates (Friedland and Alford 1991:248). An example of logics in the field of sustainability is provided by Heiskanen (2002), who conceptualises life-cycle thinking as an institutional logic that influences the way environmental problems are conceptualized and responsibilities allocated.

Frames and logics play a crucial role in change processes. A new frame-logic combination – or new frame for short – that is different from and that challenges existing frame-logic combinations, can open up solution spaces previously not recognised, not seen as relevant or not considered feasible. A *solution space* designates the (set of) solutions that are highlighted as realistic by a problem definition (Dorst and Cross 2001). (The proverbial: “To someone with a hammer every problem looks like a nail,” applies here. In this proverb, the “hammer” refers the frame, and the underpinning logic can be summarized as “hammers are to be used for applying nails.”) Through pointing towards alternate solution spaces, new frames have the potential to divert established courses into new directions. (Glue or a screwdriver may be required instead.) To affect change, the new frame has to successfully replace established meanings and become widely accepted (Benford and Snow 2000, Gray et al 2015).

In the context of industrial systems, it has been demonstrated that new frames can transform value chains, industries and markets (Rao et al 2003, Anand and Watson 2004, Benner and Tripsas 2012). Framing processes also have bearing on the waste and resource management discourse. The historical shifts in the perceived scope and purpose of waste and resource management – that is, from being oriented towards city sanitation and bolstering production to having sustainable development at its core (Blomsma and Brennan 2017), can be seen as instances where new ideas were successful in challenging established meanings with regards to what constitutes appropriate waste and resource management.

New frames exercise their transformative potential through operating at scale and enduring over time. In the context of waste and resources, the application of frames results in particular management practices to assert themselves and become established in industrial systems (Lounsbury et al 2003, O’Brien 2008, Boons 2009, Corvellec and Hultman 2012, Silva et al 2016). This involves a process referred to as *enactment*, where decisions and actions become aligned with meanings (Goffman 1974, Weick 1995). This results in the establishment of enabling infrastructure, the adoption of particular technologies, and the creation of dedicated executive and supervisory organizations and institutions. As a result of these enactment processes waste and resources come to flow in particular ways, as opposed to a range of alternative ways. Baumann (2012, 2014) and Hoffman (2003) describe

¹ ‘Logics’ is used as shorthand for ‘institutional logics,’ for reasons of simplification. The concept of institutional logics is well established within organizational science.

this phenomenon as the *embeddedness* of flows in social systems. Specifically, in the context of circular resource flows Boons and Howard-Grenville (2009) point out that industrial systems “do not self-organize automatically in such a way that loops are closed,” but that people shape these systems based on their perceptions and beliefs. To paraphrase: without people, no (industrial) flows.

2.2. *Collective action frames and their function*

Collective action frames (CAFs) are those frames that are deliberately wielded by one or more groups of people to address one or more specific problematized issue within a (part of) society. The new frames proposed by CAFs are intended to be, but may not yet be, widely shared within a (part of) society. Frequently, CAFs are used by *social movement organisations* (SMOs) – any organisation that aims to inspire action in order to address an issue. CAFs function as discursive instruments that help SMOs orient their audience towards a topic, and to free resources (time, money, attention, etc) for affecting the proposed change. See for examples of CAFs with societal relevance the nuclear disarmament movement Benford (1993) and the student revolutions in China (Zuo and Benford 1994). More recent work describes the role of frames in social media mobilization (Goh and Pang 2016) and bioenergy siting proposals (Eaton et al 2014)².

CAFs perform their function by rendering the presence or absence of something meaningful and creating an ‘action recipe’ for changing the current situation (Benford and Snow 2000, Gray et al 2015). Specifically, CAFs have three characteristic functions: punctuation; elaboration, divided in the sub-functions diagnosis and prognosis; and motivation (Creed et al 2002). These functions can be seen as a series of steps, as each step is contingent on the preceding one, see Figure 1 (left). The steps are as follows: 1) problematize an issue of importance, 2) diagnose the cause of the identified problem, 3) propose a course of action to address it and 4) name actors that should remedy the situation.

2.3. *Waste and resource CAFs*

The 10 frameworks reviewed in this paper can be thought of as CAFs with applicability in the domain of waste and resource management. That is: these frameworks point out the salience of waste and resource management and identify (part of) current waste and resource management practices as inappropriate. In addition to this, they propose new practices, as well as discuss who is called upon to take a proactive role in addressing the situation. As such, the structure of waste and resource CAFs follows the general structure of CAFs. How this structure applies to these frameworks is discussed below. First, however, the methodology for selecting the 10 frameworks is introduced, including an overview of the frameworks thus selected. How the frameworks draw on various ‘logics’ features in the subsequent section.

² CAFs are a well-known and widely researched phenomenon within the field of sociology.

Structure of collective action frames (CAFs)

Figure 01 Schematic overview of how waste and resource CAFs (right) draw on the general CAF structure (left). What is depicted are the steps that both generic and waste and resource CAFs go through to devise suggested 'action recipes.'

3. Method and selection of waste and resource frameworks

Ten frameworks were selected for analysis. The first group forms the basis of the CE framework proposed by the Ellen MacArthur Foundation (EMF 2013), which is currently the most well-known interpretation of CE. The choice was made to look at the constituting frameworks of this interpretation, in order to understand how different frameworks can be expanded upon and combined. The synthesised framework does not feature separately, but is examined in the discussion section. Thus included are: Cradle-to-Cradle™ (Braungart and McDonough 2002), Blue Economy (Pauli 2010), Performance Economy (Stahel 2006), Regenerative Design (Lyle 1994) and Industrial Symbiosis (e.g. Lowe and Evans 1995)³.

The second group of frameworks was added through following a snowballing approach as a result of the historical work described in Blomsma and Brennan (2017), which traced the emergence of the circular economy concept from the second industrial revolution to the present. Frameworks included here stem from the period described in this work as the 'excitement period' that lasted from about 1985 to 2013, and which is identified as a period in which many waste and resource frameworks with the CAF format were created. Thus included are: the Waste Hierarchy (EC 2008), The Natural Step (Robèrt 2002), Sustainable

³ Please note that these frameworks are not equated to academic fields. That is: Industrial Symbiosis does not represent the sub-field of Industrial Ecology also known as Industrial Symbiosis, in the same way that Cradle-to-Cradle™ does not refer to the field of green chemistry. Rather, Industrial Symbiosis, as used here, refers to the core ideas of facilities exchanging waste – which is the idea at the heart of the academic field of Industrial Symbiosis, but further elaborated upon within this field.

Materials Economy (Geiser 2001), Product Life Cycle System (EPA 1993) and Material Efficiency (Allwood et al 2011).

The following criteria were applied for selecting frameworks in the second group:

- 1) a large role is assigned to resource productivity or circular strategies;
- 2) the framework is codified by means of a set of heuristics or principles;
- 3) the framework is linked to a conceptual diagram that visually explains the framework's vision for waste and resource management;
- 4) the framework is of a generic character covering the industrial system and economy and not case, company or industry specific;
- 5) documentation was (also) available in the public domain; that is, an attempt was made at wider dissemination of the framework;
- 6) sufficient documentation describing the framework was available, to be able to fully capture the nuances in the proposed vision⁴.

Excluded were conceptual frameworks that are more appropriately thought of as 'schools of thought,' such as industrial ecology (Frosch and Gallopoulos 1989) or natural capitalism (Hawken et al 1999), as these do not offer the specificity that the diagrams and heuristics in the selected frameworks do. Excluded also are (design) philosophies such as biomimicry (Benyus 1997), which invoke circularity as a principle but that do not contain a systematic approach to it.

Table 01 provides an overview of the 10 selected frameworks. Where available, multiple sources were used to build a complete picture of the framework: see Figures 2 to 5 for an overview of the sources consulted. The purpose here is not to provide a comprehensive overview of all waste and resource management that have ever existed, but to illustrate how such frameworks produce meaningful interpretations of waste and resource management. The included set was judged sufficiently large and diverse for meaningful contrasting and comparing to be able to highlight similarities as well as differences in how they arrive at their respective 'action recipes.'

Next, two analysis and results sections follow. Through critical analysis, it will be shown how the concepts outlined in the previous section – 'collective action frames' and 'logics' – apply to waste and resource frameworks and what role these concepts play in such frameworks. The first section discusses how the CAF structure applies to the waste and resource frameworks. The second section examines – through the development of the *waste and resources grid* – the underpinning logics of the frameworks in terms of the underpinning definitions regarding what constitutes 'waste' and what a 'resource'.

⁴ Not every framework or diagram has sufficient 'depth' underpinning it, rendering any interpretation of it speculative.

	Description of included waste and resource frameworks
Featuring as input for the EMF's CE framework	Regenerative Design John T. Lyle was a landscape architecture professor and systems thinker. Lyle, inspired by emerging ideas and philosophies around sustainability during the 70's and 80's, worked with his students and colleagues to create 'community support systems' that use on-site resources, operate with renewable energy, and work with biologically based processes. The lessons learned resulted in the 1994 publication of <i>Regenerative Design</i> .
	The Blue Economy His previous experiences as an entrepreneur taught Gunter Pauli that "biodegradability and renewability do not equate sustainability" (Pauli 2010:xxvi). His subsequent search for what sustainability entails resulted in the formulation of the Blue Economy, based on principles formulated by the Zero Emissions Institute (ZERI). The associated publication <i>The Blue Economy</i> (Pauli 2010) was designated a Report to the Club of Rome. Blue Economy has a focus on the provision of basic human needs.
	Cradle-to-Cradle™ Cradle-to-Cradle™ comprises an inspirational vision, analytical framework and prescriptive certification programme for product design and material composition. The framework was born from the cooperation between chemist Michael Braungart and architect William McDonough. An outline of the ideas contained within this framework can already be found in the Hannover principles (McDonough 1992), published a decade before the seminal <i>Cradle-to-Cradle: remaking the way we make things</i> (Braungart and McDonough 2002).
	Performance Economy Various iterations of Stahel's thinking since he co-authored the 1982 publication of <i>Jobs for Tomorrow</i> (Stahel and Reday-Mulvey 1981) eventually culminated in the 2006 publication of <i>The Performance Economy</i> . The Performance Economy is a framework and inspirational vision targeted at businesses and policy makers alike that proposes a focus on utility, performance and radical efficiency, as opposed to product ownership.
	Industrial Symbiosis A sub-field of Industrial Ecology (Chertow and Park 2016), Industrial Symbiosis is not associated with a single organization or a specific person as its advocate, although the first academic article on Industrial Symbiosis is generally attributed to Lowe and Evans (1995). Instead, the case study of Kalundborg in Denmark fulfils the role of icon or illustrative symbol: referring to the material and energetic by-product exchanges between the industrial facilities located there (Kalundborg Symbiosis 2014).
From snowballing from historical review	The Natural Step The Natural Step framework is the result of a consensus building effort among Swedish scientists, led by oncology doctor and researcher Karl-Hendrik Robèrt. In 1989 this culminated in the founding of what has grown into an international non-profit, that advice, outreach and education services. The essence of the approach are its techniques for dialogue and the 'backcasting' method, where a projection into the future is made to plan backwards from.
	Sustainable Materials Economy Kenneth Geiser's book <i>Materials matter: towards a sustainable materials policy</i> (Geiser 2001), is the result of a personal encounter with victims of a factory tragedy and the ensuing quest to prevent such disasters from occurring in the future. The work contains evidence in support of both the necessity and the feasibility of such policies. Prof Kenneth Geiser held a chair at University of Massachusetts Lowell.
	The Waste Hierarchy The Waste Hierarchy, based on Lansink's Ladder developed in the 1970s (Kemp and Van Lente 2011), was included as part of the European Waste Directive: a legislative framework for dealing with non-hazardous waste that defines key waste related concepts and responsibilities for member states (EC 2008). The Waste Hierarchy is often referred to as '3R,' because colloquially it is referred to as 'reduce, reuse and recycle.' The directive encourages application of the Waste Hierarchy, but does not enforce it.
	Product Life-Cycle System Developed as part of the Pollution Prevention Research Program, the Product Life-Cycle System framework suggests the means of cycling as proposed in the Environmental Protection Agency's <i>Life Cycle Design Guidance Manual</i> (EPA 1993). This document is generally regarded as an early eco-design manual.
	Material Efficiency Material Efficiency codifies the insights of a 5-year collaborative research project with industry, led by industrialist-turned-scholar Julian Allwood (Allwood et al 2011, Allwood and Cullen 2012). The framework is primarily concerned with engineering materials: the materials used in bulk in buildings, infrastructure and goods, such as steel and aluminium, but also paper, cement and plastic.

Table 01: Short description of the included waste and resource frameworks.

4. Analysis and results part I - Waste and resource frameworks as CAFs

Figure 1 (right), gives an overview of how the general CAF structure is adapted by waste and resource CAFs. How this structure is filled in by the 10 frameworks individually, is summarised in Figures 2 to 5. To aid comparison of the flow diagrams in these images, the original branding and layout was replaced with a uniform visual language that preserves the original strategies and their relationships⁵.

The following illustrates the general applicability of the CAF structure to waste and resource frameworks.

4.1. 'Punctuation' and 'diagnosis', or 'purpose' and 'mechanism'

Starting with punctuation, termed 'purpose' in the context of waste and resource CAFs, all frameworks point to the presence of certain problems or the absence of particular benefits in the context of waste and resource management. However, individual frameworks focus on different (sets of) problems or benefits, thus defining their purpose in different ways. For example: the Blue Economy poses that hunger and unemployment need not exist and that all basic human needs can be provided for by handling waste and resource in a different manner. This purpose is very similar to that pursued by Regenerative Design, which focusses on providing the necessities of daily life: energy, shelter, water, food and waste processing. In contrast, The Natural Step framework, defines the purpose of waste and resource management as 1) preventing waste from systematically accumulate in nature, and to 2) reconstitute material quality. The Waste Hierarchy, on the other hand, focuses on the reduction and avoidance of environmental harm and landfilling. Although not mutually exclusive, these are different ambitions.

In the 'diagnosis' step the included frameworks identify what, in the view of their proponents, needs to change about the workings of the economy and/ or industrial systems. Laid bare is a high-level 'mechanism' for orchestrating flows in a different manner. For example, Industrial Symbiosis proposes to match industrial input and output to the carrying capacity of the earth by optimizing manufacturing systems through the reintroduction of relevant relationships between production facilities.

In contrast, the Performance Economy suggests that a variety of issues among which stagnating levels of wealth and growth and excessive resource consumption can be solved through the implementation of radical performance improvements, by focusing on utility and radical efficiency. The underlying thought here is that through focussing on outcomes and results, it becomes possible to find different ways of achieving goals, but with radically less resources used in the process. That is: the Performance Economy proposes a reorientation of the mind-set of businesses, designers, R&D and engineers. In a similar vein, Regenerative Design suggests a mind-set change, where, instead of placing humans outside of nature, humans are seen as an integral part of nature. This implies that human

⁵ The exception to this is the diagram for the Blue Economy: Gunter Pauli does not provide a general conceptual diagram in The Blue Economy (Pauli 2010). Instead, this diagram is based on the waterfall metaphor he uses and the format used in the diagrams that accompany his case descriptions. Figures 2, 3 and 4 are from Blomsma (2016). Used with permission.

development needs to be better integrated in the environment, through the appropriate design of infrastructure such as buildings.

Cradle-to-Cradle™, on the other hand, poses that the problem is a “materials-in-the-wrong-place problem,” and that materials simply need to be directed to their proper processing metabolisms. This can be achieved through the use of materials appropriate for different cycling mechanisms and by adjusting product design. Because ‘purpose’ and ‘mechanism’ are closely intertwined they are grouped under a single header in Figures 2 to 5.

4.2. ‘Prognosis’, or ‘prevention’ and ‘perpetuation’

Typically, a comprehensive set of heuristics in the form of a list of guidelines or principles, provides the basis for selecting waste and resource management strategies. These heuristics embody a CAF’s ‘prognosis’ function. The proposed strategies often consist of two main categories, depending on the framework: preventative strategies, and those that can be designated as looping or cycling, labelled respectively as ‘prevention’ and ‘perpetuation.’

‘Prevention’ refers to strategies that forestall resource use, such as efficiency measures and functional replacement, or measures that prevent harmful effects, such as the choice for non-toxic materials. Prevention plays an important role in frameworks like the Blue Economy, Waste Hierarchy and the Performance Economy: in these frameworks, the reduction of resource use is prioritized over cycling strategies. In other frameworks, such as Cradle-to-Cradle™, prevention through reducing the magnitude of flow plays a minor role⁶. However, this framework stresses the importance of using non-toxic materials as a way of reducing harm. Regenerative Design and The Natural Step similarly highlight the importance of safe re-assimilation of wastes in the biosphere.

‘Perpetuation’ refers to strategies that facilitate the preservation of resources for subsequent use. Cradle-to-Cradle™, for example, emphasizes recycling and composting of materials as ways to preserve industrial “nutrients,” where Industrial Symbiosis emphasizes material and energetic exchanges between industrial facilities. Blue Economy expands on the scope of Industrial Symbiosis, by proposing substance cascading⁷ as a general operating principle for manufacturing firms. That is: firms should, through the controlled transformation of inputs, generate multiple outputs and benefits. Other frameworks propose that a variety of cycling strategies supplement each other, such as Product Life-Cycle System, Material Efficiency, Performance Economy, Waste Hierarchy, The Natural Step and Regenerative Design. Usually this consists of a mix of two or more of the following: direct reuse, redistribution, remanufacturing and refurbishment, upgrading, alternate use, the reuse of parts and the reuse of materials through recycling (mechanical or otherwise), substance cascading or energy recapture (incineration).

For the elaboration step, half of these frameworks look at nature for inspiration. They see nature as either as a model for emulating (Industrial Symbiosis) or as a provider of (benign)

⁶ As with CAFs, the waste and resource management CAFs can contain counter-framings. These consist of the negative portrayal of other frames, resulting in a deliberate oppositional placement of the two frames. Cradle-to-Cradle™’s portrayal of eco-efficiency as ineffective is an example of this. For this work, counter-framings are considered out of scope.

⁷ The term ‘substance cascade’ is used here to distinguish material cascading from that of ‘product cascading’ (Stahel 2006).

processes and/ or materials (Blue Economy), or both. In case of the latter, a compromise is proposed that acknowledges that natural processes and/ or materials can be used where possible, but that their application in industrial systems requires adaptations. Examples of these frameworks are Cradle-to-Cradle™, Regenerative Design and The Natural Step.

4.3. 'Motivation', or 'proaction'

Lastly: the 'motivation' step, or 'proaction' as it is termed for waste and resource CAFs. The Blue Economy, Cradle-to-Cradle™ and The Natural Step see business as a primary actor, as it is thought to be in business' self-interest to exercise custodianship over the inputs that enable businesses to exist in the first place. Within the business environment Cradle-to-Cradle™ targets designers specifically, as can be deduced from their conceptualisation of the issue as a 'design problem.' Blue Economy and The Natural Step, on the other hand, focus more on the executive and strategy level of businesses.

Industrial Symbiosis also has a focus on business, but on a specific part of the value chain: on manufacturing facilities, their managers and other stakeholders in industrial facilities, such as planners and regions. Instead, Regenerative Design places an emphasis on system and infrastructure design, and thus on the involvement of those in planning and landscape architecture professions. Sustainable Materials Economy and Material Efficiency, on the other hand, pose that a myriad of actions by many parties are required to achieve more sustainable waste and resource management. This may involve consumers, business, legislators, NGOs, etc.

The above has shown how waste and resource CAFs use the general CAF structure to build internal coherence around a proposed set of actions that a specific audience is meant to execute. In summary: the included waste and resource frameworks can indeed be regarded as CAFs. Examined next, is the role of 'logics' in the selected frameworks.

Waste and resource management collective action frames - part I

Product Life-Cycle System (PLCS)

sources: Environmental Protection Agency (1993)⁶

Performance Economy (PE)

sources: Stahel (2006)⁶, (2014)⁶, Stahel and Clift (2016)⁶.

Material Efficiency (ME)

sources: Allwood ET AL (2011), Allwood and Cullen (2012)⁶

Figure 02 Overview and summary of Product Life-Cycle System, Performance Economy and Material Efficiency frameworks.

Waste and resource management collective action frames - part II

The Blue Economy (BE)

sources: Gunter Pauli (2010)⁶, (2012)⁶

Cradle-to-Cradle™ (C2C)

sources: Braungart and McDonough (2002⁶), McDonough and Braungart (2013⁶), Braungart ET AL (2007)

Sustainable Materials Economy (SME)

source: Kenneth Geiser (2001)⁶

Figure 03 Overview and summary of Blue Economy, Cradle-to-Cradle™ and Sustainable Materials Economy frameworks.

Waste and resource management collective action frames - part III

Waste Hierarchy (WH)

sources: EC (2008)⁶, DotE (1995)⁶

Industrial Symbiosis (IS)

sources: e.g. Lowe and Evans (1995), Korhonen (2005), Chertow and Park (2016)⁶

Figure 04 Overview and summary of Waste Hierarchy and Industrial Symbiosis frameworks.

Waste and resource management collective action frames - part IV

The Natural Step (TNS)

Eriksson & Robèrt (1991), Robèrt (199X)⁶, Natrass & Altomare (1999)⁶, Cook (2004)⁶, Broman & Robèrt (2017), thenaturalstep.org^{6*}

*Accessed: April 2018.

Regenerative Design (RD)

sources: Lyle (1994)⁶

Figure 05 Overview and summary of The Natural Step and Regenerative Design frameworks.

5. Analysis and results part II - Logics and waste and resource CAFs

This section introduces the *waste and resources grid*, which is based on the two types of 'resource' and the two types of 'waste' that are present in the selected frameworks. First, the two types of waste and the two types of resources acknowledged in the frameworks are introduced. Next, these are combined in a grid-based typology. This is followed by a discussion of how the respective logics apply to the included frameworks. Lastly, in a critical analysis it is shown that it is important to acknowledge the existence and joint use of these logics, as their different use leads to different interpretations of individual cycling strategies⁸.

A typology based on 'waste' and 'resource'

In the context of CE, a 'resource' is a valued thing of physical nature which is considered worth preserving for continued value extraction or because its preservation prevents (further) value loss or destruction (Blomsma and Brennan 2017). What constitutes a *resource* is typically defined in one of two ways⁹. First, it can be defined as a collection of elements, particles, molecules and (mixed) substances, often simply referred to as a 'material.' In contrast, a resource can also be defined from the perspective of a specific physical form from which an end-user can extract value. This type of resource is typically labelled as a 'good' or 'product.'

Generally, 'waste' can take one of two forms¹⁰. First, a resource can be considered wasted when it is not renewed. This describes situations where the means exist to restore or rejuvenate a resource in a manner that re-establishes its functionality in relation to a fixed or evolving quality level. That is: a limiting state – the occurrence of functional, stylistic or other constraints – can be prevented, undone or reversed. To neglect the execution of such renewal means that value is lost unnecessarily and thus that waste is created. To prevent such open ended or wasted life-cycles, strategies can be used that turn end-of-use/ life into new or extended life, which is usually not (significantly) different from the previous life. For example: end-of-life materials can be returned to a virgin-like state as advocated by Cradle-to-Cradle™, or broken products repaired, refurbished or remanufactured to restore them to functional use as the Performance Economy and Material Efficiency propose.

A second type of waste occurs when resource capacity is not exhausted, fully consumed or 'used up.' This covers situations where more value or utility may be extracted from the resource by changing or allowing for an evolution in the definition of 'quality.' After all, the end-of-use/ life of a resource in a particular context does not have to be the end of value extraction from that resource altogether: there may be other uses or contexts where the resource can continue to deliver value.

Examples of strategies that prevent wasted life cycles from occurring are material and product cascades, where the quality of the resource is appropriately matched to not exceed the minimum quality level required in each subsequent use phase as suggested by the Blue

⁸ The focus is on resource productivity or cycling strategies: preventative logics are out of scope for this work.

⁹ The interested reader can find more information on 'resource states' in Blomsma (2016). Here, a distinction is made between three resource states, that of materials or particles, parts and subassemblies and products. For reasons of simplicity, only materials and products are discussed here.

¹⁰ Used here are two expressions inspired by and adapted from Lacy and Rutqvist (2015).

Economy and the Performance Economy. The latter framework also includes sharing and pooled use as other examples of strategies that can serve to better use otherwise un- or underused capacity of products.

The ‘resource consumption’ perspective differs from the ‘resource renewal perspective’ in that it does not require restoration or improvement of quality levels. In fact, a (controlled) transformation, deterioration or redefinition of the resource ‘value,’ ‘quality’ or ‘utility’ may be involved¹¹.

These different definitions of waste and resources are not mutually exclusive. Rather, they co-exist and can therefore be depicted as a matrix, see Figure 6 (top). This creates four strategy categories: ‘Closed loops,’ ‘Extended loops,’ ‘Long life loops’ and ‘Intensifying loops.’ To implement ‘closed loops’ strategies means that materials are contained within or return to cycles that preserve or restore their quality levels. ‘Extend loops’ extract more value from materials through controlled transformations that exhaust or ‘use up’ a material’s capacity to deliver value. ‘Long life loops’ serve to extend value extraction possibilities from a product. Strategies in this category serve to keep a product performing on consistent or evolving standards of performance. ‘Intensifying loops’ allows for tapping into un- or underused capacity of a product, and includes strategies that facilitate the subsequent use of a product for either its intended purpose or for alternate purposes. See for more explanation on the strategies covered by each category Figure 6 (top).

5.1. ‘Logics’ as used by the waste and resource CAFs

Figure 6 (bottom) illustrates the emphasis the 10 frameworks put on the different waste and resource categories. Frameworks that have a particularly strong affinity with resources as ‘materials’ are Industrial Symbiosis, Cradle-to-Cradle™, Blue Economy, Sustainable Materials Economy and The Natural Step. However, to a lesser degree Cradle-to-Cradle™¹² also discusses cascading; and Blue Economy, as well as emphasising cascading, also highlights the importance of cycling materials in the biosphere. Sustainable Materials Economy has a somewhat broader scope by also including product oriented strategies. Frameworks that place a strong emphasis on resources as ‘products’ are Material Efficiency and Performance Economy, although strategies aimed at materials also feature.

Frameworks that have a particularly strong focus on combatting waste as a result of a lack of resource renewal are Cradle-to-Cradle™, Material Efficiency, Sustainable Materials Economy, Regenerative Design and The Natural Step. In contrast, frameworks that have a strong focus on combatting wasted capacity are Industrial Symbiosis and Blue Economy. Performance Economy emphasises combatting both types of waste equally. The Waste Hierarchy and Product Life-Cycle System both seemingly point to a broad solution space, across the four categories, without a particular emphasis.

¹¹ See for a comprehensive explanation of material and product cascades: Sirkin and Ten Houten (1994).

¹² In the updated version of the framework, see McDonough and Braungart (2013).

Waste & Resources Grid

Emphasis of waste and resource collective action frames

Figure 06 Waste and resources grid (top), with mapping of waste and resource CAFs' focus (bottom).

5.2. Why 'logics' and their application context matter

Why is it important to acknowledge the existence and joint use of these logics? This is because logics do not function independently: a specific strategy takes on its function *in relation* to the other strategies that a framework encompasses, the relationship that is said to exist between the strategies and the logic's application area. To illustrate this, one has but to look at the role different strategies play within these frameworks. Take, for example, recycling. In the Waste Hierarchy recycling is applied when the best practical environmental option demands it, even if this leads to a significant degradation of the material's chemical or performance characteristics. That is: within the Waste Hierarchy both the preferred order and the feasibility of application are considered, with the latter overruling the former. As such, 'downcycling' – i.e. the use of a material in a manner that is considered somehow 'lesser' than its preceding use – is acceptable within the Waste Hierarchy framework.

However, according to Cradle-to-Cradle™, downcycling is to be avoided. This framework primarily advocates two types of cycling: cycling within the biosphere or composting, and cycling within the technosphere or recycling. As recycling is one of the two major mechanisms for cycling, the goal is to achieve (near) infinite cycling¹³. This means that recycling should lead to the restoration of recycle to a virgin-like state, or as close to this state as possible.

The Performance Economy, on the other hand, positions recycling as taking place after a succession of other strategies, such as reuse, upgrading, remanufacturing and refurbishment. At every subsequent stage value is preserved and/ or generated. When recycling comes into play, it is one of the few options remaining to recapture any residual value whatsoever. As such, within these three frameworks, recycling fulfils a very different role: although the same label is used to describe it, 'recycling' is envisioned to lead to very different outcomes.

As well as the combined use of different logics, the application context of logics also matters. For example: cascades play an important role in both Industrial Symbiosis and Blue Economy. However, Industrial Symbiosis is targeted at industry facilities and Blue Economy at the strategic level of businesses. As such, cascading fulfils a different role within both frameworks: within Industrial Symbiosis it is used to describe the continued use of substances within industry networks, and within Blue Economy it describes the strategy of deriving more value from material uses through controlled transformations of substances within the boundaries of an organisation.

As such, it is important to recognise that the frameworks can draw on one or more logics and that their combination as well as their application area can lead to different interpretations of individual cycling strategies and their respective roles.

6. Discussion

¹³ See Cullen (2017) for a comprehensive critique on the notion of perpetual cycling.

In the theoretical background, it was shown that CAFs are important instruments in societal change processes. Section 4 showed that the included waste and resource frameworks can indeed be considered to be CAFs. This implies that frameworks of this type have an important function in orienting audiences towards the importance of appropriate waste and resource management and in outlining possible interventions on the level of industrial systems and economies. This has a number of implications for academics and practitioners active within the CE.

First, for opportunity finding in immediate practical situations, the work discussed in this paper can be used to assess a considered framework's suitability in a given context. This can be done by examining its structure and by making explicit the argumentation used in the CAF steps. Furthermore, the *waste and resources grid* can be used to determine whether the considered framework covers appropriate circular strategies, based on the type of resources that are considered and the type of waste that is expected to be encountered in the application context.

A second implication is that, within academia, the purposeful construction and development of waste and resource frameworks should be seen as a serious task in its own right. This means that the following questions should be further explored: How can resonant frameworks be developed? How widely should they resonate and for what audiences? In relation to existing frameworks it means that it should be interrogated if, when and how CAFs should be elaborated upon and synthesised.

Such elaboration and synthesis is already ongoing. For instance, Cradle-to-Cradle™ explicitly included cascading as a cycling strategy in the second version of the framework. However, accompanying conceptual diagrams were not updated to reflect this. Another example is the synthesis performed by the Ellen MacArthur Foundation, which synthesised at least five frameworks into a single CAF (EMF 2013). However, in this effort the precise meaning of individual strategies could benefit from clarification. As was discussed above, 'recycling' fulfils a different function in the Performance Economy and Cradle-to-Cradle™, and both meanings seem to have been embraced by the EMF framework. Moreover, the term 'regeneration' – borrowed from Regenerative Design – is used as a much more widely encompassing term than in Lyle's framework, who mainly focusses on (building) utilities. These points raise issues of how best to achieve meaningful synthesis, how to resolve conceptual differences between included terminology and how to resolve the critique on the individual frameworks. The CAF structure and the *waste and resources grid* discussed in this paper can be used as a basis for such interrogations, as they provide a means to unpick the argumentation underpinning a framework, as well as serve as a basis for identifying potentially conflicting and complimentary logics.

Another set of relevant questions in relation to the development of CAFs is to understand what makes frameworks endure and exercise their influence over time. CAFs are not static entities: their meaning is continuously negotiated. A case in point is the Waste Hierarchy. Looking at earlier interpretations of this framework (see: Lansink's Ladder, but also DotE (1995)), it has broad applicability. However, it became a much narrower framework due to the way it was operationalised (Bulkeley and Gregson 2009), and was subsequently regarded

as a framework targeted primarily at manufacturing and waste treatment activities. This raises the question of how frameworks can be designed to be truly transformative, and what processes lead to frameworks fulfilling their transformative potential.

Salient questions also arise in relation to the suitability of CAFs for particular levels and contexts, and how these can best be linked to other frameworks that facilitate operationalisation. CE has applicability to the nano, micro, meso and macro levels, as well as covers a wide range of activities along the life cycle and value chain (Saidani et al 2017, Ghisellini et al 2015, Kirchherr et al 2017). Efforts are ongoing to link the CE concept with circular business models (e.g. Ludeke-Freund et al 2018), circular metrics (e.g. Saidani et al 2017) and circular design practices (e.g. Moreno et al 2016, Mestre and Cooper 2017). This raises the question of how an ecosystem of CAFs and operationalising frameworks can be created that engages with the full complexity of circular economy. Important in this respect is that (dangerous) over-simplification is avoided (Murray et al 2017) and that relevant audiences are assisted with unpacking complexity in a suitable manner (i.e. frameworks are sensitive to the audience background and application context, the time investment required for application of the framework(s), and information and considerations are structured and layered as to prevent overwhelming audiences).

7. Conclusion

This paper made a connection between framing and waste and resource frameworks, posing that such frameworks can be conceptualised as collective action frames, or CAFs. This means that such waste and resource frameworks point out the salience of waste and resource management. In addition to this, they draw attention to the fact that waste and resources could be managed in a different, more sustainable manner. They furthermore propose new practices, as well as discuss who is called upon to realise the proposed change and articulate why these stakeholders should act. It was furthermore shown how such frameworks draw on different definitions of 'waste' and 'resource,' and that they can constitute of different mixes of these 'logics,' which leads them to identify and put emphasis on different types of strategies.

A case was made for the careful consideration, creation, use and further development of such frameworks. By having illustrated the applicability of the concepts of CAF and logics, as well as the construction of the *waste and resource grid*, this paper has contributed to the creation of a language and conceptual toolbox, that can be used to reflect upon the use of such frameworks or further develop and improve them.

As such, this paper has expanded on earlier work that observed the existence of many waste and resource frameworks (e.g. Blomsma and Brennan 2017, Reike et al 2018) by providing an in-depth discussion of directions for further developing the CE concept into a robust concept. It is my hope that this facilitates a constructive and appropriately critical debate around the CE concept, that supports its function as a catalyst for change.

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