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Characteristics of a circular economy framework to support strategic renewal in manufacturing firms

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Abstract

Circular economy (CE) is one of the most discussed topics in academy and industry. Yet, the vastness of the subject can easily distract the discussions and cause incoherence to CE related plans and solutions. To assist in these challenges several frameworks and conceptual structures have been created. In this paper, we compare different CE frameworks from literature and evaluate their suitability to assist manufacturing companies in their strategic development work that aims for transformations towards CE. As an outcome, we propose synthesized guidelines for developing a CE framework, which would better support firms' strategic decision-making and growth in CE.

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1. Introduction

Sustainability has been the hot topic of research community, industry and policy makers for two decades now. Although certain principles of circular economy (CE) originate from 1970s [1], CE has gained major attention as a sustainability enabler only quite recently. As in sustainability, the impact of CE is typically evaluated through economical, ecological and social dimensions.

Our article focuses on the technical cycle of CE and more accurately, we approach CE from the perspective of discrete manufacturing firms. However, majority of research is focusing on the ecological dimension of CE [2], which may cause firms to see CE as a constraint instead of potential source of growth [2]. In addition, wide array of literature on so-called circular business models (CBM) focus in studying how to manage and benefit from waste instead of paying attention on more value added approaches aiming to change the way that products and services are offered for customers [3].

The goal of our paper is two-folded. First, we evaluate, how fit the existing CE frameworks are to support firms' growth in

CE. In another words, how well the frameworks clarify the business potential in CE, and whether or not the requirements for successful business are clarified in terms of capability requirements and strategies. Second, we propose guidelines for CE framework development where the aim is to support firms' strategic decision-making and growth in CE.

Next chapter explains the methodology of our research. The third chapter is a literature review, which results as a concept for framework evaluation. In the fourth chapter we identify and compare existing CE frameworks. The fifth chapter presents a synthesized set of characteristics a CE framework should have in order to support strategy formation (SF). The final chapter concludes the paper and gives recommendations for future work.

2. Methodology

Our first goal concerns the evaluation of the existing CE business models. For this purpose, we create a concept that systematically evaluates the frameworks. To reach these goals we need to answer the following research questions (RQ):

RQ1. What kind of concept fits for CE framework evaluation from strategic business renewal perspective?

- a. *What are the elements of the concept?*
- b. *How these elements relate to each other?*

RQ2. What are the maturities of the existing? CE frameworks in relation to the evaluation concept?

To answer RQ1 we conducted a literature review to identify relevant concepts from the perspective of strategic level business renewal and to find out how these concepts are linked to each other. Based on these findings we created a concept simple enough to evaluate systematically multiple CE frameworks.

To answer RQ2 we were able to identify 29 CE frameworks, which in principle are suitable for supporting business development in discrete manufacturing industry. From this list, 14 frameworks were chosen to be evaluated by our evaluation concept (RQ1). From those frameworks, nine are from academic literature and rest from various public or semi-public actors.

Our second goal is to identify framework characteristics to be considered during method development of CE frameworks that aim to support firms' strategic decision-making and growth in CE. For this purpose, we need to answer following question:

RQ3. Based on our findings from evaluation, what characteristics should be in a framework, which would better support firms' decision making and growth in CE?

To answer RQ3 we conducted a synthesis, which includes a combination of most fitting elements from the evaluated frameworks.

3. Literature review

3.1. Business models

BM has various meanings in management literature as well as in practice. Zott et al. [4] found out in their literature review that BM has been referred e.g. as a statement, description, conceptual tool or model, and method. However, despite the variance in definitions, various authors agree that BMs' one main purpose is to explain customer value generation and value capturing [4]. Chesbrough [5] suggested that BMs should fulfil the following value creation and capturing related functions:

- Articulates the value proposition
- Identifies a market segment and specifies the revenue generation mechanism
- Defines the structure of the value chain required to create and distribute the offering and complementary assets needed to support position in the chain
- Details the revenue mechanism(s) by which the firm will be paid for the offering;
- Estimates the cost structure and profit potential

- Describes the position of the firm within the value network linking suppliers and customers
- Formulates the competitive strategy by which the innovating firm will gain and hold advantage over rivals

Although BM has a stand on similar aspects as strategy, BM is more generic concept than strategy and can be relatively easily imitated [6]. According to Zott et al. [4], unlike strategies the BMs do not typically explain e.g. the actual mechanisms of value creation or market segmentation, evaluate offering differentiation or cost leadership, or define the activity systems of organization. Nevertheless, from single firm's view it is not usually relevant under which concept the business is planned as long as required plans and directions are created to do profitable business.

3.2. Strategy

As Minzberg [7] wrote, strategies typically form through two main processes. The strategy can be formulated through a conscious process, which typically results as a plan that guides the future actions of the organization. On the other hand, the process or the outcome may not be that explicit. Strategy can form also gradually in which case strategy can be defined as an "evolved, a posteriori consistencies in decisional behavior" [7]. Although the latter definition occasionally reflects the actual situation in SMEs, we choose to focus on the former approach for two main reasons. First, as we review the explicit CE frameworks it is natural that the strategy process to which they are reflected is also explicitly described. Second, we believe that the transformation towards CE requires commitment from several functions and individuals in the organization, which can be supported by having explicit information and transparency in the strategic processes. That said, it is natural that in most real-life cases both approaches co-exist, meaning that decisions are made based on plans but also on decisional behavior.

3.3. Resource-based view

The paradigm of industrial organization focuses on the linking successful strategies with external business environment [8]. However, the changes in environment are faster, more unpredictable and larger than before [9]. This means, that focusing solely on the threats and opportunities of the environment may cause organization to lose its competitive advantage because of not being able to benefit from its cumulated capabilities. The resource-based view (RBW) emphasizes the role of resources and capabilities as the source of competitive advantage and encourages organizations to choose a strategy that fits its core competencies [8, 10]. This means that organization should aim to benefit from its core competencies to gain competitive advantage.

However, in real-life, firms are not in either-or situation between outside-in or inside-out thinking. Good example of an approach that combines both perspective is the concept of dynamic capabilities (DC). In DC, the main emphasis is on explaining the sources for gaining sustainable competitive advantage through capabilities, which are dynamic by their nature [6]. In DC, sensing external changes, threats and opportunities, is seen as one of the capabilities [6]. In other

words, the level or maturity of sensing capability defines how well a firm understands changes in its environment. Together with other two main DC's (seizing and managing threat/transforming) the firm can exploit opportunities in its business environment successfully. Unlike BM, the capabilities are also often extremely complex and thus hard to imitate, which makes RBW a valid concept for gaining sustainable competitive advantage.

3.4. Linking Business Models, Strategy and Capabilities

In chapter 3.1, 3.2 and 3.3 we shortly presented the concepts of BM, strategy and resource-based view. From these three business management concepts, we conducted the framework presented in Fig. 1. The framework presents definitions for the concepts and relations between them in such a way and level of detail in which we believe to be suitable for a business renewal. It also gives an answer to RQ1.

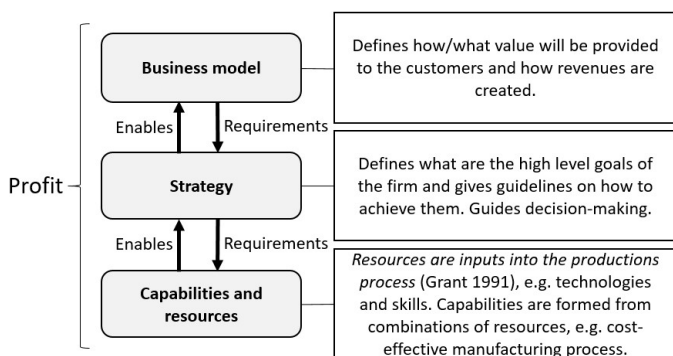


Fig. 1. A concept for framework evaluation.

From the framework in Fig. 1, we conducted the following criteria in table 1 for evaluation of CE frameworks' suitability to support firm's transformation towards CE:

Table 1. Evaluation criteria for CE frameworks.

Fit for identifying business models	Fit for forming a strategy	Fit for capability development	Indication symbol
BMs describe value propositions, value creation, value capture and revenue mechanisms	Strategical goals and strategical means are described	Capabilities are described in forms of core competencies and in causal relation to BMs or strategies	++
Circular economy concepts are described that can be interpreted as BMs	Descriptions support strategy formation to some extent	Capability requirements are described to some extent	+
No BMs are described	No contribution to strategy formation	No description of capability requirements	0

Although the previous criteria seem to give clearly defined definitions and criteria for CE BM evaluation, we are aware that in literature or in practice the terms are not as clear-cut. Especially the interfaces between strategic goals and BMs, and strategic means and capabilities are often somewhat blurry. Nevertheless, in this research orientation, we emphasize that, regardless the scope or approach of the CE framework, it should have clear descriptions of the CE business potential and related requirements to be truly useful for business development.

4. Circular economy frameworks

During the recent years, Circular economy (CE) has received a lot of attention among public organizations, academia and business [11]. CE is an ideal target against take-make-dispose linear way of producing and consuming [3]. It is often characterized as a way for decoupling economic growth from environmental impacts addressing to the challenge of planetary boundaries [12].

Although there are signs of CE originating from sustainable development and literature can widely agree that CE supports economic and environmental aspects, it is nothing but a concise and unified framework. Kirchherr et al. have alone identified 114 different definitions for CE [13]. Vastness of different CE meanings can distract and make it difficult to use such definitions to support the implementation of sustainable business. Furthermore, Lieder and Rashid have identified that particularly for manufacturing companies there is a shortcoming in literature of sufficient descriptions of economic benefits and competitive advantage on CE activity [2].

We make a two staged literature review evaluation on extant CE frameworks through using the concept for framework evaluation (Fig. 1). First, we begin with recently made literature reviews within the CE context to identify the CE literature landscape and to identify possible directions for frameworks supporting transformation towards CE. Second, based on the identified varying focus points in CE literature landscape, we choose a collection of different promising frameworks for further evaluation. These frameworks in the forms of articles, reports and website portals are selected based on (1) their popularity in the CE literature, or (2) their particular fit to research focus, and/or (3) based on authors' experience in CE development projects.

Each framework's fit towards BM development, SF and capability building are examined using the categories of "fitness" towards evaluation framework presented in table 1. We use three categories to indicate the maturity of framework in relation to the pointed dimension in the evaluation framework.

In the first stage of literature review, we looked in 10 readily available literature reviews [1,2,3,12-18]. From these literature reviews in addition to our experience in CE development projects, we identified 29 CE frameworks that have some forms of business support relevance in CE.

The initial findings from literature indicate that most of the identified CE frameworks describe CE on a very general level, from which it is hard to identify the operational concreteness for business. Another finding is that in some specific areas of CE, descriptions are well defined such as considerations on remanufacturing [31] but the overall concept of CE is not described. Due to these generality or narrowness aspects, we finally chose 14 frameworks in total for the evaluation (table 2).

Most of the chosen frameworks are new, formed within the last three years from the point of this literature review. There are only a few CE frameworks that are designed directly for CE business development in discrete manufacturing. Instead, most of the frameworks represent business support in general.

Table 2. Evaluated CE frameworks.

	Name of the framework	Description	Measures
NON-ACADEMIC	1 Towards the circular economy - Economic and business rationale for an accelerated transition [19]	A set of general information on circular economy business opportunities on systemic level.	Fit for BM + Fit for SF + Fit for CD +
	2 Circular economy BMs for the manufacturing industry [20]	A Playbook of strategic support for manufacturing companies.	Fit for BM ++ Fit for SF ++ Fit for CD ++
	3 ECO-INNOVATE [21]	A guide to eco-innovation for SMEs and business coaches.	Fit for BM + Fit for SF + Fit for CD 0
	4 Circular BMs [22]	Circular BM innovation and road mapping.	Fit for BM + Fit for SF + Fit for CD 0
	5 Guided choices towards a circular BM [23]	Guided support for companies to find out how the Circular Economy can be of value for them.	Fit for BM ++ Fit for SF + Fit for CD ++
ACADEMIC	6 Material efficiency options [24]	Strategies for reducing material demand through material efficiency.	Fit for BM + Fit for SF + Fit for CD 0
	7 Resource value retention options [11]	Hierarchical description of CE driven from R3 model of Reduce, Reuse and Recycle.	Fit for BM ++ Fit for SF 0 Fit for CD 0
	8 Product design and business model strategies for a circular economy [25]	BM innovations in different circular economy BM strategies.	Fit for BM ++ Fit for SF + Fit for CD 0
	9 Designing the BMs for Circular Economy [17]	Description of BM for the Circular Economy.	Fit for BM ++ Fit for SF 0 Fit for CD 0
	10 Skills and capabilities for a sustainable and circular economy [26]	Successful practices and necessary design skills to create products for closed loops.	Fit for BM + Fit for SF 0 Fit for CD +
	11 Service-based business concepts: A typology for business-to-business markets [27]	Framework to classify new service-based business concepts.	Fit for BM ++ Fit for SF 0 Fit for CD 0
	12 Resource Conservative manufacturing Design Methodology for Multiple Lifecycle Products [28]	Methodologies, software-based tools for the implementation of closed-loop manufacturing.	Fit for BM ++ Fit for SF + Fit for CD +
	13 Back casting and Eco-Design for the CE Framework [29]	Support for implementing circular economy requirements in business.	Fit for BM + Fit for SF ++ Fit for CD 0
	14 CE strategies and CE implementation databases [30]	Exhaustive description of CE strategies and implementation levels.	Fit for BM + Fit for SF + Fit for CD 0

BM = business model, SF = strategy formation, CD = capability development

BM descriptions and considerations on BM innovation are well represented in literature. For the purpose of SF there are some supporting frameworks. However, in relation to capability development (CD) there were only few contributions. Next, we outline some examples from the chosen CE frameworks. First, we will look into what descriptions can be found on BMs and continue to SF and capability building descriptions.

In non-academic literature, Ellen MacArthur Foundation's CE framework is highly cited, and provides generic information on CE business potential [19]. In their view, CE is divided into biological material cycles and technical material cycles. These cycles include different strategies and functions to keep materials and value in use through many product life cycles. More detailed CBM descriptions can be found for example in Sitra et al.'s CE framework grouped in systemic level categories of CE [20]. In their view, there are five Circular business models (CBM) of circular supply chain, sharing

platform, product life extension, recovery and recycling, and product as a service. Then again, the BMs have more detailed sub-models. For example, product life extension includes repair and maintain, upgrade, resell and remanufacture.

In academic literature, more focus is in finding consensus to CE descriptions. Here, Bocken et al. provide an option to categorize linear and circular approaches for reducing resource use [25]. The categories include more detailed descriptions of BM innovations that can be used either individually or in combinations. Similarly Reike et al. provides a hierarchical model of 10 different value retention options [11]. These options are indicated with different R-imperatives, and are placed in an order where smaller numbered imperatives enable more value retention.

SF descriptions in general are provided as methods where strategies are developed in stages and in each stage, specific tools are used to clarify decision-making. Different methods emphasize different points of SF [22, 23]. For example, Joustra et al. promote stages of read, learn, talk, try and test to implement CE opportunities in a pilot way in manufacturing companies [23]. Mendoza et al. promote an approach combining back casting and eco-design to meet companies starting point with CE opportunities and continuing to product and service considerations before a detailed roadmap [29]. Bakker et al. suggest companies to visualize their CE strategy to uncover different interpretations different personnel in company may have on CE' systemic goals in transforming company's current linear production towards a circular kind [28].

Finally, CD in CE covers aspects such as skill requirements, technology requirements and identification of company's strengths, weaknesses and readiness in relation to CE business. For example, Ellen MacArthur Foundation emphasizes the skill requirements to obtain CE on a systemic level [19]. On the contrary, Joustra et al. promote mapping of company's stakeholder's requirements and industry benchmarking in order to identify company's starting grounds in relation to its' business environment. Sitra represents knowledge and technology requirements per CBM in order to identify company's gaps in relation to potential CBMs [20].

5. Characteristics of CE framework to support strategic renewal in manufacturing firms

Based on the results of the CE framework evaluation we formulated a synthesis. The synthesis combines different characteristics of the existing frameworks that fulfilled the evaluation criteria on levels (++) and (+). This description of a CE framework synthesis indicates such elements that should be expected from a framework aiming to support strategic CE business development. For academics, public organizations and business, this synthesis can be considered as a set of guidelines and support for developing a CE framework. Although the aim of this synthesis is not to define a subjective definition for a good CE framework, it still takes into account aspects of CE framework development that based on the literature review should positively affect the SF and implementation of CBMs.

Table 3 outlines normatively the identified characteristics of a synthesized CE framework. This description answers the following questions:

- What elements support decision-making and development on CE BMs?
- What elements support formation of strategies?
- What elements support CD?
- What kind of structures of CE framework supports SF and implementation of CE BMs?

Table 3. Synthesized characteristics of the analyzed CE frameworks to support strategic renewal in manufacturing firms.

Business models	Capability development
There is emphasis on providing support for companies in the transition process from product to services.	There is an emphasis on design and redesign capability requirements.
CBMs are described in an executable and well-distinguished form.	Capabilities are described in the forms of skill requirements (expertise) and technology requirements.
BM's are structured on systems level to clarify BM's similarities and differences in relation to sustainability strategies.	There is a link between CBM and capability requirements.
Descriptions are supported with analysis tools that show potential BM impacts to support initial decision-making.	CD is supported with tools to describe company's existing capabilities and gaps in capabilities.
There are tools to support BM innovation taking into account companies' varying requirements.	CD is supported with mapping of business environment's solutions and readiness in relation to CE business.
The BM decisions and innovations are supported with databases of terms and case studies.	
Strategy formation	Structure of CE framework
There is emphasis in developing products into services.	There are strong interrelationships especially between BM development and SF.
SF considers company review, planning of BMs, and implementation of actions.	Methods have step-by-step process with possible parallel tracks.
Strategies consist of roadmaps, action plans, and considerations on monitoring.	Sub-methods and tools are connected to each phase.
Longer-term vision is supported with visualizations of CE transformation goals in company.	Method structure is flexible in how it starts taking into account different starting points in companies.
There are support tools to prioritize proposed actions for short term and long term planning.	Method is either a stand-alone and ready to be used by a company or led by external experts.
SF is supported with case studies and state of the art of implementation.	There are supportive material e.g. case studies and links to external sources to support development process.

The framework approach towards CE BMs have four concurrently important aspects. Firstly, individual BMs should be described on a level where the concrete business potential and executing ability per model become explicit. Secondly, the BMs should be readily distinguishable from each other to enable understanding for manufacturing companies the differences and similarities of BMs. Continuing to the third aspect, CE is seen much more than just single BMs, and therefore the BMs should be framed on systemic level to further clarify the sustainability goals of BMs. Finally, the fourth aspect promotes the BM innovation, providing a process and set of tools to further develop potential BMs to fit to companies' business landscape.

With these kind of BM descriptions, discrete manufacturing companies can anchor readily CE business activities in their

own operations. In other words, descriptions enable companies to see CE BMs concrete and executable reflecting to their own experience. After the initial decisions on BMs, the innovation process becomes important to facilitate BM development in close connection with SF.

SF support is the glue between BMs, strategies and CD. It looks like logically linked set of tools to answer varying information needs in different phases of planning of strategy and implementation. Its primary function is to support decision making throughout a structured process. Tools in general are simple and easily applicable by company personnel. CE framework's flexibility comes from the characteristics where there are tools readily available for companies that are landing to SF in different phases.

At its best, a CE framework supports SF that has the ability to steer business development. Tools provide information that are critical for strategic decision making, where especially the profitability aspects should be possible to calculate before any actual development steps have been started. This is important as CE BMs compete with other companies' development investments. In addition, the tools provide the ability to prioritize goals and actions so that the results can be expected both on in short-term and in longer term to maintain motivation of different stakeholders.

Synthesized CE framework has two primary aspects for CD. Firstly, there is ability to map and measure the baseline of company's capabilities and resources. Secondly, the framework makes explicit the capability requirements that are enablers for CE BMs.

With such characteristics, ideally CE framework enables companies to locate themselves in relation to the increasing needs for CE BMs. In other words, the companies' readiness, potential strengths and weaknesses becomes explicit. These kinds of descriptions contribute to the SF promoting the existing capabilities as a natural starting point for CE business development.

Finally, the synthesis promotes three aspects for defining a structure for a CE framework. Firstly, at its best CE framework is a well-structured method, which provides a company to take interesting CE BMs systematically as part of its strategy and into development actions. Secondly, the three dimensions of BM, SF and CD are inseparable and should be interlinked iteratively. Well described CE BMs and quick analysis tools for providing first-hand information of the BM potential are important in the beginning of the process. Capability aspects are natural follow up after the initial decisions on BMs are made. Later on, planning and development requires BM innovation concurrently with other development steps such as product development steps. Thirdly, the structure should have also interlinks with external information on supportive databases, web sites, case studies and state-of-the-art solutions.

6. Conclusions and Discussion

This paper contributes to research on sustainable manufacturing with a specific focus in CE framework development aiming to support firms' strategic decision-making and growth in CE. The contributions are three folded. First, we present a concept for CE framework evaluation

criteria to identify existing CE frameworks' fit in supporting firms' BM development, SF and CD. Second, we present a literature review that indicates the maturity level of the existing CE frameworks in relation to the evaluation criteria.

Third, we propose guidelines for CE framework development by synthesizing different characteristics of extant frameworks. This synthesized CE framework can be used as a guideline for framework development directed to manufacturing businesses that aim to promote CE BMs in their strategic development and capability building. Our hypothesis is that a CE framework that considers the characteristics of the synthesized CE framework during its method development rationale has the ability to positively effect on CE business development in companies.

This research has pointed out potential areas for future research. A natural next research step is to create archetypes for CE framework that uses the guidelines provided in this research. During the literature review, we came across to the fact that CD in relation to CE BMs is undermined. There is still quite little information and frameworks available on capability requirements of different CBMs and ways to identify companies existing capabilities strengths and weaknesses in relation to potential CE business potential. Therefore, empirical evidence is needed from companies operating successful CE business on how they have developed their capabilities.

The literature provides competing aspects on CE business development. There are literature that promotes more the systemic nature and high ambitions of CE BMs, where radical innovations, risky steps and entirely new capabilities are required. However, there are also literature that supports more incremental development steps for promoting CE. From our point of view, especially for discrete manufacturing, taking the first steps towards CE can be incremental and based on strengths identified in existing capabilities. The more ambitious systemic level goals, that may be more disruptive kind, are also important but their priority should be seen in a longer term. A good CE framework for strategic development could take into account both of the aspects.

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