WaysTUP!

VALUE CHAINS FOR DISRUPTIVE TRANSFORMATION OF URBAN BIOWASTE INTO BIOBASED PRODUCTS IN THE CITY CONTEXT

D6.2: Business Models Analysis

WP6 – New business & marketing concepts along the entire value chain from urban biowaste

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List of Acronyms

AD	Anaerobic Digestion
BM	Business Model
BMC	Business Model Canvas
BOLT	Build – Operate – Lease – Transfer
BOM	Build Operate Manage
BOO	Build Own Operate
BOT	Build Operate Transfer
CAGR	Compound Annual Growth Rate
CEBM	Circular Economy Business Model
CE	Circular Economy
CEBM	Circular Economy Business Model
CHP	Combined heat and power
CSR	Corporate Social Responsibility
CSTR	Continuous Stirred-Tank Reactor
EBM	Enabling Business Models
EC	European Commission
EU	European Union
FP7	Seventh Framework Programme
H2020	Horizon 2020
GDPR	General Data Protection
ICT	Information and Communications Technology

LDO	Lease – Develop - Operate
NRR	Noise Reduction Rating
OPM	Open Business Model
PPP	Public-Private Pertnarship
R&D	Research and Development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RED	Renewable Energy Directive
ROT	Rehabilitate – Operate – Transfer
SDG	Sustainable Development Goals
SME	Small and Medium Enterprise
TBL	Triple Bottom Line
TRL	Technology Readiness Level
WP	Work Package

Executive summary

This deliverable, is the direct outcome of **Task 6.2,** titled as **"Development and setup of innovative business models and marketing strategies for valorising urban biowaste",** which is implemented in the context of WP6 of WaysTUP! project. Task 6.2 foresees the **development and practical set up of new innovative business models based on the outcomes of the project.** Within the framework of this task, two deliverables will be produced – this one, D6.2 Business Models Analysis, and D6.3 Individual business and Marketing strategies.

This deliverable aims to **gather and analyse relevant information about business models** and their importance, enumerate and present the basic types of business models, **keeping its focus on the circular models,** whose role in the circular economy is explained in detail. The significance of the business model is perceived due to the fact that it is a tool that helps the organization (private and public) to define where the business is in the value chain; determine what the consumer gets out of it; **determine the future of a business – whether it succeeds or fails.** Successful implementation of any type of business model, largely depends on the attention paid to the specific characteristics of its building blocks, such as cycles, strategies, value creation, customer relations, revenue streams etc.

This document also presents a catalogue of relevant **tools for business model development**, and it will be used as the base research tor further development of individual business models for within this project. While searching for the best suited **business model tool** for the participants of WaysTUP! Project, through which the generated innovation can be brought to the market, we analyzed business models tools that are widely used and that can be applied in the context of WaysTUP! project: **Business Model Canvas, Lean Startup Canvas, Value Proposition Canvas and Prototyping Canvas**. Each of the mentioned tools has its own strengths and weaknesses, so one of the important next steps **is to develop a custom toolset for development of the business model** that will suit the Pilots, within the workshop planned for the first half of 2021.

As this deliverable is perceived as a strong base for successful development of innovative business models for WaysTUP! Pilots, it also analyzes **successful case studies**, given in the Annexes. The analysis of **successful examples from the European market** (EU countries) show the ways in which organizations overcame the initial barriers, how they **successfully placed their bio-based products on the market,** how they provided stable financing of the R&D sector and began to generate revenue, all through the application of basic principles of circular economy.

1. Introduction

Development of individual business models for each Pilot and defining their market entry strategy, will be based on the outcomes of Task 6.2. The aim of the developed business models is to quickly gain traction in the market, to exploit the pilot solutions to their fullest potential and to be sustainable over a longer period. In order to have a strong base for this important step, this document (D6.2) will provide a detailed insight into all elements of the business modeling process, by defining common business model types and explaining the differences between them and introducing theoretical and practical findings on innovative business models, which streams from the Circular Economy. The topic of business models is very extensive, it requires a systematic approach to research, and information relevant to WaysTUP! Pilots will be elaborated in this deliverable, according to the structure given below.

1.1.Structure of the Deliverable

At the first part of this deliverable, the **overall concept and methodological approach** is presented and analyzed. The methods used correspond to the aims and objectives of the deliverable.

In the next part of the deliverable, an **overall introduction on business models and their importance** is given, as well as a **list of existing business model types**. The aim of this section is to plainly define the main subject of this report.

The following part of the deliverable is focused on **Circular Economy** and identification and analysis of existing **Business Models stemming from the Circular Economy**, as well as **Enabling Business Models** which are defined, in the context of this deliverable, as enablers of implementation of a circular business model in bioeconomy sector. This part is also dedicated to **City Business Models** that can support smart services and make the city sustainable.

The **Business Model Development Tools** that follow, incorporates analysis of **common, sustainable and circular business model tools**. Each tool of these categories can be used as a perfect solution by for-profit organizations depending on their current business priorities. This section also presents **business model tools for non-profit organizations**, taking into account specific aspects of their work. Moreover, **city business model tools** are explored in order to discover how business model concept can be translated from individual organizations to cities. This kind of business model aims to guide a City Council in articulating how it will accomplish the objectives of its sustainable city strategy.

Every chapter in this Deliverable includes a brief conclusion on the covered topic, but main conclusions are drawn in the chapter 6 titled **Concluding Remarks.**

Annexes of this Deliverable include short overviews of 6 different business cases, covering different types of bio-based products, production processes, and legislative frameworks which can favor the Circular economy and create certain barriers at the same time. All case studies have a similar context with the Project's PILOTs and should be considered as a record of successfully implemented Circular Economy-related Business Models in **real-life conditions**.

References are provided at the end of this Deliverable.

2. Methodology

In order to successfully implement the deliverable and reach reliable conclusions, carefully selected literature needed to be gathered, analysed and presented. This is done through a detailed **systematic approach to desk research** that had to be planned and elaborated.

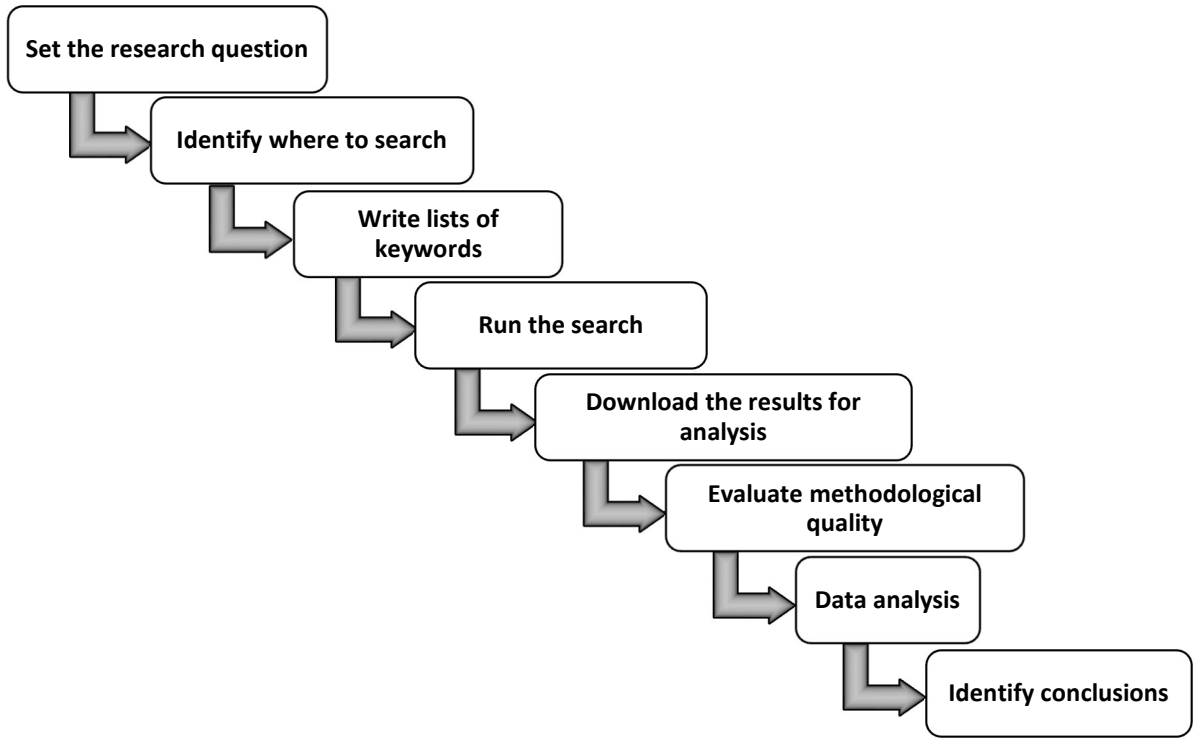

Figure 1 Systematic approach to desk research

Source: Own elaboration by BIOS

The desk research method applied is strongly related with the aims and the objectives of the deliverable. The research question set at the beginning is "**What kind of business models would suit organizations involved in WaysTUP! Pilots and could make their businesses profitable and sustainable?**".

Guided by this question, we investigated **different sources of information** that is reliable and relevant - data from industry unions, public organizations, as well as scientific publications from universities and non-profit research organizations, websites of major market players, reports of research and news agencies. **Most frequently used keywords** during the desk research include: business model, circular business model, sustainability, circular economy, tool, smart city.

After running the organized search, methodological quality was evaluated applying different **inclusion and exclusion criteria**. This was done by keeping in mind the overall goal of the deliverable.

Next step, after sorting search results and applying the inclusion and exclusion criteria, involves **qualitative analysis** which leads to the **final conclusions**. In order to safeguard the integrity of the research results, the resources are reviewed internally between the members of the consortium.

Next Steps

Besides the methodological approach of the current deliverable, there is a number of **next steps** that are expected to **enhance the usability of the deliverable** towards to the various stakeholders that is directed to, but most importantly towards the main stakeholders, which are **WaysTUP! Pilots**.

There is a number of complementary next steps that will be implemented during the first half of 2021, in order to safeguard the further utilization of the deliverable.

Step 1 – Preliminary Workshop:

A preliminary workshop will be implemented, and will be directed to the **WaysTUP! Pilots**. In the context of this Workshop, we will be able to present the **findings of this deliverable** to the Pilots but also to the whole project consortium. Therefore, on the one hand we will be able to present the most important findings in a more targeted and interactive manner, while on the other hand we will be able to get valuable feedback for specific issues. The main focus of this workshop will be on **case studies presentation as examples of good practices**.

Step 2 – Two Workshops on Business Model Generation:

The **first workshop** will be dedicated to **for-profit and non-profit organizations**. The overall goal of the workshop will be to **generate one business model for each organization** by applying the most suitable business model tool chosen from the group of all elaborated tools within this deliverable. Creating a visual canvas with elements describing value proposition, customers, finances, organization, will allow organizations to align their activities by illustrating potential strategies, that will include identifying significant opportunities, possible obstacles, and essential resources.

The **second workshop** will be dedicated to **City Business Model Tool exercise** that will allow city authorities to develop insights on how their city operates including all relevant stakeholders and resources. The aim of the workshop will be to help municipalities to

understand their current situation and the point they want to reach, and to direct their actions to close the gap by applying the appropriate business model tool which will be developed during the workshop.

3. Introduction to Business Models

In past decades, accelerated progress in technology and science radically changed the ways many industries work. Globalization, European integration, ICT development, and the fourth industrial revolution, are just some of the major circumstances that are causing drastic changes in the European and worldwide markets. Companies are forced to adapt their business strategies and business models in order to fight against the challenges imposed by global competition. **A business model can be used as a tool to foster company changes and to adapt the business to the current situation**[1]**.** For those who are just entering the market with new ideas, offering innovative products or services, planning a sustainable business model plays a vital role. It represents the axis of the business success, and one of the main tools to predict company's future on the market. The development of a suitable business model can be done with the use of different methodologies and tools, some of which will be mentioned ahead.

3.1. Definition and Importance of business models

A business model can be defined in many ways, but the simplest and shortest definition is that **a business model is a framework for how a company will create value; a framework that is explaining how to organize and evolve a business venture**. For developing a sustainable model, it is important to consider current industrial environment and future circumstances that will be shaping the industry, within which the firm will operate.

As previously stated, business model can have multiple definitions, can be formed of different elements and in many different ways. In order to achieve consistency in the definition of a business model and its constitutive elements, many experts from different business disciplines tried to distill this concept down to its essence and give answers to fundamentally important questions. Early researchers provided the first definition of business model in 1998. Since then, many updates occurred, as the industry and competition altered. In order to better understand the essence and the importance of the business model and its role in a business organization, we will try to summarize most of the relevant definitions in the following table[2] .

[1] D. J. Teece (2010): „Business Models, Business Strategy nd Innovation", Long Range Planning 43

[2] http://journalofbusinessmodels.com/media/1017/vol-1-no-1-pp-85-105.pdf

A selective overview of business model definitions (ordered by year and author name)	
Author(s)	Definition
Timmers (1998)[3]	Definition of a business model: (a) an architecture for the product, service and information flows, including a description of the various business actors and their roles; and (b) a description of the potential benefits for the various business actors; and (c) a description of the sources of revenues.
Mahadevan (2000)[4]	A business model is a unique blend of three streams that are critical to the business. These include the value stream for the business partners and the buyers, the revenue stream, and the logistical stream.
Rappa (2000)[5]	In the most basic sense, a business model is the method of doing business by which a company can sustain itself - that is, generate revenue. The business model spells-out how a company makes money by specifying where it is positioned in the value chain.
Afuah and Tucci (2001)[6]	A business model is the method by which a firm builds and uses its resources to offer its customers better value than its competitors and make money doing so. It details how a firm makes money now and how it plans to do so in the long-term. The model is what enables a firm to have a sustainable competitive advantage, to perform better than its rivals in the long term.

[3] P. Timmers (1998): „Business Models for Electronic Markets", European Commission, Directorate-General III

[4] B. Mahadevan (2000): "Business Models for Internet-Based E-Commerce: An Anatomy", Indian Institute of Management Bangalore

[5] M. Rappa (2000): „Business models on the Web: managing the digital enterprise", North Carolina State University

[6] A. Afuah & Ch. Tucci (2001): "Internet Business Models and Strategies" - https://www.researchgate.net/publication/37408327_Internet_Business_Models_and_Strategies

Amit and Zott (2001)[7]	A business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities.
Tapscott (2001)[8]	A business model refers to the core architecture of a firm, specifically how it deploys all relevant resources (not just those within its corporate boundaries) to create differentiated value for customers.
Chesbrough and Rosenbloom (2002)[9]	The business model provides a coherent framework that takes technological characteristics and potentials as inputs, and converts them through customers and markets into economic inputs. The business model is thus conceived as a focusing device that mediates between technology development and economic value creation. It "spells out how a company makes money by specifying where it is positioned in the value chain".
Morris et al. (2005)[10]	A business model is a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets.
Shafer et al. (2005)[11]	We define a business model as a representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network.
Chesbrough (2006)[12]	At its heart, a business model performs two important functions: value creation and value capture. First, it defines a series of activities that will yield a new product or service in such a way that

[7] R. Amit & Ch. Zott (2001): „Value Creation in E-Business", Strategic Management Journal 22 - https://www.researchgate.net/publication/215915200_Value_Creation_in_E-Business

[8] D. Tapscott (2001): "Digital Capital: Harnessing the Power of Business Webs", Harvard Business Press

[9] H. W. Chesbrough & R. S. Rosebloom (2002): „he Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corporation's Technology Spin-Off Companies", Industrial and Corporate Change

[10] M. H. Morris, M. Schindehutte & J. Allen (2005): „The Enterpreneur's Business Model: Toward a Unified Perspective", Journal of Business Research

[11] S. M. Shafer, H. J. Smith & J. C. Linder (2005): „The Power of Business Models", Business Horizons

[12] H. Chesborough & A. K. Crowther (2006): „Beyond high tech: Early adopters of Open Onnovation in other industries", R&D Management, Vol 36

	there is net value created throughout the various activities. Second, it captures value from a portion of those activities for the firm developing the model.
Johnson, Christensen, and Kagermann (2008)[13]	A business model, from our point of view, consists of four interlocking elements that, taken together, create and deliver value. The most important to get right, by far, is the customer value proposition. The other elements are the profit formula, the key resources and the key processes.
Demil and Lecocq (2010)[14]	Generally speaking, the concept refers to the description of the articulation between different BM components or 'building blocks' to produce a proposition that can generate value for consumers and thus for the organization.
Osterwalder and Pigneur (2010)[15]	A business model describes the rationale of how an organization creates, delivers, and captures value.
Teece (2010)[16]	In short, a business model defines how the enterprise creates and delivers value to customers, and then converts payments received to profits.
Zott and Amit (2010)[17]	A business model can be viewed as a template of how a firm conducts business, how it delivers value to stakeholders (e.g., the focal firms, customers, partners, etc.), and how it links factor and product markets. The activity systems perspective addresses all these vital issues [...]
George and Bock (2011)[18]	A business model is the design of organizational structures to enact a commercial opportunity [...] three dimensions to the

[13] M. W. Joshnson, C. M. Christensen & H. Kagermann (2008): „Reinventing Your Business Model", Harvard Business Press

[14] B. Demil & X. Lecocq (2010): „Business Model Evolution: In Search of Dynamic Consistency", Long Range Planning 43

[15] A. Osterwalder & Y. Pigneur (2010): „Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers", ISBN: 978-0-470-87641-1

[16] D. J. Teece (2010): „Business Models, Business Strategy nd Innovation", Long Range Planning 43

[17] Ch. Zott & R. Amit (20210): „Business Model Design: An Activity System Perspective", Long Range Planning 43

[18] G. George & A. J. Bock (2011): "The Business Model in Practice and Its Implications for Entrepreneurship Research", Enterpreneurship Theory and Practice 35

	organizational structures noted in our definition: resource structure, transactive structure, and value structure

Table 1 A selective overview of business model definitions

All of the above definitions see the business model as an architecture, some are making distinction between a model and a strategy, some are influenced by the specific context in which the business model is used. Phrases used in most of the definitions are related to value (creating and capturing value), building blocks (business model components), sustainability and business strategy.

First, it is important to realize that **the business model is not the same as the business strategy** – it is a product of a good business strategy. **A business strategy** refers to the actions and decisions that a company takes to reach its business goals and be competitive in its industry. Therefore, strategy determines which business model will be the most suitable or leads the way toward the development of a custom model, for a particular company. **Sustainability is one of the main factors to be considered during the business analysis**, as it stresses the ambition to survive over time and create a successful, perhaps even profitable, entity in the long run. The reason for this apparent ambiguity around the concept of profitability is, of course, that business models apply to many different settings than the profit-oriented company. Many non-profit organizations also have functional business models, that help them survive on the market, although it is not based on profit gaining. This is the reason why some researchers gave their business model definition using the word „value" instead of „profit" or „revenue". **Value, that is created by a business entity, can go beyond a simple product or a service,** and a value that is created (and returned) by their customers doesn't always have to be money. We will rely on this concept, since this deliverable will include the analysis of business models that can be applied to both, for-profit organizations, as well as non-profit organizations.

3.2. Types of business models

As already discussed, neither a profit nor a non-profit company cannot be successful without a good and clearly set business model, which is mostly defined by the industry branch in which the company will operate. By far, researchers have defined more than a hundred types of business models, covering almost all industries. Some researchers, such as Demil & Lecocq

(2010)[19], Shafer, Smith & Linder (2005)[20] or even Morris (2005)[21] claim that there are only 5 basic models that all profit-oriented firms fit into, and that all other types are actually subtypes of the following five:

1. **Manufacturer** – creating a product from raw materials, or assembling of pre-made components into a product. A manufacturer may sell its products directly to its customers, or it can outsource sales to another company;
2. **Service provider** - providing intangible deliverables (like design, consulting, legal services, physical services, such as hairdressing, sewing, repairing, maintenance…) to customers and/or companies;
3. **Distributor** - purchasing products directly from a manufacturer for resale either to retail outlets, or directly to the public;
4. **Retailer** - purchasing products from a distributor or wholesaler, and then selling those products to the public through physical or online stores;
5. **Franchise** – buying and adopting a business model of the franchise company (which can be a manufacturer, retailer or distributor).

Technology has been highlighted as a critical factor for business models, as nowadays digital solutions either replace current ways of operating businesses or create a basis for new businesses. Digitalization has affected traditional marketing and sales, yet more recently has expanded to include organizing exchanges around platforms, which links increasingly more parties together and hence affects companies' abilities to develop and operate multi-party business models. With innovative digital solutions, new subtypes of business models have emerged through years. By collecting the categorizations from several researchers involved in digital revolution, such as Rappa (2000)[22], Mahadevan (2000)[23] and Tucci (2001)[24], we recognized 13 most common subtypes that emerged in past two decades:

1. **Subscription Model** - the customer pays a recurring payment on a monthly basis (or another specified timeframe) for access to a service or product;
2. **Bundling Model** - involves companies to sell two or more products together as a single unit, often for a lower price than they would charge selling the products separately;

[19] B. Demil & X. Lecocq (2010): „Business Model Evolution: In Search of Dynamic Consistency", Long Range Planning 43

[20] S. M. Shafer, H. J. Smith & J. C. Linder (2005): „The Power of Business Models", Business Horizons

[21] M. H. Morris, M. Schindehutte & J. Allen (2005): „The Enterpreneur's Business Model: Toward a Unified Perspective", Journal of Business Research

[22] M. Rappa (2000): „Business models on the Web: managing the digital enterprise", North Carolina State University

[23] B. Mahadevan (2000): "Business Models for Internet-Based E-Commerce: An Anatomy", Indian Institute of Management Bangalore

[24] A. Afuah & Ch. Tucci (2001): "Internet Business Models and Strategies"

3. **Freemium Model** - the customer has a free access to a product or a service, but with limited use of some key features, which will over time become necessary to them. Company charges to unlock or sell those features;
4. **Razor Blades Model** - companies offer a cheaper product with the understanding that customers will continue to purchase more expensive accessories in the future;
5. **Product to Service Model** – companies allow customers to purchase a result rather than the equipment that delivers that result;
6. **Leasing Model** - a company buys a product from a seller. That company then allows another company to use the product they purchased for a periodic fee;
7. **Crowdsourcing Model** – this model involves receiving opinions, information, or work from many different people using the internet or social media. These types of business models allow companies to tap into a vast network of talent without having to hire in-house employees;
8. **One-for-One Model** - company donates one item to a charitable cause for every item that is purchased;
9. **Distribution Model** - a company operating as a distributor is responsible for taking manufactured goods to the market, through a physical store or e-commerce website;
10. **Affiliate Marketing Business Model** – an affiliate promotes a product or service to their audience and upon purchase receive a commission;
11. **Blockchain** – models based on blockchain are not owned or monitored by a single entity. Rather, they work on peer-to-peer interactions and record everything on a digital decentralized ledger;
12. **Consulting Business Model** – companies focus on specialist skills and knowledge, often within industry verticals;
13. **Dropshipping** – an e-commerce business model where an online store is set up to sell products from other companies, with no stock ever purchased. Instead, once the order is placed it is sent to the manufacturer, or distributor, who then fulfils the order.

Most of the listed business models can be used both as linear and circular ones – the difference is that in the linear model, raw materials are extracted, transported to manufacturing sites, and processed into a diverse range of products. These products are then shipped to retailers, sold to customers, used, and ultimately discharged and replaced by other products. By adding just a few crucially important elements, regarding sustainability and the environment, the linear model becomes circular - based on keeping resources in the economy for as long as possible. Circular-based models can potentially minimize material, energy, and environmental deterioration without restricting economic, social, and technical progress. The importance of Circular Business Models (CBMs) will be thoroughly examined and described in the following chapters.

3.3. Conclusion

In this chapter, we explained what a business model is, why is it important, which types of business models exists and what are the ways to compose a good and sustainable business model. The significance of the business model is perceived due to the fact that it is a tool that helps the organization to define where the business is in the value chain; determine what the consumer gets out of it; determine the future of a business – whether it succeeds or fails; achieve success of any business; create a foundation for optimizing innovative technology; create a clear statement of the business mission and vision; create a set of values that can help to steer business; create a clear-eyed analysis of the industry, including opportunities and threats; create a portrait of potential customers; create a roadmap and timetable for achieving goals and objectives; create a résumé that can be used to introduce the business to suppliers, vendors, or lenders. Numerous research in the area of entrepreneurship have shown that a company simply cannot be successful without a good and firmly set business model.

4. Business Models in the Circular Economy

Currently, the most popular economic model in the world follows the "take-make-dispose" trend and is responsible for extensive natural resources depletion and waste production. It is predicted that, by 2050 the global industrial system will be under huge pressure to double their production output to meet growing demands, while aiming to use only half of the current resources and generating one-fifth of the current CO2 emissions. To accomplish this, a new industrial revolution is required. One widely discussed way to overcome the impending resource scarcity and meet global commitments, is the **transformation from a 'linear economy' towards a 'circular economy'**.

This chapter presents the concept and main principles of circular economy in comparison with the traditional 'take-make-waste' model. It explains why new way of doing business is necessary. Planing (2015) lists **four essential building blocks** for moving from a linear economy to a circular economy: (1) materials and product design (2) new business models (3) global reverse networks (4) enabling conditions.[25,26] This chapter focuses on **new business models for the Circular Economy** that present a completely new way of thinking in today's world.

To shift from linear to circular business models, companies need to revisit existing strategies, structures and operations and design business models free of the constraints of the linear thinking. Within this chapter, we will explore how circular economy principles can be translated into practical business model categories. Also, we will try to capture an existing typology for circular business models.[27] Without the courage from businesses to change their strategies, a successful transition towards eco-friendly and sustainable economy is not possible. We need brave forerunners to show us the way towards circular economy, therefore we aim to help WaysTUP! pilots to become circular economy pioneers.

[25] download (lu.se)

[26] Planing, P. (2015). Business model innovation in a circular economy reasons for non-acceptance of circular business models. Open J. Bus. Model Innov.

[27] Understanding circular business models: drivers, obstacles and conditions towards a successful transition (aalto.fi)

4.1 Circular Economy

The European Union produces more than 2.5 billion tonnes of waste every year. In order to tackle this issue, it is currently updating its legislation on waste management to promote a transition to a more sustainable model known as the circular economy.[28]

A circular economy is an economic system that aims to redefine growth by eliminating waste and the continual use of resources. Circular system goes beyond the current take-make-waste extractive industrial model that presents a linear process of taking resources from the ground to make products, and when products are no longer usable, throwing them away. Linear economy is not a sustainable solution. The world's population is growing and with it the demand for raw materials. However, the supply of crucial raw materials, such as fossil fuels, is limited. Additionally, the extraction of raw materials has led to an increase in the levels of carbon emissions across the globe and adversely impacts the environment.[29] However, a smarter use of raw materials can lower CO2 emissions. Therefore, shift to a circular economy is inevitable.

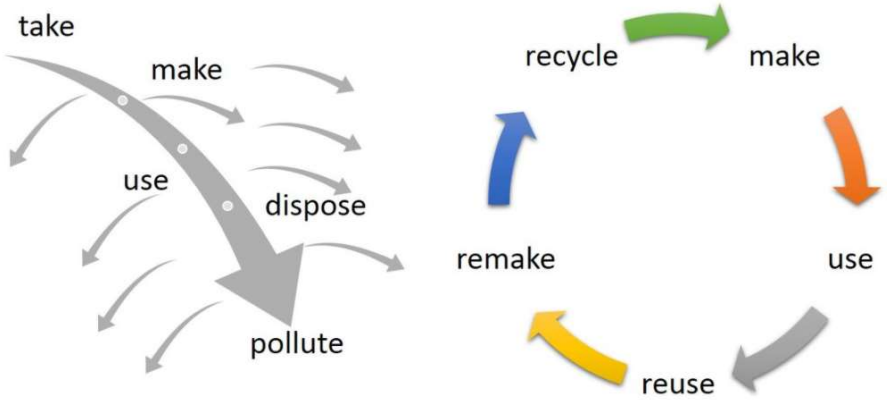

Figure 2 Linear versus circular economy

Source: CC 3.0 Catherine Weetman 2016

Circular economy systems employ reuse, sharing, repair, refurbishment, remanufacturing and recycling to create a closed-loop system, minimising the use of resource inputs and the creation of waste, pollution and carbon emissions.[30] The circular economy aims to keep products, equipment and infrastructure[31] in use for longer, thus improving the productivity of these resources. It takes a regenerative approach where all "waste" should become an input

[28] Circular economy: definition, importance and benefits | News | European Parliament (europa.eu)
[29] Circular economy: definition, importance and benefits | News | European Parliament (europa.eu)
[30] The Circular Economy – A new sustainability paradigm? (cam.ac.uk)
[31] Developing policies for the end-of-life of energy infrastructure: Coming to terms with the challenges of decommissioning - ScienceDirect

for another process: either a by-product or recovered resource for another industrial process or as regenerative resources for nature (e.g., compost). Food and biologically-based materials (such as cotton or wood) are designed to feed back into the system and these biological cycles regenerate living systems, such as soil, which provide renewable resources for the economy. Combined with the use of renewable energy, reduced emissions, and greater industry efficiency, a circular economy provides our best chance to live within the bounds of the Earth's capacity.[32]

As explained, transitioning to a circular economy does not only include adjustments aimed at reducing the negative impacts of the linear economy. Rather, it represents a **systemic shift in technologies, society, businesses, finance methods and policies, that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits**.[33]

Circular economy benefits include:

- Reduced waste as it promotes the recycling of finished goods
- Creation of new green industries and jobs
- Reduced dependence on importation of raw materials
- Fewer materials and production processes are needed to provide good and functional products, thanks to reusing and dematerializing
- Avoidance of environmental damage caused by resource extraction
- Less pollution entering the earth's life support systems.[34]

On the other hand, despite great advantages coming with the application of circular economy principles, there are certain **challenges** that arise with it. First, some businesses – mainly their structure, operations and supply chains – are deeply rooted in the linear concept of growth, and they can actually lose by shifting to strategies based on circularity. This is the case with the industries where virgin materials, materials sourced directly from nature in their raw form (such as wood or metal ores), are produced. Traditional fossil fuel based raw materials remain cheaper than more effective substitutes. Integrated global supply chains mean that businesses find they lack the critical mass needed to start large-scale efforts to substitute resource scarce or hazardous materials with cleaner, restorative or more regenerative ones. Current regulations give linear economy an unfair advantage over circular economy by making it more financially

[32] 4 Benefits of a Circular Economy (wastewiseproductsinc.com)
[33] What is a Circular Economy? | Ellen MacArthur Foundation
[34] 4 Benefits of a Circular Economy (wastewiseproductsinc.com)

attractive by increased profits through expanding resource use. Hence, appropriate policies need to manage these kinds of effects.

Second, **implementation of new, circular solutions requires high upfront investment**, and immediate cost savings are not always guaranteed. In addition, additional **hidden and indirect costs such as time and human resources might occur and therefore** need to be covered in order to make environmental improvements.[35]

Nevertheless, the European Commission has adopted circularity as the new economic paradigm for Europe, starting with the launch of its first EU Circular Economy Action Plan in 2015. Even though progress from back then is visible, EU strives for better results and continues its mission by adopting a new **Circular Economy Action Plan**, on March 11th, 2020 - one of the main building blocks of the European Green Deal, Europe's new agenda for sustainable growth. The aim of the Action Plan is to reduce the EU's consumption footprint and double the EU's circular material use rate in the coming decade, while boosting economic growth. This will be done in full cooperation with stakeholders and business.[36]

4.2 Circular Economy Business Models (CEBMs)

Businesses all over the world have understood they can no longer focus mainly on profit maximization or pursue cost-cutting through greater efficiency in supply chains, factories, and operations as the primary corporate objective. Instead, they should focus on rethinking products throughout the value chain in order to be prepared for a future of resource constraints. Main factors that move companies and consumers towards adoption of circular economy principles include the development of technology, urbanization, resource scarcity and stricter environmental regulations.[37] Moreover, **circular economy strategy provides lots of benefits for businesses**, offering them an opportunity to achieve a great competitive advantage by concentrating on efficient material circulation and service-based models.[38]

The core difference between the circular economy business model and the traditional one lies in the fact that circular economy business models concentrate on creating value for a broader range of stakeholders and they take into consideration social and environmental benefits. **The ambition of a circular economy business model is to maintain resources in circulation for as long as possible**. It promotes use of fully renewable, recyclable or biodegrable inputs instead

[35] Miisa Salmela (2016). Circular Economy Business Models. Lahti University of Applied Sciences Ltd.
[36] Circular Economy Action Plan - background guide — EUbusiness.com | EU news, business and politics
[37] Lacy, P. & Rutqvist, J. 2015. Waste to Wealth: The Circular Economy Advantage. Palgrave Macmillan UK: Kindle Edition.
[38] Miisa Salmela (2016). Circular Economy Business Models. Lahti University of Applied Sciences Ltd.

of scarce resources. Furthermore, circular economy business models expect from companies to find new ways to offer product usage or access to it instead of selling goods, and to optimize the ability to function through the whole value chain.[39]

Profitable circular economy business models will encourage other players to adopt similar strategies and thus the concept of circularity will be expanded geographically, making a greater positive impact on the environment. However, implementation of circular economy requires changes that companies need to face. These changes may refer to production processes, products and services, internal and external relationships, customer base, and revenue models.[40]

It has to be noted, that in the context of the Project and in order to make a stronger connection between circular economy business models and bio-economy, an area that is also supported by WaysTUP! project, we also use/ introduce the term **'enabling business model'.** Against this background, enabling business models can be typical Business Models that in a way the enable implementation of a CEBMs in the field of bioeconomy.

4.2.1. Classification of Circular Economy Business Models

Circular economy is a manifestation of economic models that highlight business opportunities where **cycles** rather than linear processes, dominate. It is **restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times.** Cycles enable value creation and retention because the parties involved cooperate in such a way that (raw) materials and products can be used as optimally as possible.

There are different approaches on how to establish the classification of circular economy business models (CEBMs). Here, we will try to include all key types of CEBMs mentioned in the different literature.

Four different types of CEBMs were determined according to Achterberg et al. (2016) who recognized three main phases of a product's life - **the 'pre-use' phase** (design, development and production phase of a product)**, the 'use' phase,** and **the 'after-use' phase.** For each of these phases there is one corresponding circular economy business model (see table 2). Furthermore, since there is also a need for coordination of activities, information flows,

[39] Miisa Salmela (2016). Circular Economy Business Models. Lahti University of Applied Sciences Ltd.
[40] Mentink, B. 2014. Circular Business Model Innovation -A process framework and a tool for business model innovation in a circular economy. Master thesis of Science in Industrial Ecology & Leiden University

material flows, energy flows and services, the Circular Support Models have been identified as CEBMs related to all phases of a product's life.[41]

Circular Economy Business Model	Phases of a product's life
Circular Design Models: design products and materials with the aim of long term value retention	'Pre-use' phase
Optimal Use Models: these business models seek to optimise the use of the product by providing services or add-ons to extend the lifetime of a product or provide ways to use products more intensively or efficiently	'Use' phase
Value Recovery Models: capture the value from used products (formerly known as waste or by-products)	'After-use' phase
Circular Support Models: these business models are engaged in the management and coordination of circular value networks	All phases

Table 2 Categorization of CEBMs according to Achterberg et al., 2016

Source: Achterberg, E., Hinfelaar, J. and Bocken, N. (2016). The Value Hill Business Model Tool: identifying gaps and opportunities in a circular network

Another interesting classification of circular economy business models has been developed within the R2π H2020 project (2016 – 2019) which examined the shift from the generic concept of a CE to one of a CEBMs by facing both policy and market constraints. This classification has been done based on the similar approach – taking into account each phase of product's life. There are seven CEBMs identified.

Circular Economy Business Model	Phases of a product's life
Circular sourcing: implies that the sourcing of recycled or renewable materials can be	Production phase

[41] Achterberg, E., Hinfelaar, J. and Bocken, N. (2016). The Value Hill Business Model Tool: identifying gaps and opportunities in a circular network, Retrieved March 27, 2020

returned to either the technical or biological cycle[42]	
Co-product recovery: implies that secondary material, by-products and residual output flows generated either by a value chain or by one process can become input for another value chain and/or another process.	
Re-condition: refers to product improvements through faults' fixing and aesthetic upgrades (for example, repair and refurbishment) but with no an extra warranty on the entire product.	
Re-make: aims to bring one product's part or the entire product back to like-new or better performance, with warranty to match.	
Access: refers to the concept of 'product-as-a-service' by giving access to end-users of a products instead of ownership.	Use phase
Performance: This model guarantees high level of performance due to good technical characteristics and assets of a product.	
Resource recovery: refers to products or materials at their end-of-cycle which can be either reutilised and incorporated into different products, or can be consumed as	End-of-cycle phase

[42] Technological cycles involve the management of finite resources. The resources are extracted and used in multiple economic cycles through reuse, repair, and remanufacturing of the materials and resources. Biological cycles involve the management of renewable resources. Bio-based materials are designed to be restored into the natural systems and subsequently regenerated to provide renewable resources.

input flows and feedstock for another value chain and/or another process.[43]	

Table 3 The seven CEBMs identified by R2π project

Source: Homepage - R2PI Project

Another common classification found in the literature suggests categorization of CEBMs based on **(1) closed and (2) open cycles**.[44] Closed cycles imply that the same actors preserve the material cycle organisationally, technically and economically, over and over again. Therefore, they refer to the **recycling of resources**. On the other hand, **open cycles include upcycling and conversion of (raw) materials**. This means that a substance which lost all value in the original purpose is converted into a new, valuable resource. According to this, it is possible to make a distinction into broadly **five types of cycles that present categories of circular business models** (which are not mutually exclusive):

1) short cycles,
2) long cycles,
3) clean cycles,
4) cascade cycles and
5) access cycles.[45]

Before we explore different categories of circular business models, first we need to introduce the diversity of business strategies existing in the circular economy framework.

Classification that is previously mentioned was developed by Stahel and Reday-Mulvey[46] who recognized two distinctive approaches to develop circular business models in their publication for the European commission. The first one focuses on **product life extension via re-use, re-manufacturing, and maintenance**, which refers to short and long cycles (loops). The second focuses on **resource sourcing, resource recoverability and resource efficiency**, referring to clean loops and cascading loops. In Performance Economy (2010), Stahel extended its thinking further: the **shift from selling product to selling services** is presented as the ultimate approach

[43] K. Valta, 2020. 'Turning waste into a resource: a new circular business model for Greek municipalities', Hellenic Open University
[44] Jonker J., Kothman I., Faber N., Montenegro Navarro N., 2018. Organising for the Circular Economy. A workbook for developing Circular Business Models.
[45] Kraaijenhagen, C., Van Oppen, C., Bocken, N., 2016. Circular business. Collaborate & Circulate. Circular Collaboration, Amersfoort, The Netherlands.
[46] Stahel, W.R. and Reday-Mulvey, G. (1981) 'Jobs for Tomorrow, the potential for substituting manpower for energy'; Vantage Press, New York, N.Y.. ISBN 533-04799-4

to close the loop.[47,48] This type of circular business model innovation which focuses on Product-Service Systems is recognized as the access loop.

SHORT LOOPS and LONG LOOPS Business Models

Circular business models that aim to extend the lifecycle of products and assets can do so by:

- **Maintenance** - scheduled activity or routine that extends the product's lifetime by preventing faults or break down. It also includes cleaning or other aesthetic measures;
- **Repair** - returns used products in working order (to the original performance of use state, or less) after a fault or break down;
- **Reuse**,
- **Redistribution** - capitalizes on the product's value by finding users with different needs which (still) match the original product;
- **Refurbishment** - brings the quality of used products up to a specified level by disassembly to the module level, inspection and replacement of broken modules;
- **Remanufacturing** - brings used products up to quality standards that are as rigorous as those for new products by complete disassembly down to the component level and extensive inspection and replacement of broken/outdated parts.[49] Sometimes, remanufactured products can even have a higher performance than the original product and thus, to be considered as new product;
- **Upgrading** - replaces outdated modules or components with the ones that are more technologically advanced;
- **Recycling** - reclaims material streams useful for application in products. Disassembly into material fractions increases the value of the materials recycled by removing material contaminants, hazardous materials, or high value components;[50]

[47] Erwan Mouazan (2016). Understanding circular business models: drivers, obstacles and conditions towards a successful transition. Aalto University School of Business

[48] Stahel, Walter R. (2nd ed) (2010). The performance economy. Basingstoke, England; New York: Palgrave Macmillan

[49] Parlikad, A.K. and McFarlane, D. and Fleisch, E. and Gross, S., (2003) "The roles of product identity in end-of-life decision making", Auto-Id center, Cambridge, White Paper, Vol.1, 2003.

[50] Rose, C. M., Ishii, K., & Stevels, A. (2002). Influencing Design to Improve Product End-ofLife Stage, Research in Engineering Design March 2002, Volume 13, Issue 2, pp 83-93

- **Energy recovery** - converts non-recyclable waste materials into useable heat, electricity, or fuel through different so-called waste to-energy processes;
- **disposal**.[51,52,53]

Each of these options implies that the product either (1) stays in the ownership of the end-user, or (2) returns to the manufacturer. According to the fact who gets the ownership of the product at the end, Stahel (2010) classified business models - the first case refers to so-called **short loops**, and the second one to **long loops**.

CLEAN LOOPS and CASCADING LOOPS Business Models

Looking from the perspective of the resources used to make a product, rather than on the product lifetime itself, specific business models can be defined, focusing on material sourcing (circular supplies), product transformation and resource recovery.[54, 55] Here, we can analyze different business models that are listed below:

- **Circular supplies business model** – all inputs supplied are fully renewable, recyclable, or biodegradable. These products can be reconditioned in their entirety or some of their components that carry a high value can be reused.
- **Product transformation business model** – product is made by putting together components of the products that are no longer in use.
- **Resource recovery** business model - aims to recover the embedded value remaining at the end of one product lifecycle to feed into another. Industrial symbiosis solutions within which by-products and waste materials are recovered and reprocessed (or converted into energy input) present a great opportunity towards circular economy. Benefits of these

[51] Damen, M.A. (2012) 'A resources passport for a circular economy. An assessment of the possible content and format of a resources passport in order to successfully contribute to the achievement of the circular economy'.
[52] Mentink, B. (2014). Circular Business Model Innovation. Master's thesis, TU Delft.
[53] Parlikad, A.K. and McFarlane, D. and Fleisch, E. and Gross, S., (2003) "The roles of product identity in end-of-life decision making", Auto-Id center, Cambridge, White Paper, Vol.1, 2003.
[54] Lacy P, Rosenberg D, Drewell Q, Rutqvist J. (2013) 'Five business models that drive the circular economy", webpage fastcoexist.com (2013, April 24)
[55] Lacy, P. (2014) Circular advantage, innovative business models and technologies to create value in a world without limits to growth. Accenture.

business models include the avoidance of material leakage and maximization of product value return flows.[56]

- **Made to order** business model – production of goods based on customer specifications. For example, production of specific items one at a time such as wedding cake, or suits tailored to the customer by a professional tailor. The goal of this business model is to reduce volume of resource used and to avoid potential losses from over-stocking products.

ACCESS LOOP Business Models

In the **Product as a Service** approach, companies maintain the ownership of the product, and deliver access to the customers, through **renting, leasing or pay per use** schemes for instance.[57] It means that company sells items as a service that were traditionally sold as a product. Therefore, companies that apply this business approach see longevity, reparability, reusability as the most valuable product attributes.

Product-Service Systems as a category can take several forms:

- The access model - provides product access rather than ownership (for example, car sharing service).
- The performance model - provides product performance rather than the product itself (for example 'Power-by-the-Hour' jet engines).

At the core of the **Sharing platforms** approach is maximization of utilisation. It involves collaboration of consumers and organisations around the sharing of underused resources. Clear example of this circular economy solution is room-sharing (AirBnB).[58]

These are advantages of using Product as a Service models:

- Save raw materials,
- Customer demand increase,
- Technology enables innovation, existing products can be upgraded through smart assets,
- Enhance customer relationship, and
- Drive recurring revenue and cost savings.[59]

[56] Lacy, P. (2014) Circular advantage, innovative business models and technologies to create value in a world without limits to growth. Accenture
[57] Bakker, C., Wang, F., Huisman, J., Den Hollander, M., (2014). Products that go round: exploring product life extension through design. Journal of Cleaner Production vol 69, pp 10- 16.
[58] Miisa Salmela (2016). Circular Economy Business Models. Lahti University of Applied Sciences Ltd.
[59] Product-as-a-service, the business model for a circular economy (linkedin.com)

Figure below shows five specific categories of circular business models previously explained - **clean loops, short loops, access loops, long loops and cascading loops**. Each of these models focus primarily on one aspect of the product/service entire life cycle, but achieved effects are spread throughout the various building blocks of business models.

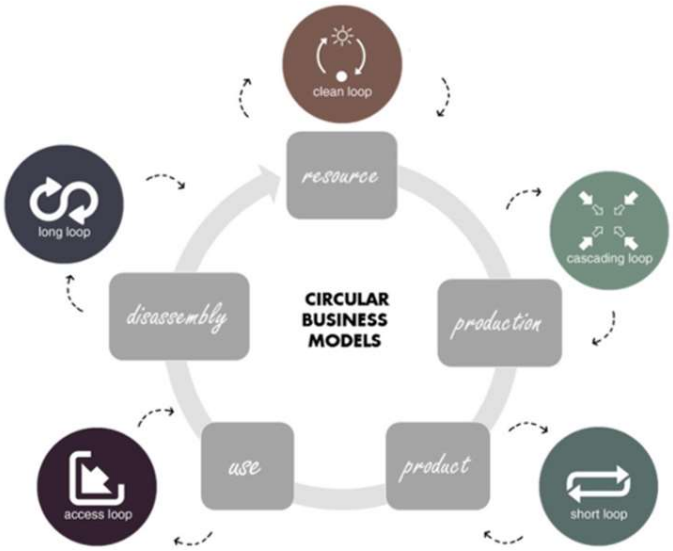

Figure 3 Circular business models

Source: circular academy | Circular business model typology

Circular Business Model Typology	Description	Description of key strategy	Sub strategy
Clean loops 	Product is designed to be eco-friendly, fully recyclable; it does not rely on scarce materials	Use of clean and renewable resources	Use of bio-sourced materials
		The product is 100% biodegradable/ recyclable	Green process. Separation of biological and technical nutrients
Short loop 	Product stays in user hands, but is maintained, repaired or upgraded to extend its lifetime	Extend life of product	Maintenance, Repair or Upgrade
Access loop 	Product is used by several users	Maximization of product use	Reuse/redistribute
			Rent/lease
			Product as a service
Long loop 	Resource is reused for same or different product, for same of different function	Extended material use	Refurbishment
			Remanufacture
			Recycle
			Energy valorisation
Cascading loop 	Product is designed with a view to create multiple value creation	Extend material use	Cascading
	Product is using resources that can be recovered for another use		Industrial symbiosis

Table 4 Circular business model typology

Source: circular academy | Circular business model typology

4.2.2 Towards a circular business model

A circular business model consists of seven building blocks.[60] After we have been introduced to the **cycles** and **strategies** – two building blocks of the circular business model, we need to explore other buildings blocks of the circular business model and these are:

- Value creation,
- Organisation,
- Revenue model,
- Parties and
- Impact.

Value creation

Closing the cycle is not the only condition that a company needs to meet if it wants to define a circular business model. Rather, it has to create a sustainable value for its environment. **Adopting a business model based on a circular economy means striving for multiple value creation including social, ecological and financial**.

Organisation

Prerequisite for a circular business model is a coordinated and cooperative organisation of multiple value creation. This needs to be supported by suitable organisational model. Since no organisation is able to close an entire cycle independently, **organisational models have to support collective organizing**.[61]

Revenue model

CBMs have to be supported by suitable revenue models. **Turnover is created differently than in conventional value chains**, for example over time (e.g. focused at product-as-a-service with a lease contract) or due to the joint creation of value. When single transactions are no longer the focus, but instead the 'lending' of the function of a product, a whole range of new revenue models emerge like leasing structures, but also pay-per-view, pay-per-print, etc.

Parties

Parties work together to close a cycle. Hence, the intensity and the size of cycle they aim to close can differ greatly. Overall, it is preferable if closed cycles address core activities rather

[60] The idea for this model emerged during the Dutch national research on Business Models for the Circular Economy (BMCE) which took place in 2016 and 2017

[61] Jonker J., Kothman I., Faber N., Montenegro Navarro N., 2018. Organising for the Circular Economy. A workbook for developing Circular Business Models.

than those on an organization's periphery. Whatever the differences are, these **parties have to cooperate to realize a collective value proposition.**

Impact

Creation of a circular business model needs to be inspired by the ambition to achieve certain results that go beyond revenue, in other words, to generate impact (social, environmental etc.). This building block aims to define and measure these desired outcomes.

After we have determined all building blocks of a circular business model, we also need to take into account the context in which an organization operates. Four **contextual factors** are listed below:

- Market: who are the buyers of your product (whether or not by means of a service) in your business model – now, and in the future?
- Capacity: what capacities do you or your collaborators in the cycle need to invest in order to operationalize their business model?
- Flexibility: what room for maneuver exists in terms of available financing, rules and regulations, technological developments, etcetera?
- Influence: what influence can be exerted and by whom in order to foster the transition to a circular business model?

Lastly, but importantly, there is one aspect of the model that must not be forgotten**. Closing a cycle is not a goal in itself, but parties cooperate and work together to come to a collective value or collective business proposition**. The proposition is both the starting point when working on the CBM, and the end point. Frankly, the collective value proposition is the centre of the business model and therefore not a building block.

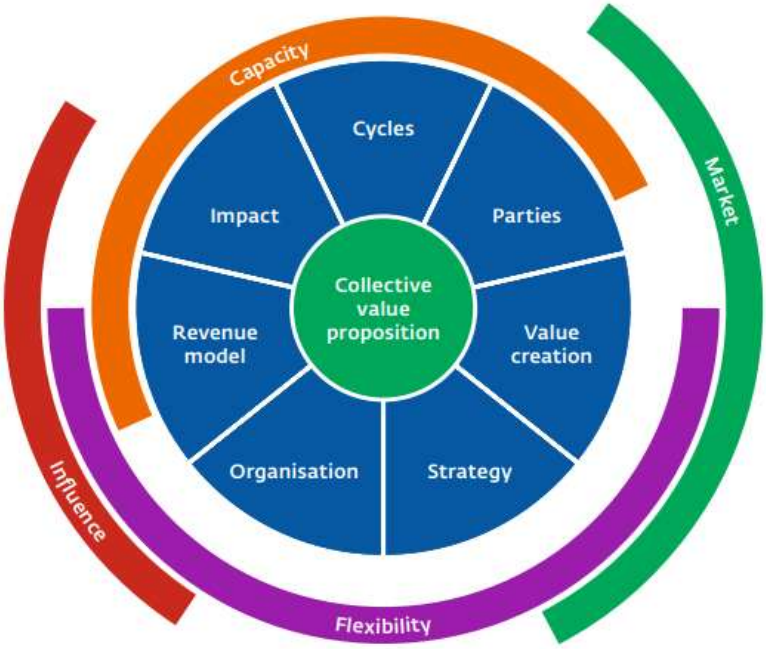

Figure 4 Generation of a circular business model

Source: *Jonker J., Kothman I., Faber N., Montenegro Navarro N., 2018. Organising for the Circular Economy. A workbook for developing Circular Business Models.*

4.2.3 Conclusion

Business model steaming from circular economy is known as a circular economy business model (CEBM) which promotes use of fully renewable, recyclable or biodegradable inputs instead of scarce resources. There are different types of CEBMs according to (1) main phases of a product's life and (2) the cycles which enable value creation: clean loops, short loops, access loops, long loops and cascading loops. Each of these models focus primarily on one aspect of the product/service entire life cycle and require different business strategies in the circular economy framework.

In order to successfully implement circular business model, a company needs to take into account specific characteristics of its building blocks: cycles, strategies, value creation, organization, revenue model, parties and impact. On top of that, contextual factors that also play an import role are market, capacity, flexibility and influence.

Appropriate application of circular economy principles, by businesses and other parties of society, contributes to economic opportunities, and provides environmental and societal benefits.

Principles of circular economy are synchronized with the concept of bioeconomy, and this fact contributes to the efforts of implementation of circular business models in the field of bioeconomy – enabling business models. Key adjustments of CEBMs need to be made in order to generate a business model that will present a perfect fit for the specific environment such as bioeconomy. These changes refer to individual elements of a business models - value proposition, key activities/resources/partners, customer segments/relationships, channels, cost structure and revenue streams.

To conclude, enabling business models rely heavily on social and environmental value creation, without neglecting economic aspects of a business. This is achieved by key activities such as facilitation of the reuse and recycling of biomass, logistics management and culture adjustments in organizations.

4.3. Business Models of Sustainable Cities

After we have defined and analyzed business models in the context of circular and bioeconomy that could be applied to both the industry and cities (or generally the Public Sector), we need to utilize a number of Business Models which are specifically targeting cities. Our aim is to provide a comprehensive insight into the application of business models.

Since cities today need the tools to tackle unprecedented environmental and economic challenges, they are transforming to so-called **'smart cities'**. While the 'smart city' is not consistently defined in the literature, we can describe it as a city that uses data, information and communications technologies (ICT) strategically to:

- provide more efficient, new or enhanced services to citizens,
- monitor and track government's progress toward policy outcomes, including meeting climate change mitigation and adaptation goals,
- manage and optimise the existing infrastructure, and plan for new more effectively,
- reduce organisational silos and employ new levels of cross-sector collaboration,
- enable innovative business models for public and private sector service provision.[62]

The overarching **mission of a smart city is to optimize city functions and drive economic growth while improving quality of life for its citizens using smart technology and data analysis.** Inseparable part of Smart City concept is the application of Circular Economy Strategies for cities that include circular economy business models. Furthermore, **smart city transformation from a linear to a circular economy involves high complexity "as material and energy, product design, business models, manufacturing, service and distribution processes and data management (and more) have to be considered."**[63]

4.3.1. Why cities need a business model?

A good business model is vital for any company because it allows the organization to put together basic elements of a business in the framework of how it creates, captures and delivers value, and to organize its activities accordingly.[64] A company uses its business model in order to answer the main questions of its core business - for whom it creates value (its customers),

[62] The Climate Group, Arup, Accenture, Horizon. University of Nottingham. 2011. Information Marketplaces. The New Economics of Cities

[63] The Circular Economy: Vision, Problems and Smart City Solutions (beesmart.city)

[64] Osterwalder, A., & Pigneur, Y. 2010. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.

how it will deliver that value to them, and how it will produce that value consistently in a way that is economically sustainable in the long term.[65]

The need for city business models, however, is less clear. Cities also need a framework for establishing the concept of how they will create value for and with their citizens in the long term. This value includes economic prosperity, personal health, educational and professional opportunities, etc., and should be achieved in a way that is environmentally viable. In this context, the **City Business Model is defined as the logic of how a city can create and deliver value through the development of smart services that are economically and socially sustainable, while reducing the city's overall environmental footprint**.[66]

In order to make a city sustainable the key principle of CE has to be implemented – creation of a closed loop for each natural or man-made product by transforming the linear resource flow into a circular flow. This principle refers to all kinds of industrial processes and products. **For the urban environment the scale of thinking shall be more global in order to address the urban metabolism as a whole, and create not only specific CE systems but an overall resource management system for the urban biosphere**.[67]

Another reason why cities need new business models lies in the fact **that complex value creation ecosystem of public services is currently changing**. Therefore, governments are resorting to new models of collaboration and co-production in the design and delivery of services. Unlike traditional approach to delivering value to citizens that included only city governments and local service providers, new methodologies perceive not only these actors as responsible parties for delivering value to their residents**, but also private entities (large firms and SMEs) and non-profit organizations**.[68] Service users and their communities also play a vital role in **co-creating and coproducing public value** because they are the ones that can best identify their needs and evaluate how current and proposed solutions address those needs. What this means for city governments is that they are operating in a **service system, where value creation depends on the engagement of a wide range of stakeholders**.[69] In this

[65] Timeus, Krista; Vinaixa, Jordi; Pardo-Bosch, Francesc; & Ysa, Tamyko 2017. Report on the Business Models of the Lighthouse Cities (Horizon 2020: REPLICATE Project Reports No. 2.2). Barcelona: ESADE Business School.

[66] Timeus, Krista; Vinaixa, Jordi; Pardo-Bosch, Francesc; & Ysa, Tamyko 2017. Report on the Business Models of the Lighthouse Cities (Horizon 2020: REPLICATE Project Reports No. 2.2). Barcelona: ESADE Business School.

[67] Background – Circular City (circular-city.eu)

[68] Osborne, S. P. 2010. Delivering Public Services: Time for a new theory? Public Management Review, 12(1), 1–10. Available online: https://doi.org/10.1080/14719030903495232

[69] Timeus, Krista; Vinaixa, Jordi; Pardo-Bosch, Francesc; & Ysa, Tamyko 2017. Report on the Business Models of the Lighthouse Cities (Horizon 2020: REPLICATE Project Reports No. 2.2). Barcelona: ESADE Business School.

service system, the role of the city government is increasingly one of **guiding and overseeing the delivery of services**, rather than one of only creating and delivering services to passive consumers.[70]

A city business model should be seen as an element of the circular strategy that articulates in a structured logic the key elements of how a city will achieve a resilient, sustainable and healthy urban environment.

4.3.2. Classification of Smart City Business Models

Frost & Sullivan[71] suggested **four Smart City Business Models** that can help urban planners with identifying ways to best support smart city development:

1. **Build Own Operate (BOO) –** A public-private partnership (PPP) project delivery method, usually for large-scale infrastructure projects, in which a private organization builds, owns and operates some facility or structure with some degree of encouragement from the government. Although the government doesn't provide direct funding in this model, it may offer other financial incentives.
2. **Build Operate Transfer (BOT) –** A form of project delivery method, wherein a private entity, as a trusted partner, receives a concession from the public sector to finance, design, construct, own, and operate a facility stated in the concession contract, within a set period of time. After completion, the operation is handover to the city planner. Role of the private sector partner is to bring the finance for the project and take the responsibility to construct and maintain it. In return, the public sector will allow it to collect revenue from the users.
3. **Open Business Model (OPM) –** The city planner allows any qualified company or business organization to build city infrastructure and provide city services. The city planner, however, will impose some regulatory obligations.
4. **Build Operate Manage (BOM) –** The city planner appoints a trusted partner to develop city infrastructure and services. The partner operates and manages the city services. The city planner has no role further. Most of the public-private partnerships are built on this model.

[70] Osborne, S. P., Radnor, Z., Vidal, I., & Kinder, T. 2014. A Sustainable Business Model for Public Service Organizations? Public Management Review, 16(2), 165–172. Available online: https://doi.org/10.1080/14719037.2013.872435

[71] A Growth Strategy Consulting & Research Firm | Frost & Sullivan

Depending on the economic, readiness, complexity and probably culture of a country, the business model can vary between one country and the other.[72]

Besides the **public-private partnerships** previously explained, there are other commonly adopted forms of PPPs such as build-operate-lease-transfer (BOLT), lease-develop-operate (LDO), rehabilitate-operate-transfer (ROT), etc. All of these models operate on different conditions on the private sector regarding level of investment, ownership control, risk sharing, technical collaboration, duration of the project, financing mode, tax treatment, management of cash flows etc.

Build-Operate-Lease-Transfer (BOLT) - The government gives a concession to a private entity to build a facility (and possibly design it as well), own the facility, lease the facility to the public sector and then at the end of the lease period transfer the ownership of the facility to the government.

Lease-Develop-Operate (LDO) - The government or the public sector entity retains ownership of the newly created infrastructure facility and receives payments in terms of a lease agreement with the private promoter. This approach is mostly applied in the development of airport facilities.

Rehabilitate-Operate-Transfer (ROT) - The governments/local bodies allow private promoters to rehabilitate and operate a facility during a concession period. After the concession period, the project is transferred back to governments/local bodies.[73]

4.3.3. Circularity in Cities

All previously mentioned business models need to be in line with the circular economy concept in order to make a city not only smart, but also circular and sustainable. **Circularity in a city** can be achieved by planning and acting on different levels and mobilizing stakeholders, as elaborated further in the fifteen steps below.

[72] Smart City – What Are the Business Models? | | MyICSC (icsc-my.org)
[73] What are the different models for Public Private Partnership (PPP) in infrastructure? (indianeconomy.net)

PLAN	1. **C**haracterise and analyse local context and resource flows, and identify idle assets
	2. **C**onceptualise options and prioritise among sectors with circular potential
	3. **C**raft a circular vision and strategy with clear circular goals and targets
ACT	4. **C**lose loops by connecting waste/residue/water/heat generators with off-takers
	5. **C**onsider options for extending use and life of idle assets and products
	6. **C**onstruct and procure circular buildings, energy and mobility systems
	7. **C**onduct circular experimentation – address urban problems with circular solutions
	8. **C**atalyse circular developments through regulation, incentives and financing
	9. **C**reate markets and demand for circular products and services – be a launching customer
	10. **C**apitalise on new ICT tools supporting circular business models
MOBILISE/ MONITOR	11. **C**oach and educate citizens, businesses, civil society and media
	12. **C**onfront and challenge linear inertia, stressing linear risks/highlighting circular opportunities
	13. **C**onnect and facilitate cooperation among circular stakeholders
	14. **C**ontact and learn from circular pioneers and champions
	15. **C**ommunicate on circular progress based on monitoring

Table 5 The 15 circular steps for cities

Source: [The 15 circular steps for cities (eib.org)]

Circular city is not the sum of its circular activities, it must also fully realize and exploit its potential to be a cradle for circular development and use its governance tools and levers as catalysts for circular change. Having in mind the benefits that can smart city features provide together with the circular city elements, we can conclude that the perfect solution for the future developments of cities would be to make a circular city that will be at the same time a smart city. This transition would require collaborative efforts across the value chain, involving individuals, the private sector, different levels of government and civil society.

Circular characteristics of the **circular smart city** should include:

- Clean and shared mobility systems
- Shared/leased assets and products with end-of-life recovery
- Production with local value loops and industrial symbiosis
- Urban bio-economy with organic by-product/waste recovery and urban farms
- Renewable and local energy production
- Reverse logistics to facilitate re-use, repair and remanufacturing
- Modular and shared buildings, designed for disassembly

- Digital tools that facilitate sharing/recovery applications.[74]

4.3.4. Conclusion

The rapid urbanization and increasing population have put a lot of strains on city infrastructures and service deliveries. Many cities are enhancing quality and performance of urban services by being digitalized, intelligent and smarter. A **circular smart city is a municipality that aims to create urban environment where will be no garbage or pollution produced, and a solid foundation for a circular economic model to make today's products tomorrows' resources will be given.**[75]

As the system of value creation and delivery changes in cities and currently includes not only governmental bodies and local service providers, but also private entities and non-profit organizations, new city business model is needed – the one that includes all relevant actors and is economically and socially sustainable, while reducing the city's overall environmental footprint.

We have identified some of the **Smart City Business Models** that refer to **public-private partnerships,** and emphasized four of them - Build Own Operate (BOO), Build Operate Transfer (BOT), Open Business Model (OPM) and Build Operate Manage (BOM) that are most commonly used. Depending on the economic, readiness, complexity and probably culture of a country, the business model can vary between one country and the other.

However, in order to make a city not only smart, but also circular and sustainable, city business models need to be in line with the circular economy concept. That can be achieved by joint efforts of the whole society.

[74] The 15 circular steps for cities (eib.org)
[75] Circular Smart City Economy – SMART Cities (ilab.city)

5 Business Model development tools

Business models are usually generated by strategic management tools that can visualize and assess concrete business idea or concept. **A business model tool represents different fundamental elements of a business and aims to clarify how different aspects of the business are related to each other.** The goal of a business model tool is to provide a quick overview of the business model without many details (compared to the traditional business plan). The visual nature of the business model tool should make it easier to refer to and understand by anyone. The following chapter presents commonly used business model tools, with a special emphasis on the **sustainable business model generation tools** which take into account economic, social and environmental dimension.

Furthermore, as we previously concluded, companies need new business models to grasp the opportunities of a circular economy. Therefore, we will also investigate to what extent existing frameworks, and tools for business model innovation are useful to cope with the challenges of designing and implementing circular business models. Taking into account the context of circular economy, we will try to find **the best suited business model development tool for participants of WaysTUP! Project**, through which the generated innovation will be brought to the market. Moreover, we will try to develop a new business model development tool, based on existing tools and methods, that will be specifically dedicated to WaysTUP! participants.

On the other hand, we will pay special attention to the analysis of **business model tools available for non-profit organizations**, because they differ from for-profit organizations in some key aspects of their business. Moreover, our research will also include **development of business models implemented in cities** which support the adoption of new technologies and innovation.

5.1. Common Business Model Tools

Competition now increasingly stands between competing business concepts. If firms within the same industry operate based on different business models, different competencies and knowledge resources are key parts of the value creation, and thus a comparison of the specific firms even within peer groups now requires interpretation based on an understanding of differences in business models[76]. These differences are made through a different combination

[76] https://fortune.com/2014/03/10/the-next-tech-revolution-busting-bureaucracy/

of „building blocks" or usage of different components while building a sustainable model. **Building blocks are the compositional elements describing what a business model is made-off.** Every researcher and author had its own list of components he considered as fundamental, which led to fuzziness and inconsistency in this field as well, as was the case with attempts to find a unique definition of the business model. After years of research, Alexander Osterwalder[77] came up with the most widely accepted concept - **Business Model Canvas.** All the other business model frameworks have been developed from it. Common business models tools that are widely used and that can be applied in the context of WaysTUP! project, are – Business Model Canvas, Lean Startup Canvas, Value Proposition Canvas and Prototyping Canvas.

5.1.1 Business Model Canvas

The most renowned tool for business model generation is the **Business Model Canvas** - a generic and easy-to-use tool, which has been applied in different industries[78]. It consists of nine building blocks and includes four main areas[79]:

1. **Infrastructure**

- Core resource/capabilities: the resource/capabilities and therefore the competencies necessary to execute a company's business model.
- Partner network: the business alliances that complement other aspects of the business model.
- Value configuration: the arrangement of activities and resources that are necessary to create value for the customer.

2. **Offering**

- Value proposition: the products and services a business offers. Quoting Osterwalder [2004], a value proposition "is an overall view of. . . products and services that together represent value for a specific customer segment. It describes the way a firm differentiates itself from its competitors and is the reason why customers buy from a certain firm and not from another."

3. **Customers**

- Target customer: the target audience for a business' products and services.

[77] Osterwalder, A. (2004). The Business Model Ontology. Université de Lausanne
[78] Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation. Hobroken, NJ: John Wiley & Sons, Inc.
[79] https://www.researchgate.net/publication/288003355_The_Importance_of_a_Business_Model

- Distribution channel: the means by which a company delivers products and services to customers. This includes the company's marketing and distribution strategy.
- Customer relationship: the links a company establishes between itself and its customer segments. The process of managing customer relationships is referred to as customer relationship management.

4. **Finances**

- Cost structure: The monetary consequences of the means employed in the business model; a company's DOC.
- Revenue: The way a company makes money through a variety of revenue flows; a company's income.

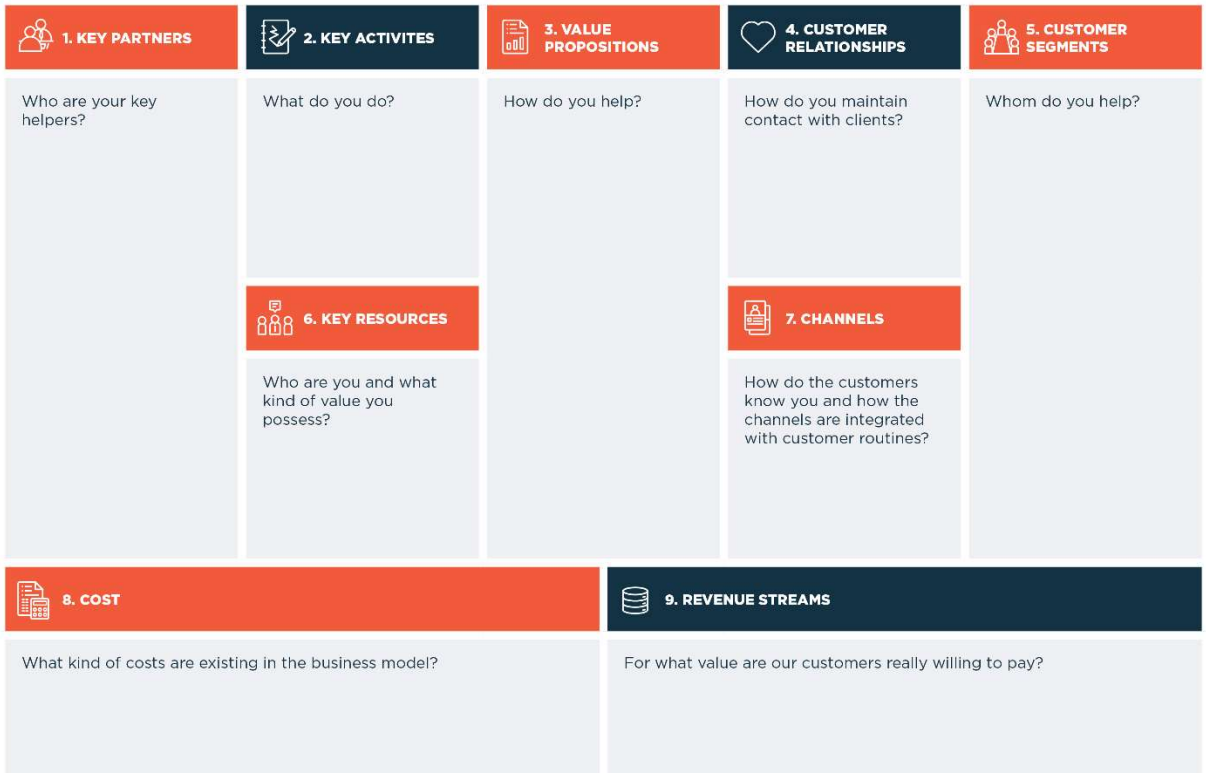

Figure 5 Business Model Canvas

Source: Business Model Canvas: Complete business model on a single sheet of paper | Ergomania UX and product design agency

As Figure 9 shows, the right side of the canvas focuses on the customer or the market (external factors) while the left side of the canvas focuses on the business (internal factors that are mostly under company's control). In the middle, value propositions represent the exchange of value between the business and its customers.

Designed like this, Business Model Canvas can be easily edited and shared with employees and stakeholders.

Although this business model development tool is very widely accepted (by large corporations as well as startups with just a few employees), it showed certain weaknesses:

- It doesn't consider business model design or business model transformation (the approach focuses mostly on business model innovation).
- It doesn't include a business model improvement and development methodology.
- It doesn't' include corporate structure and responsibility, which a business model should include.
- It doesn't include a representation of the main business goals, for example, strategic business objectives, critical success factors, and key performance indicators, which a holistic business model approach should include.
- It doesn't include a representation of the main business issues/pain points and thereby corporate weakness, which a holistic business model approach should include because these factors represent the threat to the company's business model.
- It is based on the theory that between the activities that generate cost and the activities that generate revenue is the value proposition. That view is too simplistic because you can't build a business model based on visible figures of cost and revenue alone, even though cost and revenue should be a part of a business model.
- The linkages among competences, measurements, and results are not explicit.

5.1.2. Lean Startup Canvas

Due to beforementioned weaknesses and the complexity of Business Model Canvas, **new and simpler tools for business model creation had to be developed**. This means the description of elements has become more explicitly conceptualized, shared and formal. Business model frameworks and ontologies do not only define the elements, they also define the relationships between the elements. Depending on the business maturity, different frameworks are recommended for developing a sustainable business model. If the company is in its infancy (a startup), the recommended framework for starting with a business plan development is **Lean Startup Canvas[80].** This framework presents a 1-page business plan template that helps with the deconstruction of the business idea into its key assumptions. It is **adapted from Alex Osterwalder's Business Model Canvas and optimized for Lean Startups**. It replaces elaborate business plans with a single page business model. This framework is concentrated on the way

[80] https://blog.leanstack.com/why-lean-canvas-vs-business-model-canvas-af62c0f250f0

the timeline affects the revenue stream of a business, and it is mainly entrepreneur-focused. It deeply focuses on **startup factors such as uncertainty and risk.** The key fundamental to Lean methodology is the elimination of waste — this includes time, processes, inventory, etc. Figure 6 is a visual representation of Canvas 9 components, with specific filling order:

1. **Problem** – Refers to customer's problem that a company's product or service will solve;
2. **Customer Segments** – Refers to targeting customers and users;
3. **Unique Value Proposition** – Refers to the primary reason a prospect should invest their time and buy a product or a service a company is offering
4. **Solution** – Refers to finding a solution to the customer's problems;
5. **Channels** – Refers to different ways to reach prospects;
6. **Revenue Streams** – Refers to the ways a business will earn revenue from the value propositions;
7. **Cost Structure** – Refers to all of the operational costs for taking a business to market:
8. **Key Metrics** – Refers to the key metrics that will be used to monitor business performance;
9. **Unfair Advantage** – Refers to a competitive advantage which cannot be copied and cannot be bought.

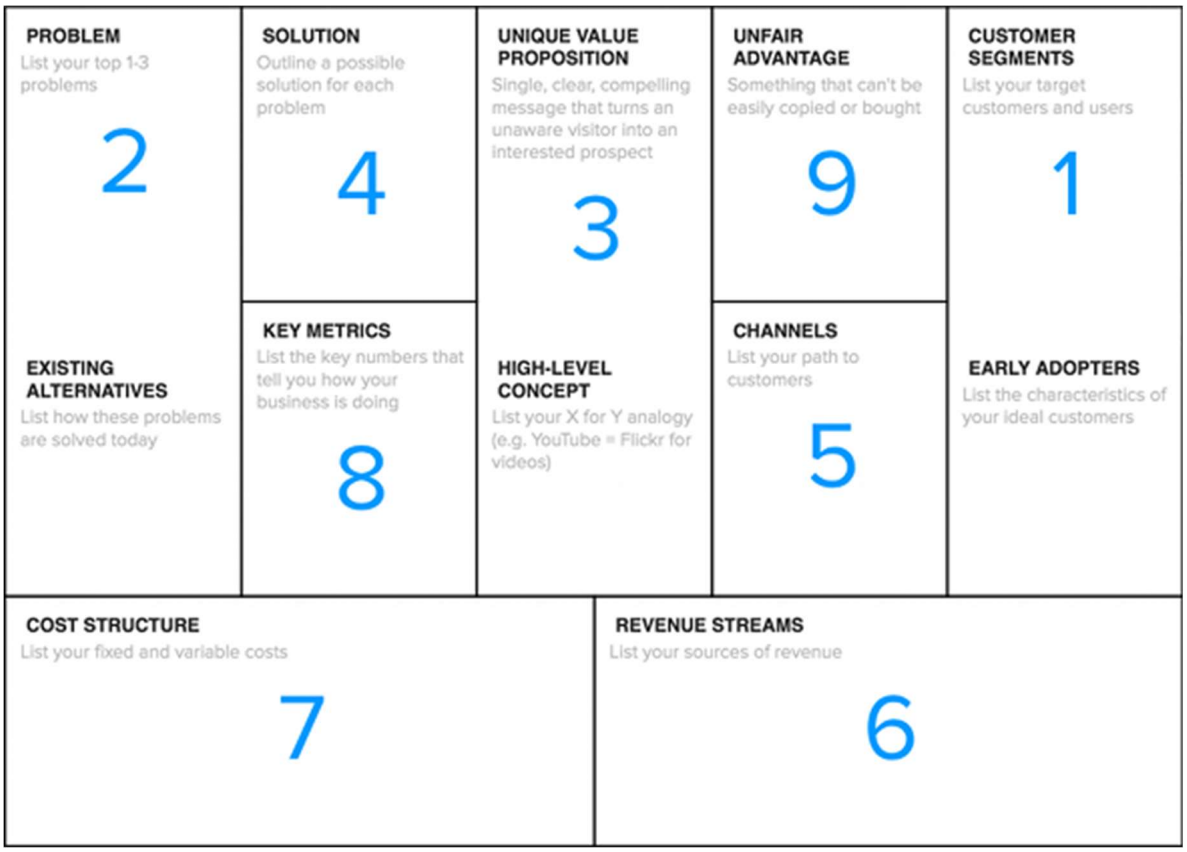

Figure 6 Lean Canvas Framework

Source: Lean Canvas at The Playce | Business model canvas, Start up, Writing a business plan (pinterest.com)

As stated earlier, Lean Startup Canvas represents a slightly modified version of the previously established model – **Business Model Canvas** by Alexander Osterwalder, **which is strongly recommended for established businesses.** The difference between both Canvas Models, as it is shown in the Figure 7, lies in the alteration of the four units:

- Key Partners (Business Model Canvas) vs. Problem (Lean Canvas)
- Key Activities (Business Model Canvas) vs. Solution (Lean Canvas)
- Key Resources (Business Model Canvas) vs. Key Metrics (Lean Canvas)
- Customer Relationships (Business Model Canvas) vs. Unfair Advantage (Lean Canvas)[81]

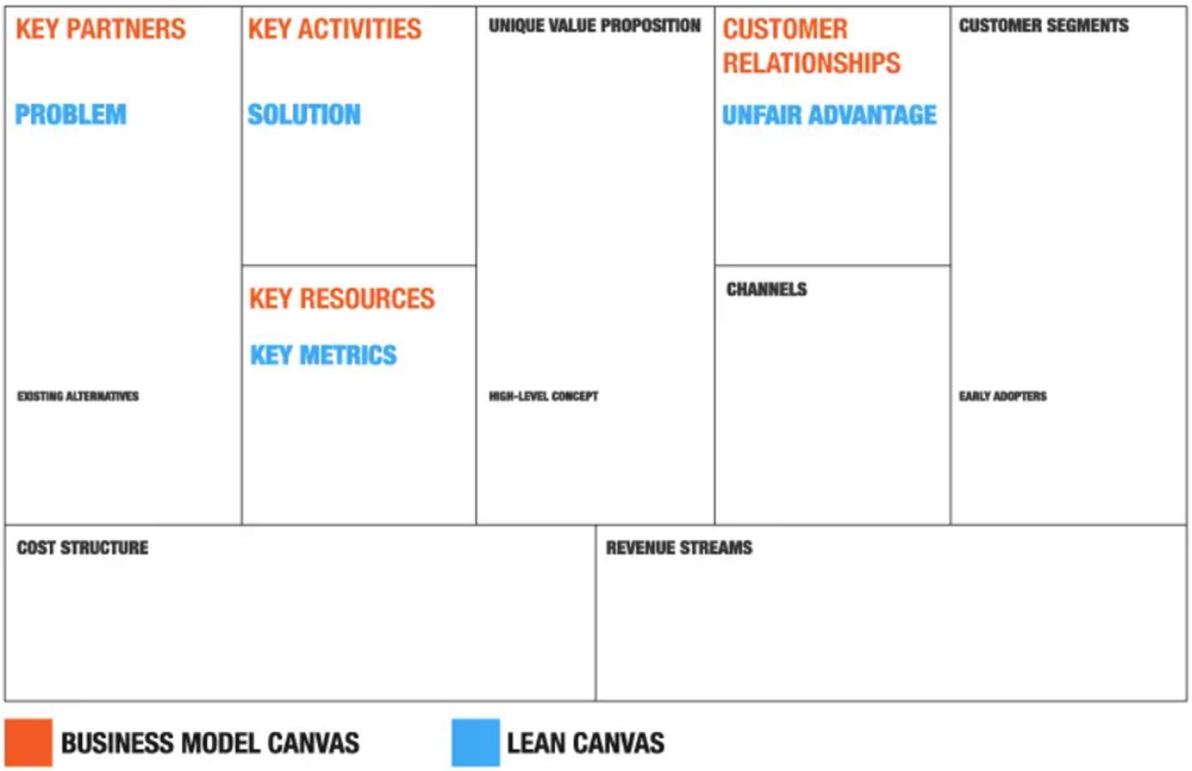

Figure 7 The difference between Lean Canvas and Business Model Canvas Frameworks

Source: https://www.garyfox.co/business-model-canvas-examples/

[81] https://uigstudio.com/insights/lean-canvas-vs-business-model-canvas-which-should-you-choose

5.1.3. Value Proposition Canvas

Created by Alexander Osterwalder, Yves Pigneur, and Alan Smith, Value Proposition Canvas aims to help organizations to position their products or services around customers' values and needs. Hence, **the primary purpose of this business model development tool is to create a fit between the product and market**.

Looking from the perspective of nine building blocks of Business Model Canvas, **Value Proposition Canvas mainly focuses on Customer Segment and Value Proposition.** These two building blocks are the core of the business model because they explain what kind of product/service is offered and to whom. In other words, it explains how a company delivers value to its audience.

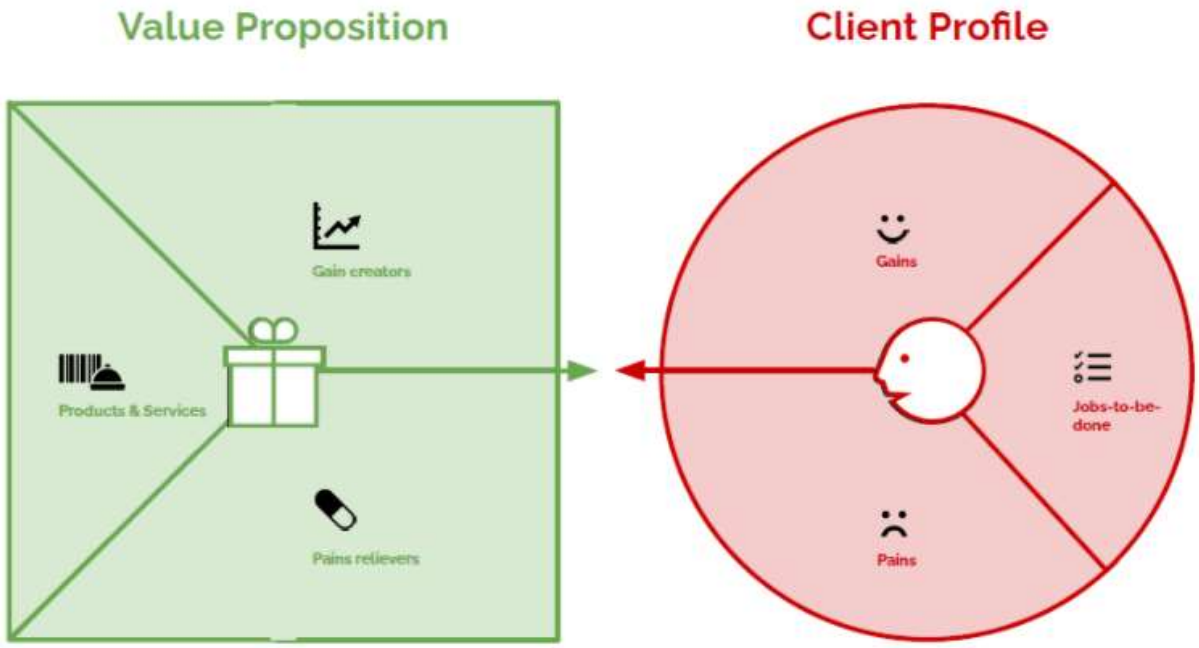

Figure 8 Value Proposition Canvas

Source: What is the Value Proposition Canvas? (businessmodelanalyst.com)

As Figure 10 shows, Value Proposition Canvas is consisted of two sides – **Value Proposition** and **Client Profile**. Value Proposition is divided into:

- Products & Services - includes all the products and services a company is planning to deliver. When building this part of a Value Proposition Canvas, one should consider if the product/service can help customers to accomplish any job-to-be-done, how relevant the product/service is, and if it is tangible or digital/virtual, etc.

- Gain Creators – refers to benefits that the product brings to its customers,
- Pain Relievers – what customer's problems does the company's product solving? For example, it can reduce their costs, negative feelings, efforts, risks, etc.

Client Profile includes:

- Jobs-to-be-done – refers to all tasks that company's customers want to perform. Among these tasks, prioritization has to exist (by the frequency and the importance of each job).
- Pains – severe, less severe and light issues that company's customers experience while they are performing their jobs-to-be-done (negative emotions, challenges, risks involved, financial costs)
- Gains – desirable benefits that company's customers expect (functional, emotional, social or financial) prioritized by relevance and the frequency.

Company needs to create one profile for each customer segment.

First step in developing Value Proposition Canvas is to map customers' profiles and only after that, it can proceed with setting the Value Proposition. This approach allows companies to understanding their customer's needs and wants, and to develop a product/service in accordance with that. Using this tool, **a company can discover its product-market fit** and gain significant time and money savings. The product-market fit is achieved when the products and services match most the most important gains and pains of the customer profile.[82]

However, **the Value Proposition Canvas does not substitute the Business Model Canvas, it rather complements it.** Value Proposition Canvas aims to help a company with understanding its customers better, meaning that it is usually used at the beginning of a startup, when adding a new feature to a product or in case when a company wants to expand its business into a new market or customer segment.

5.1.4. Prototype Canvas

Prototyping is used to make value propositions tangible and concrete. It helps a company to **test a certain aspect of the product or service that its developing**. Prototype Canvas tool is recommended to consider after having filled in the Business Model Canvas and/or the Value Proposition Canvas.

[82] What is the Value Proposition Canvas? (businessmodelanalyst.com)

Prototyping can be used in many phases of the product design, with different purposes. It can be used to find out if something is technically feasible (an 'engineering' prototype), if your design ideas look good, and satisfies design criteria, or if your ideas resonate with customers (a 'validation' prototype).[83] Figure below shows validation prototype canvas.

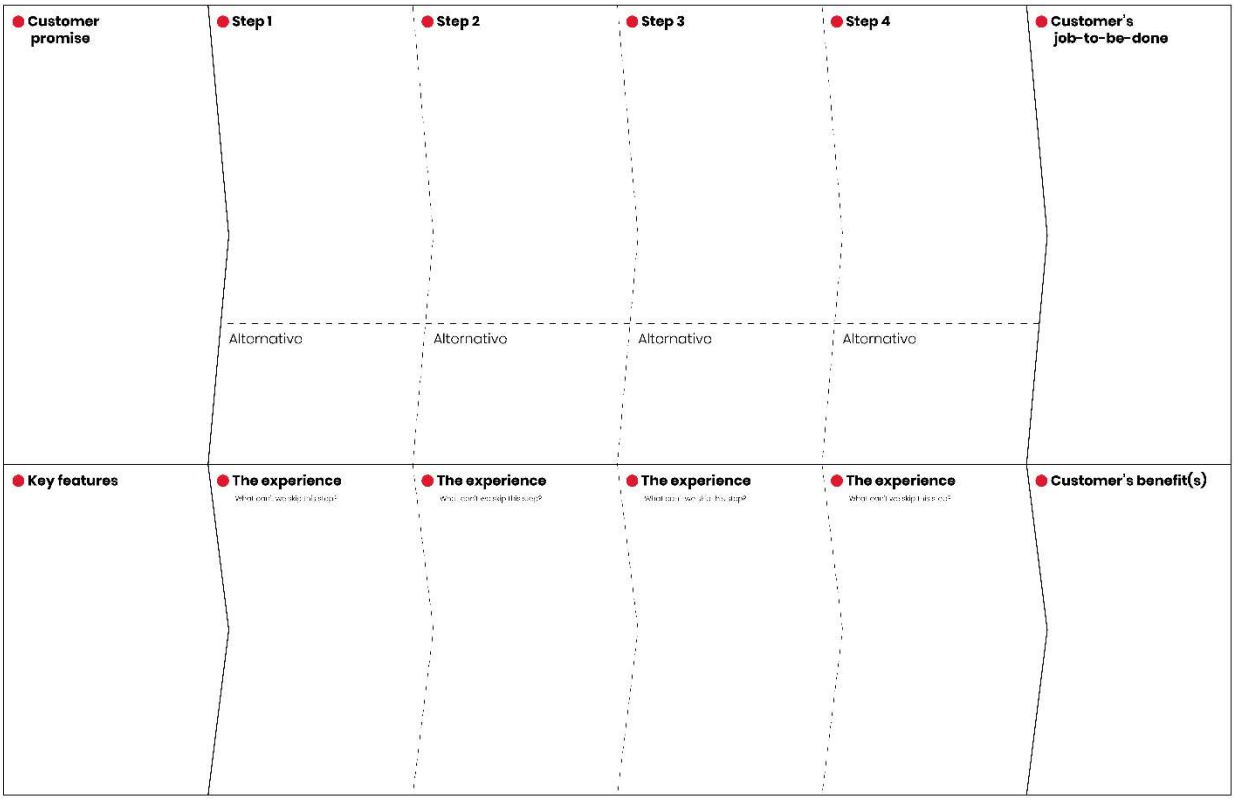

Figure 9 Prototype Canvas

Source: Prototype canvas - Business design tool - Business Models Inc.

A company should start filling in the Prototype Canvas template from the right side of the canvas, with the section '**Customer's job-to-be-done'**. Information for this section can be copied from the Value Proposition Canvas, explaining who the potential customers are and what they want to do with the company's product. After that, they can proceed with listing all the **benefits** customers want to achieve.

Turing to the left side of the canvas, next step that a company should take is to define their promise to potential customers - **What is company's promise to its customers by using the product?** And what are the **key features and functionalities of the product**?

[83] Prototype canvas - Business design tool - Business Models Inc.

Final thing to do is to write down **minimal steps the customer needs to go through to reach the job to be done and the benefits**. Here, a company needs to think if there are any alternatives for each step. Also, a company needs to assume what is customer's experience per step - Do they really need each step or would any of them slow them down in reaching the goal in mind?

Prototyping Canvas effectively guides designers through prototyping processes, facilitates a common prototyping language amongst team members. It encourages intentional prototyping practice, which should ultimately reduce resources and improve design outcomes.

5.2 Sustainable Business Model Tools

Business models are constantly evolving in present times, as new ways of creating value and making profit are being discovered. A formally defined ontology, a model definition, for profit-oriented business models has been employed globally for years, but no equivalent ontology is available in research or practice that enables the description of strongly sustainable business models, as validated by ecological economics and derived from natural, social, and system sciences.

Sustainable business models consider a much wider group of stakeholders than just customers, and explicitly consider society and environment as stakeholders. They go beyond creating value for a customer and include concerns about the benefits and harms to society and the environment by the way business is done. This is a much more systemic view on doing business than making money by delivering benefits and value to customers.

Tools that are analyzed within this section - **the Flourishing Business Canvas and the Value Mapping Tool**, represent how sustainability targets can be integrated into business model philosophy.

5.2.1 Flourishing Business Canvas

The Flourishing Business Canvas (Figure 14) can be explained as deconstructed Business Model Canvas and re-assembled by adding dimensions of sustainability thinking. Business Model Canvas, with its 9 building blocks, can help a company to **"do well"** but in order to **"do good",** business model approach needs to go one step further. It is important that the model looks at all the stakeholder roles, and therefore goes away from the classic profit model; **introducing tri-profit**. Tri-profit is the net sum of the costs (harms) and revenues (benefits) arising from the environmental, social and economic activities of a firm in a given time period measured in

units appropriate to each other.[84] As a result of this methodology, 16 new building blocks of the **Flourishing Business Model Canvas takes respect of the economy, society and environment**. The building blocks are valued co-creation and co-destruction, relationships, channels, stakeholders, ecosystem actors, needs, partnerships, governance, resources, activities, biophysical stocks, ecosystem services, goals, benefits and costs.

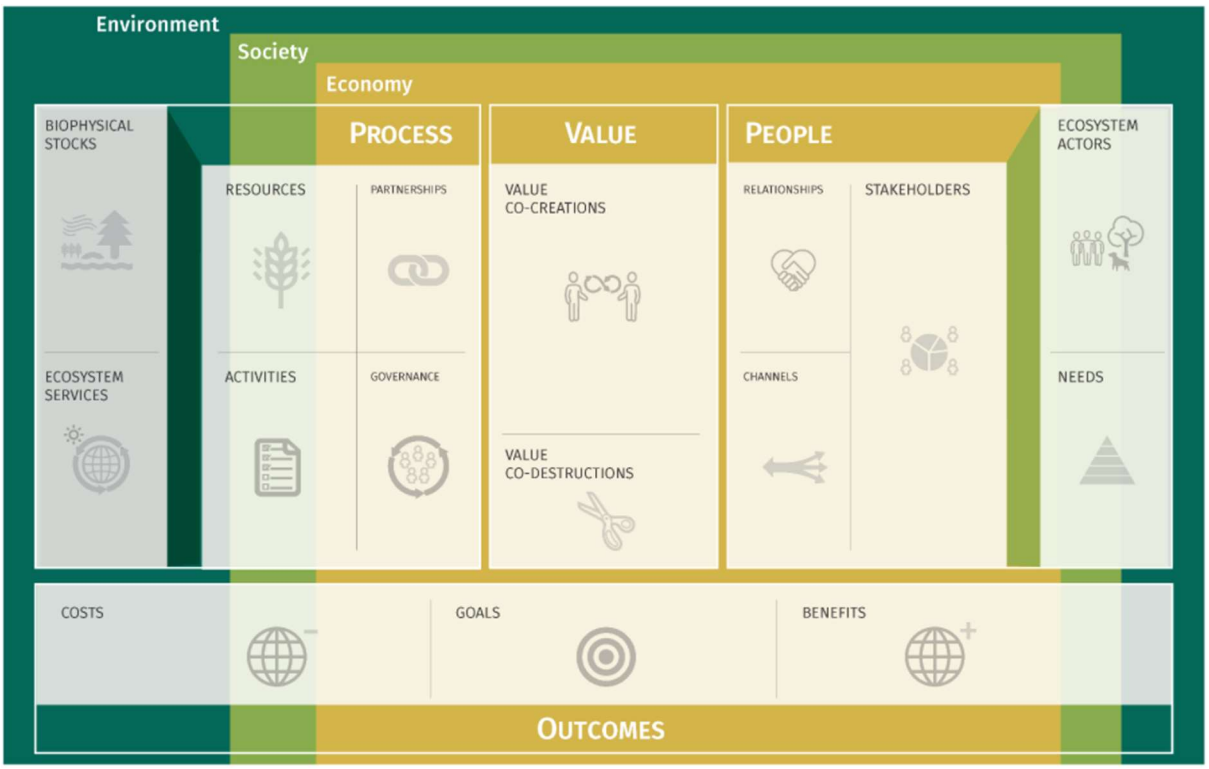

Figure 10 The Flourshing Business Canvas

Source: Eric Fath-Kolmes, Context-Based Design – A Business Model Architecture for an Innovation Centre in the Energy Transition, 2018.

In order to fully understand this business model tool, we need to further explain some building blocks that were not mentioned, or at least not in this form, within Business Model Canvas.

Ecosystem Actors – includes everyone who has an interest in the existing company. When the Ecosystem Actor engages with the company it becomes a stakeholder.

[84] Upward, A., Jones, P., 2016. An Ontology for Strongly Sustainable Business Models: Defining an Enterprise Framework Compatible With Natural and Social Science. Organization & Environment 29, 97–123. doi: 10.1177/1086026615592933

Needs - fundamental needs of the Ecosystem Actor that the company intends to satisfy via its Value Co-Creations, or that it may prevent an Ecosystem Actor from satisfying via its Value Co-Destructions.

Value Co-Creations - positive Value Proposition of a company; Values that are co-created with each Stakeholder, satisfying the Needs of the associated Ecosystem Actor,

Value Co-Destruction - negative Value Proposition of a company; Values that are co-destructed for each Stakeholder, hindering the satisfaction of the Needs of the associated Ecosystem Actor.

Governance - stakeholders who make decisions about all elements of the company's Business Model.

Biophysical Stocks - From what ultimate stocks are the tangible resources moved and/or transformed by the company's activities to achieve its goals?

Ecosystem Services - processes powered by the sun that use biophysical stocks to create flows of benefits that humans need: clean water, fresh air, vibrant soil, plant and animal growth, etc. Which flows of these benefits are required, harmed or improved by the activities of the company?[85]

5.2.2 Value Mapping Tool

A value mapping tool is another tool developed to help companies create value propositions better suited for sustainability. Benefits offered to users of this tool include:

- Better understanding of the positive and negative aspects of value in a network of stakeholders;
- Identification of conflicting values (i.e. where one stakeholder benefit creates a negative for another stakeholder);
- Identification of opportunities for business model redesign, especially to improve societal and environmental impact.[86]

[85] Fien Van den Broeck, (2017), "The Flourishing Business Canvas; the new tool for Business Modelling? – A multiple case study in the Fashion Industry", The Swedish School of Textiles, University of Borås

[86] Bocken, N., Short, S., Rana, P. and Evans, S. (2013), "A value mapping tool for sustainable business modelling", Corporate Governance, Vol. 13 No. 5, pp. 482-497

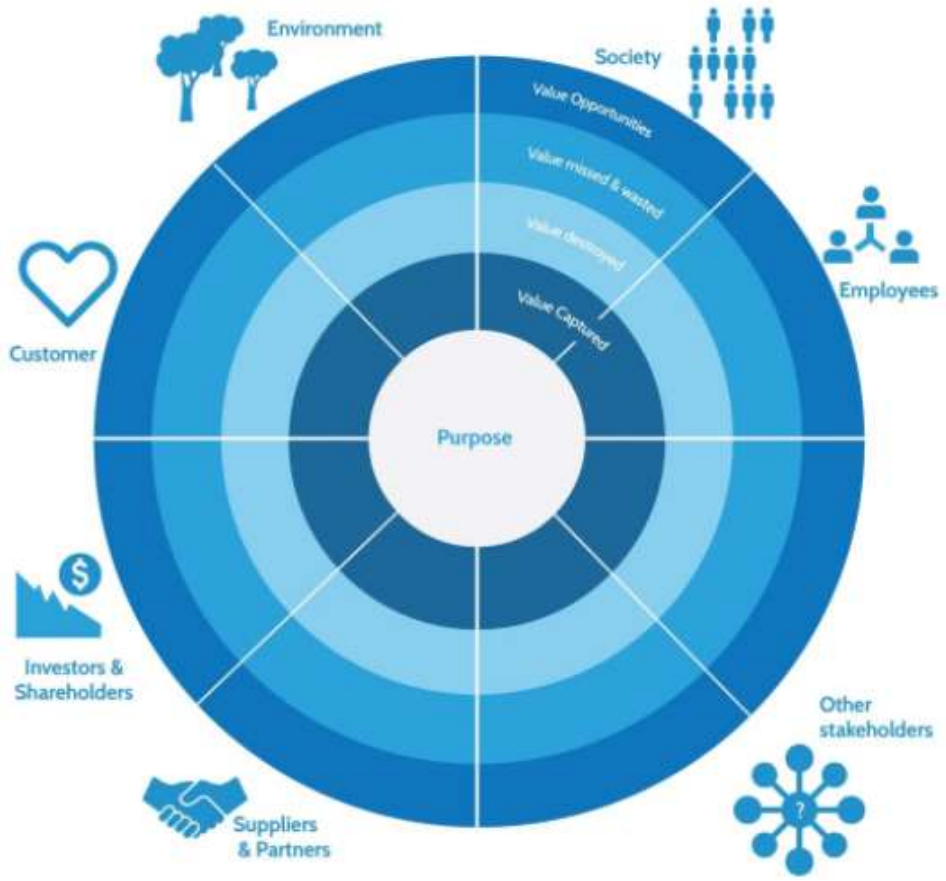

Figure 11 Value Mapping Tool

Source: [Sustainable business modelling | Nancy Bocken]

Figure 11 shows Value Mapping Tool where the primary reason for the existence of the business takes the center of the concept. From the center, four different rings are dedicated to the following aspects of a business:

- Value Captured
- Value Destroyed
- Value Missed and Wasted
- Value Opportunities.

When defining each of these categories, all relevant "stakeholders" need to be considered – customers, network actors (the company and its suppliers and partners responsible for creating value), environment and society.

Value Captured refers to the general value created for the different types of stakeholders. While a company aims to create positive value for its stakeholders, it should also pay attention to negative value that the stakeholders mitigate.

Another aspect to think about is the **value destroyed or missed or negative outcomes for any of the stakeholders**. For example, waste to landfill or loss of local employment caused by offshoring. The important thing to consider refers to the possible contradicting impacts at a global and local level. Is the business missing an opportunity to capture value, or squandering value in its existing operations? For example, are assets, capacity and capabilities under-utilised? Are potentially useful materials going to landfill?[87]

Last thing to consider are possible **value opportunities**, that can be a result of new collaborations. Also, a company can learn a lot from its competitors, suppliers, customers and even other industries.

Figure below represents a great example of canvas that can help companies with putting into practice previously developed Value Mapping Tool.

Figure 12 Canvas adjusted to the Value Mapping Tool

Source: [Sustainable business modelling | Nancy Bocken]

5.3. Circular Business Model Tools

Circular Economy (CE) concept has been popularized since its benefits and importance has been recognized by policy makers and business experts. New circular business models (CBMs)

[87] Sustainable business modelling | Nancy Bocken

have been heralded as a potential driver for CE transitions.[88] CBMs contribute to the slowing of resource loops by encouraging long product life and reuse of products, closing loops through capturing the residual value from by-products or "waste" through business model innovation, and narrowing resource loops through product design and manufacturing efficiencies.[89] Nevertheless, CBMs are not yet widespread in business practice because they require a change of the key building blocks of the business. Also, they go against dominant business paradigms that are focused on linear economy.[90]

In order to support operationalization of the CE, reliable CBM tools need to be identified. In this chapter, existing circular business model innovation tools will be analyzed. Our aim is to provide guidance in the process of circular business model innovation and help business developers overcome the challenges experienced when designing and innovating business models towards circularity.

5.3.1. Circular Business Model Canvas

In order to use Business Model Canvas in the context of CE, core circular economy principles need to be applied to the components of this tool. This requires specific approach to each building block of BM Canvas.

Value Proposition

Circular products have several specific features related to the CE principles, and these are:

- They enable product-life extension through maintenance, repair, refurbishment, redistribution, upgrading and reselling;
- They are designed to enhance reusing, recycling, and cascading by choosing appropriate materials;
- Production process tends to use less raw material or energy or to minimize emissions;

[88] Ghisellini, P.; Cialani, C.; Ulgiati, S. A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *J. Clean. Prod.* **2016**, *114*, 11–32.
[89] Bocken, N.M.P.; de Pauw, I.; Bakker, C.; van der Grinten, B. Product design and business model strategies for a circular economy. *J. Ind. Prod. Eng.* **2016**, *33*, 308–320.
[90] Nancy Bocken, Lars Strupeit, Katherine Whalen, Julia Nußholz. (2019). A Review and Evaluation of Circular Business Model Innovation Tools. The International Institute for Industrial Environmental Economics, Lund University, Tegnérplatsen 4, Lund 22100, Sweden

- Circular products can be also dematerialized and offered not as physical, but as virtual products.[91]

In a product-service system a company offers access to the product but retains its ownership. This can be done by leasing, renting, pooling, and pay-per-service unit. It is an alternative to the traditional model of "buy and own". Furthermore, circular value propositions related to services may concern shifting their traditional form to a virtual one.

Important thing to emphasize is that the value proposition must be adjusted to specific customer segments.

Channels

Virtualization represents the biggest shift towards a circular business model. For example, a company can produce digital products and use virtual channels such as online shops. Also, communication with stakeholders can be implemented via online platforms - websites, e-mails, social media etc.[92]

Customer Relationships

Building and maintaining relationships with customers can support **elimination of waste** by producing on order and engaging customers to vote for which product to make.[93]

Revenue Streams

Traditional options of revenue streams include selling pure products or pure services. However, a company operating with respect to CE principles can make money by:

- input-based product-service systems (pay per product/service)
- availability-based product-service systems (subscription-based rental – periodic payments)
- usage-based product-service systems (pay per use - a one-time payment)
- performance-based product-service systems (performance-based contracting).[94,95]

Key Resources

[91] Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. Sustainability, 8(1), p.43.
[92] Ellen MacArthur Foundation. Delivering the Circular Economy a Toolkit for Policymakers; Ellen MacArthur Foundation: Cowes, UK, 2015
[93] Van Renswoude, K.; Wolde, A.T.; Joustra, D.J. Circular Business Models. Part 1: An introduction to IMSA's Circular Business Model Scan
[94] Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. Sustainability, 8(1), p.43.
[95] Van Ostaeyen, J.; van Horenbeek, A.; Pintelon, L.; Duflou, J.R. A refined typology of product–service systems based on functional hierarchy modeling. J. Clean. Prod. 2013, 51, 261–276.

Here, we need to focus on two dimensions: **input choices** and **regenerating and restoring the natural capital**.

First dimension includes substitution of resources with eco-friendly materials or direct virtualization of materials.

Regenerating and restoring the natural capital can be done through using energy from renewable sources, land restoration or reclamation, saving water, operating in more efficient buildings etc.[96]

Key Activities

This building block should be consisted of activities that may apply the CE principles and, at the same time, directly or indirectly lead to creating, offering and delivering the value propositions. Some of these activities can be oriented on **increasing performance**, **product design, technology exchange**, and the other on **remanufacturing, recycling or even lobbying.**[97]

Key Partnerships

This building block refers to the network of suppliers and partners that make the business model effective. Collaboration enhances obtaining key resources and performing key activities. However, **for a partnership to be healthy and sustainable, there need to be visible gains on both ends**. Some partnerships may seem lucrative in theory but fail to get off the ground practically. In addition, changes in the business context may also make some business partnerships irrelevant.

Cost Structure

When a company decides to change the cost structure it might require further organizational changes, such as for materials, energy consumption, staff behavior etc., and in turn elicit more circular changes to the business model.[98]

Figure below shows potential CE business model elements to consider.

[96] Lacy, P.; Keeble, J.; McNamara, R.; Rutqvist, J.; Haglund, T.; Cui, M.; Cooper, A.; Pettersson, C.; Kevin, E.; Buddemeier, P.; et al. Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth; Accenture: Chicago, IL, USA, 2014.

[97] Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. Sustainability, 8(1), p.43.

[98] Mentink, B. Circular Business Model Innovation: A Process Framework and a Tool for Business Model Innovation in a Circular Economy. Master's Thesis, Delft University of Technology & Leiden University, Leiden, The Netherlands, 2014.

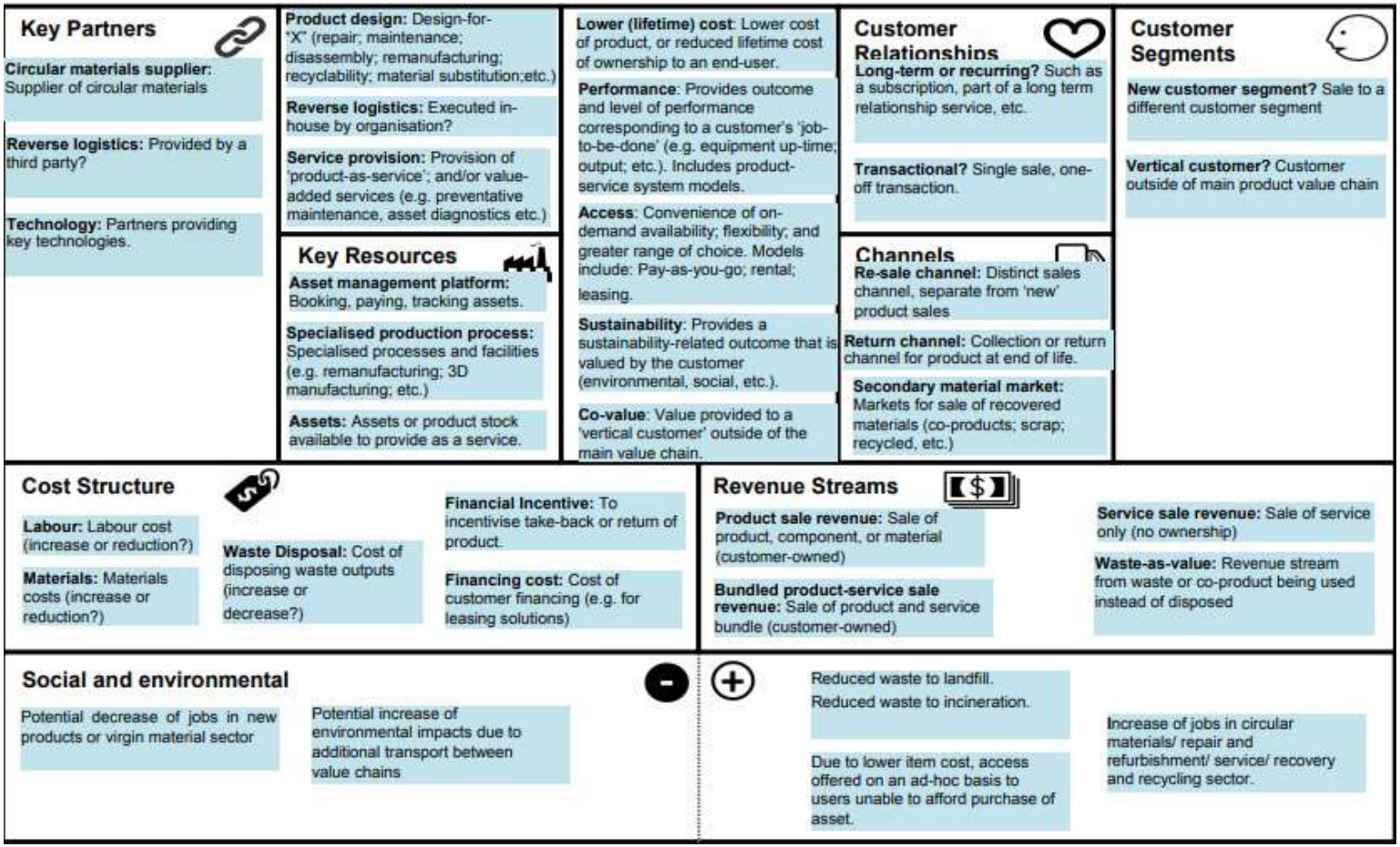

Figure 13 Summary of potential CE business model elements

Source: [11.-CE-Business-Model-Elements.pdf (r2piproject.eu)]

Lewandowski (2016)[99] presented **circular business model canvas** by adding two new building blocks to Business Model Canvas - **Take-Back System** and **Adoption Factor**.

Take-Back System

It describes a system for material circulation. The principles of the Circular Economy applied to reverse logistics are related to take-back management, incentivized return and reuse, and collection of used products. According to the direction of material flow in a supply chain, both forward and reverse are possible[100], but reversed logistics may require different partners, channels and customer relations.

Adoption Factor

This factor presents **the internal and external capabilities of a company for transition towards circular economy.** Internal factors concern organizational capabilities such as team motivation and organizational culture. On the other hand, external factors comprise technological, political, sociocultural, and economic issues.[101]

<table>
<tr>
<td rowspan="3">Partners
• Cooperative networks
• Types of collaboration</td>
<td>Activities
• Optimising performance
• Product Design
• Lobbying
• Remanufacturing, recycling
• Technology exchange</td>
<td rowspan="3">Value Proposition
• PSS
• Circular Product
• Virtual service
• Incentives for customers in Take-Back System</td>
<td>Customer Relations
• Produce on order
• Customer vote (design)
• Social-marketing strategies and relationships with community partners in Recycling 2.0</td>
<td rowspan="3">Customer Segments
• Customer types</td>
</tr>
<tr>
<td>Key Resources
• Better-performing materials
• Regeneration and restoring of natural capital
• Virtualization of materials
• Retrieved Resources (products, components, materials)</td>
<td>Channels
• Virtualization</td>
</tr>
<tr>
<td>Take-Back System
• Take-back management
• Channels
• Customer relations</td>
</tr>
<tr>
<td colspan="3">Cost Structure
• Evaluation criteria
• Value of incentives for customers
• Guidelines to account the costs of material flow</td>
<td colspan="3">Revenue Streams
• Input-based
• Availability-based
• Usage-based
• Performance-based
• Value of retrieved resources</td>
</tr>
<tr>
<td colspan="6">Adoption Factors
• Organizational capabilities
• PEST factors</td>
</tr>
</table>

[99] Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. Sustainability, 8(1), p.43.

[100] Govindan, K.; Soleimani, H.; Kannan, D. Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. Eur. J. Oper. Res. 2014, 240, 603–626.

[101] Roos, G. Business Model Innovation to Create and Capture Resource Value in Future Circular Material Chains. Resources 2014, 3, 248–274.

Figure 14 Circular Business Model Canvas

Source: Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. Sustainability, 8(1), p.43.

5.3.2. Business Cycle Canvas

System thinking is recognized by Mentink (2014) as the most vital gap among current circular business model innovation methods. It refers to the **consideration of the relation between the organization's behavior and other processes**.[102] For this purpose, circular business models need interaction between all involved stakeholders, including both the core-business network and other stakeholders.

In order to overcome this gap of circular business model canvas, and to provide a guidance in the managerial and organizational challenges of the subsequent implementation phase, Mentink (2014) created a new tool - **Business Cycle Canvas**.[103] This business model tool is based on business model canvas and that's the reason why these two canvasses have similar components. However, the main difference between them is that Business Cycle Canvas **refers to the whole 'business cycle' instead of only the individual business model.**

Business cycle of this canvas includes **four main components (who, what, how and why)** in comparison to the nine building blocks of business model canvas. Figure 19 presents business cycle canvas transformed from the business model canvas, and the explanation of its building components is given below.

[102] Renswoude, K., Wolde, A. and Joustra, D. (2015). Circular Business Models – Part 1: An introduction to IMSA's circular business model scan. Amsterdam: IMSA

[103] Mentink, B. (2014). Circular Business Model Innovation A process framework and a tool for business model innovation in a circular economy. Master of Science in Industrial Ecology. Delft University of Technology & Leiden University

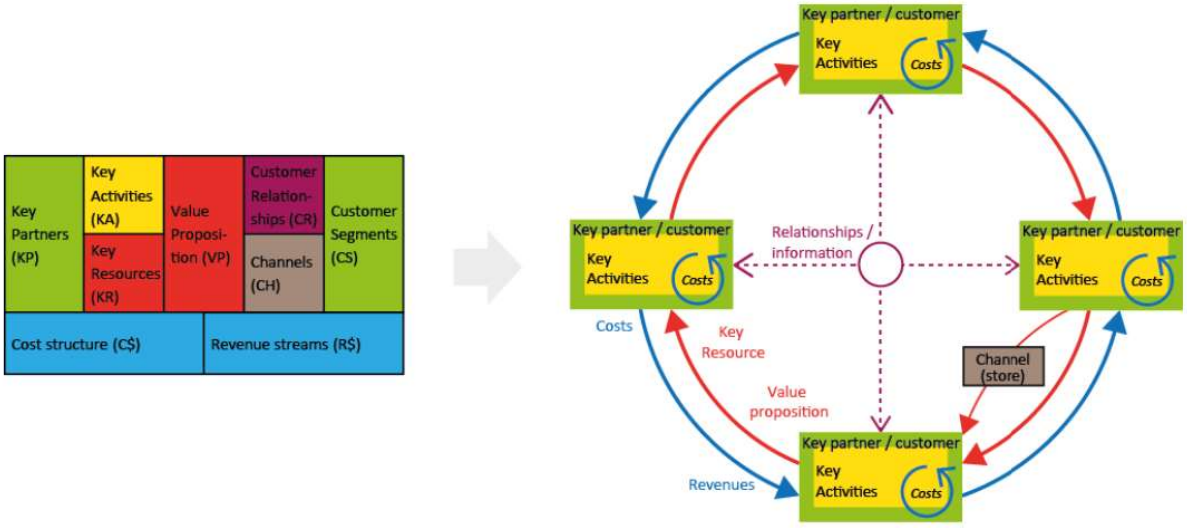

Figure 15 Business Cycle Canvas (Mentink, 2014)

Source: Mentink, B. (2014). Circular Business Model Innovation A process framework and a tool for business model innovation in a circular economy. Master of Science in Industrial Ecology. Delft University of Technology & Leiden University

What: refers to **value proposition** and **key resources** which may be recognized as materials or information. Red arrows represent material (such as products or product-services, raw materials, waste flows, water etc.) and purple arrows represent information (hard information - data, licenses, education, and soft information/relationships - trust, reputation etc.). One's value proposition is regarded as another's key resources.[104]

Who: refers to both **key partners / suppliers** and **customers** (presented by green boxes) because business cycle canvas implies that customers become suppliers in the next step of supply chain.

How: refers to everything that the company has (**Key Resources and capabilities**) and does (**Key Activities and processes**) to make a value proposition. This component is represented by yellow color inside green boxes.

Why: refers to both **incoming values** and **outgoing values**. These values include financial flows, but also social (health, happiness, etc.) and ecological values (nature conservation, biodiversity, pollution, etc.). They are represented as blue arrows and direction of the arrow determines

[104] Mentink, B. (2014). Circular Business Model Innovation A process framework and a tool for business model innovation in a circular economy. Master of Science in Industrial Ecology. Delft University of Technology & Leiden University

either incoming or outgoing value. The sum of positive values (such as revenues) should be larger than the sum of negative values (such as costs).

Building blocks from Business Model Canvas - Channels and Customer Relationships - can be incorporated in the Business Cycle Canvas by introducing **channels as other partners with separate Business Models** (e.g. retailers) and **customer relationships as reciprocating flows of 'soft information'** (reputation, credits, exposure, marketing, contact, etc.).[105]

Connecting the Business Models with different types of flows automatically generates **systems**, that may take various shapes. Business Model Canvas does not have this feature – it always has the same outline of the canvas (because it works for all individual Business Models). Figure below shows some different shapes of business cycle canvas.[106]

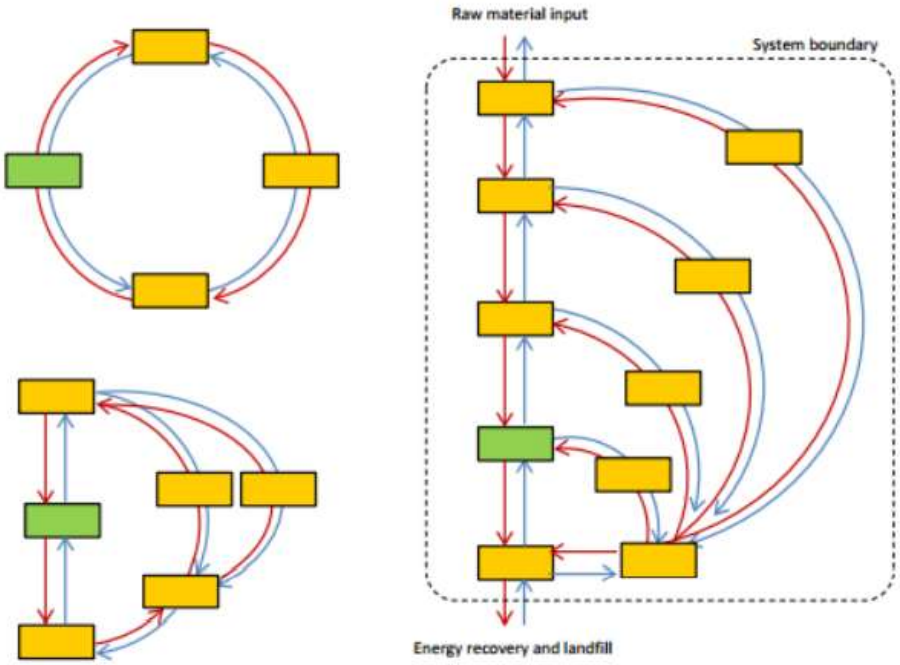

Figure 16 Different shapes of Business Cycle Canvas

Source: Mentink, B. (2014). Circular Business Model Innovation A process framework and a tool for business model innovation in a circular economy. Master of Science in Industrial Ecology. Delft University of Technology & Leiden University

[105] Mentink, B. (2014). Circular Business Model Innovation A process framework and a tool for business model innovation in a circular economy. Master of Science in Industrial Ecology. Delft University of Technology & Leiden University

[106] Mentink, B. (2014). Circular Business Model Innovation A process framework and a tool for business model innovation in a circular economy. Master of Science in Industrial Ecology. Delft University of Technology & Leiden University

5.3.3. Moonfish Circular Business Model

The Moonfish concept implies two main CE activities: (1) a design and an optimization of easily repairable, disassemblable and reusable products, and (2) a strong relationship between companies and end-users. This model tends to generate cycles able to return the intrinsic value of products back to the company.[107] **Moonfish Circular Business Model** (Figure 17) is based on Osterwalder & Pigneur's Business Model Canvas[108] and the Ellen MacArthur Foundation's Circular Economy System Diagram[109]. It presents four types of cycle:

- Maintenance - a service offered by the producers to implement the inner cycle;
- Reselling - it acts when a product can be used again for the same purpose, limiting its enhancement or change;
- Remanufacturing/Refurbishing - applied to a non-working product to restore its good operating conditions. It is also applied in components in good conditions to build new products;
- Recycling - it consists of the reincorporation of used-up products into the cycle in the form of input material.[110]

In order to emphasize the ongoing process of circular business, which never ends, the Moonfish Business Model has the structure of the infinity symbol. The smaller cycles involve fewer efforts and offer more potential for saving materials, labor and energy.

[107] Bianchini, Rossi, Pellegrini: Overcoming the Main Barriers of Circular Economy Implementation through a New Visualization Tool for Circular Business Models, 2019

[108] Osterwalder, A.; Pigneur, Y.; Clark, T. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*; Wiley: Hoboken, NJ, USA, 2010; ISBN 978-0-470-87641-1.

[109] Moonfish-Creating Sustainable Value for the Future. Available online: https://strategicvalueofdesign.org/2014/06/17/creating-sustainable-value-for-the-future/

[110] What Is A Business Model? Definition, Explanation & 30+ Examples (garyfox.co)

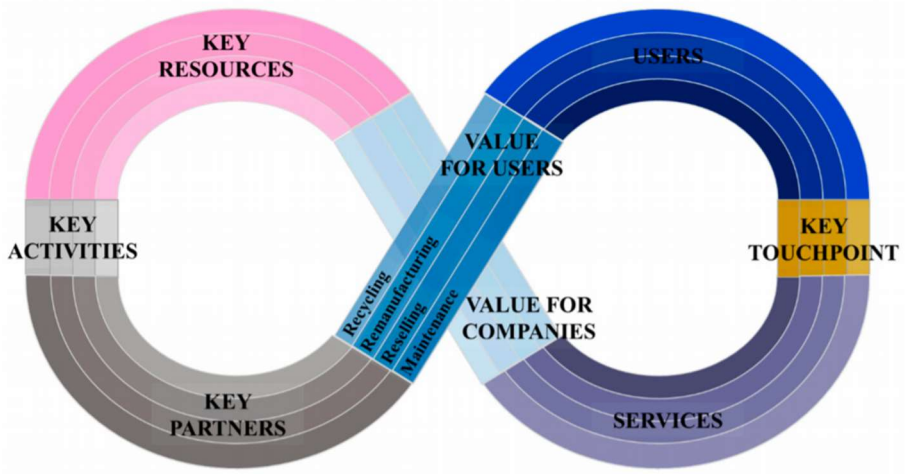

Figure 17 The Moonfish Circular Business Canvas

Source: Bianchini, Rossi, Pellegrini: Overcoming the Main Barriers of Circular Economy Implementation through a New Visualization Tool for Circular Business Models, 2019.

As Figure 21 shows, the Moonfish diagram is structured as a Business Model Canvas, using its building blocks, since it can be used to map the different partners and components that are involved in the business, identifying future opportunities through the development of circular economy capabilities within the company.[111] This business model can be a perfect solution for small and medium companies who are interested in exploring new ways of creating sustainable value.

[111] Lewandowski, M. Designing the Business Models for Circular Economy—Towards the Conceptual Framework. *Sustainability* 2016, 8, 43.

5.4. Business Models For Non-Profit Organizations

A **non-profit organization** is a legal organization whose **primary purpose is to promote public good rather than making profit**. However, these organizations are still making profit and it is used for furthering the aim of the concern. Examples of non-profit organizations include, public hospitals, religious institutions, cooperative societies, etc.[112]

Mission is not the only difference between profit and non-profit organizations. They also have different target audiences and overall problem-solving strategies. The **main differences between profit and non-profit organizations** are presented in the table below.

Basis for comparison	Profit organization	Non-profit organization
Purpose	To generate profit by developing and selling effective products and services that are valuable to consumers	To make collective, public or social benefit; promoting a social cause or advocating for a particular standpoint.
Form of organization	Sole proprietorship, Partnership firm or company	Club, Trust, Public hospitals, society, etc.
Source of revenue	Sale of goods and services	Donation, subscription, membership fee etc.
Typical type of funding	Bank loans, local/national/global investors (angel investors, private equity/venture capital), revenue generated from sales	Private donations, corporate sponsorships, government grants, crowdfunding (as a form of online fundraising)
Audience	Defined target audience, consumers who will purchase their products/services	Diverse audience which can include volunteers, donors, corporate sponsors, and the general public

[112] Difference Between Profit and Non-Profit Organisation (with and Comparison Chart) - Key Differences

Leadership	Executive director (s) who has a stake in the financial success of the organization, which often results in incentives such as bonuses and profit sharing.	Trustees, committees or governing bodies who guide the future of the organization without possessing direct financial ownership
Organizational culture	Profit- oriented, focus on finances and business metrics (KPIs)	Community-oriented, focus on problems that have little financial incentive

Table 6 Differences between profit and non-profit organizations

Source: Own elaboration by BIOS

The most common business model used by non-profit organization is **Business Model Canvas**, but its **modified version** which takes into account all the differences between profit and non-profit organizations. Figure 18 shows components of the Business Model Canvas (BMC) adjusted to non-profit organizations.

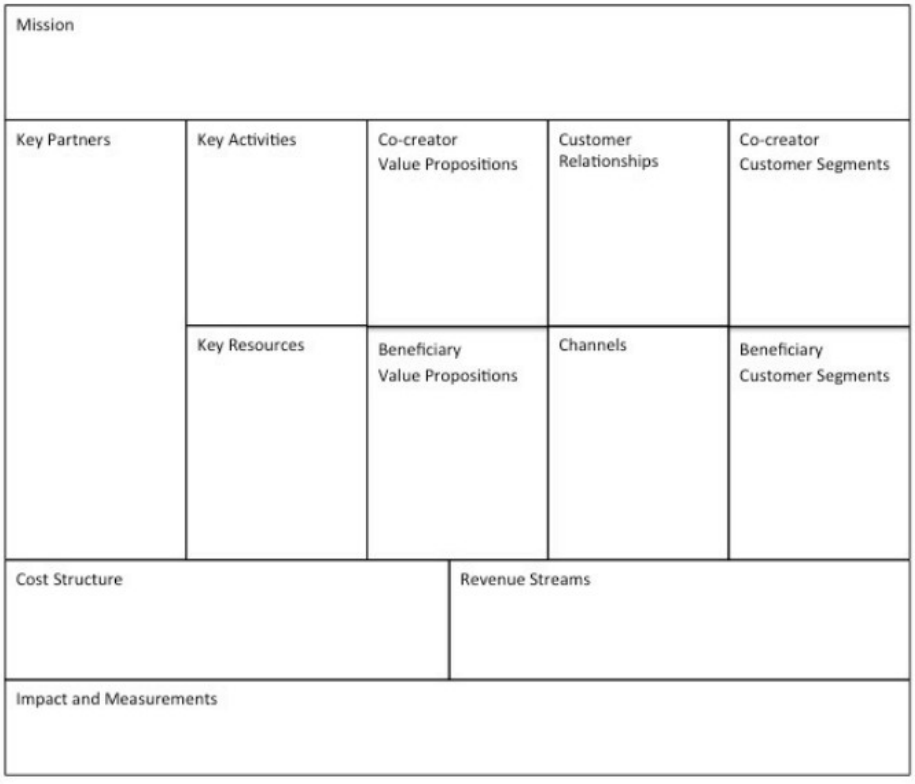

Figure 18 Business Model Canvas for Non-profit Organizations

Source: [BusinessModelCanvas2017 (glcyd.org)]

Most of the 'left-hand side' of the model in Business Model Canvas is much the same in a for-profit and not-for-profit context, but the 'right-hand side' is often radically different in a not-for-profit context.[113] In order to understand modified structure of BMC, new and modified building blocks are explained below.[114]

Mission - refers to the purpose of the organization and should be defined by a certain scope – education, community development, health and well-being contributions and so on.

Customer Segments – involves all actors the organization serves. On the **donor's side**, there are benefactors, contributors, volunteers, government, collaborators; while the **client's side** includes members of the organization, geographic and demographic groups, practitioners and/or some disadvantaged groups.

Value Proposition – here, organization must take into account **donor's priorities and client's needs and interests**. Donor's priorities include volunteer engagements, technical advancement, advocacy, financial stewardship, resource development and goodwill. On the other hand, organizations' clients may be interested in collections, information, counseling, spiritual care, education, etc.

Relationships – this building block refers to the **nature of the interaction between organization and its clients**. This interaction can be obligatory/voluntary, community-wide/ individualized, compensated/free, confidential/public, etc. Also, it can be defined by duration, frequency and fidelity.

Channels – describes **methods of interaction between organization and its clients.** For example, scheduled events and activities, direct e-mails/magazines/newsletters, website, social media, physical facility, contact center, etc.

Cost Structure should be modified to **Value-streams** – outlay and costs, in order to include non-monetary costs, such as investment of effort or potential costs to reputation, etc.

Revenue Streams should be modified to **Value-streams** – returns, in order to include non-monetary value, in particular success in terms of the charity's social/environmental aims.[115]

Impact and Measurements – organization must record its outcomes and communicate results of its work. Outcomes that contribute to society include, for example, delivered pounds of food and clothes, protected and preserved resources, educated people, developed technologies, instituted laws, and so on. Celebrating achieved goals with stakeholders is very important for

[113] Using Business Model Canvas for non-profits – Tom Graves / Tetradian
[114] BusinessModelCanvas2017 (glcyd.org)
[115] Using Business Model Canvas for non-profits – Tom Graves / Tetradian

every non-profit organization as it makes relationships stronger and stimulates further development.

5.5. Business Models For Cities

There is a fundamental difference between the purpose of a company's and a city's business model. Company's business model aims at articulating specifically how the company delivers and captures value. On the other hand, a **city business model is meant to guide a City Council in articulating how it will accomplish the objectives of its smart and sustainable city strategy**.[116] Since there is currently no generally used method to understand city business models, we will analyze how Business Model Canvas can be adjusted to city's needs.

Overall, Business Models for cities should aim to define how a city can create and deliver value through the development of economically, socially and environmentally sustainable services. The logic of a city business model can facilitate a more holistic governance framework centered on the creation and delivery of value for their citizens based on a thorough analysis of the city's needs and of how well different proposed solutions solve those needs.[117]

Business Model for cities should suit both public and private actors aiming to deliver value to a more diverse set of end users in a collaborative effort.[118] Figure 19 shows **City Model Canvas** developed within Replicate project H2020. The city business model should be considered as an element of the city's wider strategy to become a smart and sustainable city.

[116] Timeus, Krista; Vinaixa, Jordi; Pardo-Bosch, Francesc; & Ysa, Tamyko (2017). Report on the Business Models of the Lighthouse Cities (Horizon 2020: REPLICATE Project Reports No. 2.2). Barcelona: ESADE Business School

[117] Timeus, Krista; Vinaixa, Jordi; Pardo-Bosch, Francesc; & Ysa, Tamyko (2017). Report on the Business Models of the Lighthouse Cities (Horizon 2020: REPLICATE Project Reports No. 2.2). Barcelona: ESADE Business School

[118] Giourka, P.; Sanders, M.W.J.L.; Angelakoglou, K.; Pramangioulis, D.; Nikolopoulos, N.; Rakopoulos, D.; Tryferidis, A.; Tzovaras, D. The Smart City Business Model Canvas—A Smart City Business Modeling Framework and Practical Tool. *Energies* 2019, *12*, 4798.

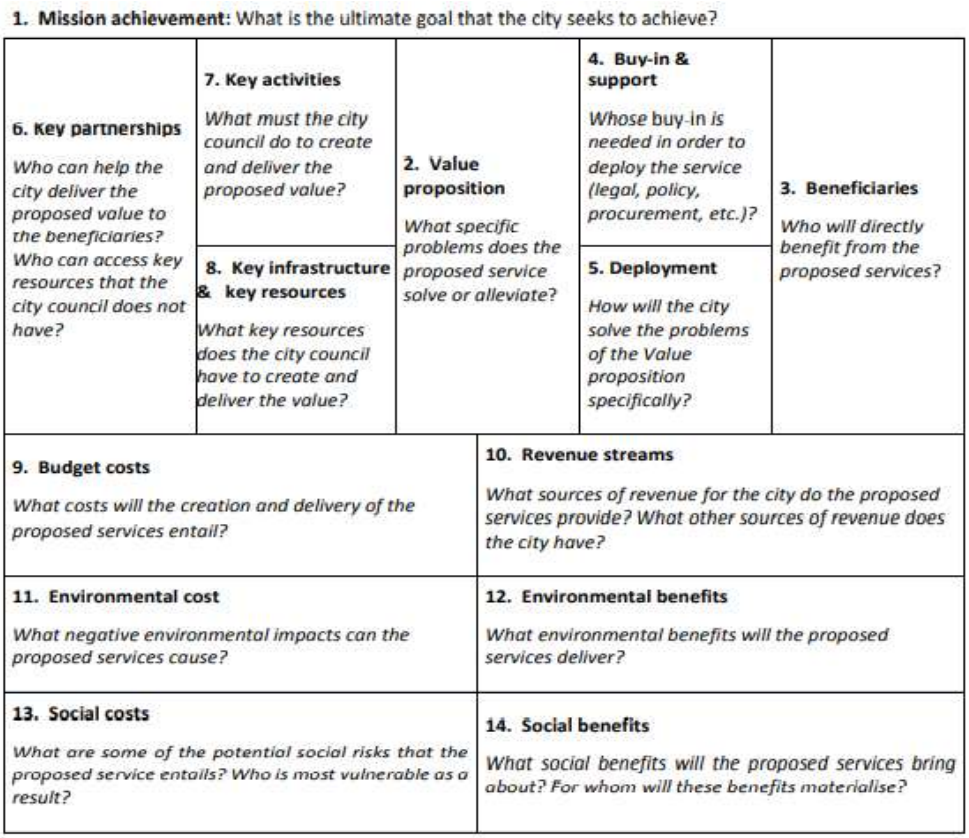

Figure 19 Smart City Model Canvas

Source: Timeus, Krista; Vinaixa, Jordi; Pardo-Bosch, Francesc; & Ysa, Tamyko (2017). Report on the Business Models of the Lighthouse Cities (Horizon 2020: REPLICATE Project Reports No. 2.2). Barcelona: ESADE Business School

We can notice that this Business Models for Cities has **three specific features** in comparison to the standard Business Model Canvas used by for-profit companies. First, some of the key BMC building blocks are re-labeled in such a way that **City Model Canvas reflects logic of a mission-driven organization (such as non-profit organization).** Second, it incorporates key elements of Sustainable Business Model Tools, meaning that **it includes not only economic, but also environmental and social values (costs and benefits).** Finally, City Model Canvas is arranged in such a way to **represent the role and the goals of a city municipality**. All these features have led to an increase in the number of building blocks, from the basic nine to the final fourteen building blocks. Elements of **City Model Canvas** that were not mentioned in this report before and/or require a more detailed explanation, are introduced below.

The direct beneficiaries – refers to physical and legal entities directly benefiting from the city's strategy. Even though, there are also indirect beneficiaries, (for example, an indirect beneficiary

of electric vehicle is a person who will not directly use one but will still benefit from cleaner air in the city), they are NOT included in this building block, but in social costs-social benefits' element, which is broader and is meant to capture societal welfare effects.

Buy-in and support - refers to the individuals, groups or entities (such as companies, NGOs or other governmental organizations) whose support of city's initiatives (projects) is necessary for their successful implementation. Subjects with high influence and high interest in the project's outcomes are usually those whose buy-in is vital to the project's success because **they can block the project's implementation and success if they are not properly considered in the model and managed accordingly**.[119]

Deployment & delivery - as the element 'Channel' of the original BMC, it describes measures which allow delivery of the value proposition to the customer or beneficiary segment.

Key resources and key infrastructure – city's key resources include its **financial, physical, political and strategic resources**, as well as **infrastructural elements** (such as the public transport system, the wireless network, and intangible infrastructural elements such as the legal and regulatory frameworks). Political resources include the authority to levy taxes or offer grants/credits and the right to issue permits or restrictions that reward particular behaviours. Strategic resources can refer to the city's geographical position and its reputation that attracts capital and people.[120]

Important thing to consider while designing City Business Model is **environmental balance** of the planned city interventions. Here, the main objective is to compare how the strategy planned in one sector generates more environmental benefits than negative impacts (including land use impact, water and fuel needs, greenhouse gas emissions, etc.).

Furthermore, besides environmental balance, cities must pay attention to **social sustainability** as well. There should be more positive than negative social impacts on a city's residents and communities. Social welfare effects can be measured with indicators such as fuel poverty, access to public transport, digital literacy, and so on.

Consistent application of the city business model over time will show the evolution of the different elements that contribute to the economy development. This means that cities are

[119] Timeus, Krista; Vinaixa, Jordi; Pardo-Bosch, Francesc; & Ysa, Tamyko (2017). Report on the Business Models of the Lighthouse Cities (Horizon 2020: REPLICATE Project Reports No. 2.2). Barcelona: ESADE Business School

[120] Timeus, Krista; Vinaixa, Jordi; Pardo-Bosch, Francesc; & Ysa, Tamyko (2017). Report on the Business Models of the Lighthouse Cities (Horizon 2020: REPLICATE Project Reports No. 2.2). Barcelona: ESADE Business School

dynamic ecosystem whose key players, political priorities and communities are in constant flux. Hence, this model is open to innovation as the cities gain expertise with smart services.

5.6. Conclusions

A business model tool provides a quick overview of the business model including all crucial elements of a business and existing relations between them.

While looking for the best suited business model tool for participants of WaysTUP! Project, through which the generated innovation can be brought to the market, we analyzed business models tools that are widely used and that can be applied in the context of WaysTUP! project – Business Model Canvas, Lean Startup Canvas, Value Proposition Canvas and Prototyping Canvas. Many companies worldwide use **Business Model Canvas as a compact and clear guideline for their businesses**, but when it comes to entrepreneurships **Lean Startup Canvas** is more suited option because it **includes startup factors such as uncertainty and risk.** Another **business model tool that is especially recommended to startups is Value Proposition Canvas**. It helps businesses to create a perfect fit between their products and market. When a company is still in the phase of product development (such as the case of WaysTUP! Pilots), **Prototyping Canvas can help with testing a certain aspect of the developing product or service.** It effectively guides designers through prototyping processes and facilitates a common prototyping language amongst team members.

Sustainable business models have specific concepts because they do not consider only economic, but also social and environmental aspects of a business. Since this is one of the key aspects of circular economy, we analyzed business model tools that can help companies to create value propositions better suited for sustainability – these are the **Flourishing Business Canvas and Value Mapping Tool.**

Another key aspect of Circular Economy concept is related to material circulation. System for material circulation is described as Take-Back System within **Circular Business Model Canvas**. This system and Adoption Factor, which presents the internal and external capabilities of a company for transition towards circular economy, are fundamental features that enable businesses to operate by CE principles. Other circular business model tools that can be applied in the context of CE are **Business Cycle Canvas** that refers to the whole 'business cycle' instead of only the individual business model, and **Moonfish Circular Business Model** which has the structure of the infinity symbol emphasizing the ongoing process of circular business, which never ends.

Business model tools available for non-profit organizations differ from business model tools meant for for-profit companies, because the primary purpose of these organizations is not to

make a profit, but to make collective, public or social benefit. In every aspect of their businesses, they need to have in mind **two types of key partners – donors** (benefactors, contributors, volunteers, government, collaborators) **and clients** (members of the organization, geographic and demographic groups, practitioners and/or some disadvantaged groups).

In addition, **business model tools that can be implemented in cities have the most complex structures** as they include much more different stakeholders and resources (such as political and strategic resources). Moreover, it applies different aspects of all previously elaborated tools – besides the basic structure of Business Model Canvas, it includes the logic of mission-driven organizations (since profit should never be the ultimate goal of city's strategies) and environmental and social values which are inseparable part of Sustainable Business Model Tools. Finally, **City Model Canvas is arranged in such a way to represent the role and the goals of a city municipality**. Cities that develop and implement strategies based on such business models are open to future innovations.

6 Concluding remarks

The conclusions derived from this document are meant to constitute a solid background for further development of Pilot's individual business models and marketing strategies. First, **we explained what a business model is**, why is it important, which types of business models exists and what are the ways to compose a good and sustainable business model. The significance of the business model is reflected in the following facts:

- it is a tool that helps the organization to define where the business is in the value chain;
- it determines the future of a business – whether it will succeed or fail;
- it creates a foundation for optimizing innovative technology;
- it creates a clear statement of the business mission and vision;
- it creates a set of values that can help to steer business and a clear-eyed analysis of the industry, including opportunities and threats;
- it creates a portrait of potential customers, and a specific résumé that can be used to introduce the business to suppliers, vendors, or lenders.

Further, the term of **Circular Business Model (CBM)** is introduced and explained, since this promotes the use of fully renewable, recyclable or biodegradable inputs instead of scarce resources, which is important for Pilots to understand if aiming organize their business cases with this particular Model. In order to successfully implement circular business model, a company needs to take into account specific characteristics of its building blocks: **cycles, strategies, value creation, organization, revenue model, parties and impact.** On top of that, contextual factors that also play an important role are market, capacity, flexibility and influence. Key adjustments of CBMs need to be made in order to generate a business model that will present a perfect fit for the specific environment such as bioeconomy. These changes refer to individual elements of a business models - value proposition, key activities/ resources/ partners, customer segments/ relationships, channels, cost structure and revenue streams.

This document, also presented the Circular/Smart City concept, identifying some of the **City Business Models** that refer to **public-private partnerships**, and analyzed four of them - Build Own Operate (BOO), Build Operate Transfer (BOT), Open Business Model (OPM) and Build Operate Manage (BOM) that are most commonly used.

Finally, we analyzed the most important and most commonly used tools for business model development. This provides a **quick overview of the business model** including all crucial elements of a business and existing relations between them. While looking for the best suited business model tool for the participants of WaysTUP! Project, through which the generated innovation can be brought to the market, we analyzed business models tools that are widely used and that can be applied in the context of WaysTUP! project: Business Model Canvas, Lean Startup Canvas, Value Proposition Canvas and Prototyping Canvas. When a company is still in the phase of product development (such as the case of WaysTUP! Pilots), **Prototyping Canvas can help with testing a certain aspect of the developing product or service**. It effectively guides designers through prototyping processes and facilitates a common prototyping language amongst team members.

7 Annexes

The Annexes to this deliverable **presents 6 successful case studies**, which should help the Pilots identify main driver of success in their own value chains. By analyzing existing case studies, we found some common key insights, such as a considerable lead time from the early investment to a break-even point as a profitable business, importance of public national or EU level finance accessibility, challenges related to price-competitiveness and customers perceptions and attitudes.

7.1 Annex 1 - Case Study: CelluComp (UK)

CelluComp is a Scottish-based company located in Fife, near Edinburgh, established in 2004, with the aim of **producing alternatives to carbon composites**. Initially, company was targeting the sports goods market, but with the development of a bio-based additive **Curran®** in 2005 – an economically viable solution to rheology and reinforcement in many different industries – company entered different markets, such as paints, coatings, ink, concrete, drilling fluids, personal care and home care products and food.

Curran® is a material developed from the **extraction of nanocellulose fibres of root vegetables**, primarily from sugar beet pulp, a by-product of the sugar industry. The feedstock used for Curran® originates from different locations in Europe, and for the production of 1 kg of Curran®, approximately 1 kg of dry sugar beet pulp is required. It is produced through green chemistry processes including water-based reactions at low temperatures and pressures, which maximise the energy efficiency of the manufacturing process. CelluComp's demonstration plant has a maximum production capacity between 400–500 tonnes/year, and it is the first plant of its kind in Europe. **Some of the key features of Curran®** are that it is light, strong, can form a film, provides sheer-thinning viscosity, has good suspension properties, is stable regardless of pH. It can be used as a composite in its own right or as an additive for many water-based formulations[121]. It is **100 % bio-based** and is commercialised in two forms: as a paste/slurry or as a powder. Other important characteristics of this product are low carbon footprint, due to efficient process, non-toxicity and price competitiveness in comparison to

[121] https://www.cellucomp.com/

traditional competing materials and other bio-based products. Curran® is protected by 10 patents covering the product, the process and some of the applications[122].

A promising application is the use of Curran® as a composite material in concrete. Earlier experiments have shown that the mechanical properties of concrete are considerably improved by the addition of nanocellulose flakes. Surprisingly, the "concrete-vegetable composite" even produced better results than concrete composites with much more expensive "miracle products" such as graphene or carbon fibers[123]. Currently, cement production accounts for **8% of global CO2 emissions**. Due to rising demand, this figure could even double in the next 30 years. Reducing the proportion of cement in concrete is therefore an important goal in climate protection. As already mentioned, the production process of Curran® has a low carbon footprint as it involves water-based reactions at low temperatures and pressures. For this reason, development and commercialization of Curran® is indirectly supported by **European and national regulatory framework** which concerns sustainability and health protection. Due to a wide range of applications, Curran® is mainly affected by the **general regulatory framework on health and safety aspects** and there are no sector-specific regulations that have an impact on the product development.

Beside obvious success factors of the product and its strong potential for expansion and growth on new market segments, CelluComp faced **initial risks regarding the research-market gap.** The company has so far successfully managed to overcome the initial risks and barriers, including risks related to the novelty of the technology, competitive barriers to the market, and high investment requirements, by securing consecutive rounds of private capital investments from business angels and venture capital, as well as by securing public grants from national investors, such as the Scottish Seed Fund[124], Discovery Investment Fund[125], the Scottish Enterprise Group[126] that promotes start-ups etc. CelluComp also benefitted from an EU grant, financed under the EU's Entrepreneurship and Innovation Programme[127] and supported both the manufacturing and the commercialisation of the Curran®. Further, CelluComp secured EU funding under FP7, with **NanoCelluComp project**[128], focused on the

[122] https://www.cellucomp.com/applications/other-uses
[123] https://blog.allplan.com/en/vegetable-concrete
[124] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/scottish-seed-fund
[125] https://www.discoveryinvestmentfund.co.uk/
[126] https://www.scottish-enterprise.com/
[127] https://ec.europa.eu/cip/eip/index_en.htm
[128] https://cordis.europa.eu/project/id/263017/reporting

development of a technology to utilize the high mechanical performance of cellulose nanofibers, which relied on the technological know-how from the production of Curran®[129].

7.1.1 The S.W.O.T. analysis

With the 100% bio-based product, which has a wide range of application areas and allows entrance to many different markets, the overall outlook for CelluComp is more than positive. High commercial potential and price competitiveness in comparison to traditional competing materials are considered as main drivers of success, together with the sustainability, price-competitiveness and flexibility of the feedstock needed for production. Also, the company's ability to attract investors and to effectively mobilise internal and external funding gradually, must be mentioned as another important driver of success. At this point, Curran® is produced in a small-scale plant in Scotland, but the company is building a commercial size factory which will enable production of around 10,000 tonnes/year of Curran® and, as a result of economies of scale, also increase its profit.

Based on the above, we can conclude that CelluComp's product have many strengths, which are summarized in the table below, together with main weaknesses, opportunities and threats:

Strengths	Weaknesses	Opportunities	Threats
High market potential and strong potential in multiple industries Access to and flexibility of low-cost feedstock Ability to attract different sources of financing for R&D and commercialisation Patents	Challenges in scaling up due to high initial investments Piloting and testing a novel product is timeconsuming and costly Steady supply of seasonal feedstock required, which may increase storage costs	EU funding opportunities in order to raise finance Market preferences – mainstreaming of sustainability demands (SDG)	The bio-based feature may not be sufficient to justify the ‚high price' but once scaled up the costs will be reduced

Table 7 CelluComp Curran SWOT analysis

[129] "Bio-based products from idea to market", Ecologic Institute, Berlin - https://www.ecologic.eu/

7.2 Annex 2 - Case Study: Novozymes (Denmark)

Novozymes is a global **biotechnology company,** headquartered in Bagsværd, outside of Copenhagen, Denmark. The company's focus is the research, development and production of industrial enzymes, microorganisms, and biopharmaceutical ingredients. Novozymes in its current structure was formed in 2000 when Novo split into three different companies: Novo Holdings A/S, Novo Nordisk A/S, and Novozymes A/S. At the time, the company already had a portfolio of enzymes for both food and beverages and household care markets[130].

As it is stated in Novozymes Report (2019) on Sustainability[131], the company's priority is **creating value for stakeholders and meeting their expectations on material sustainability issues**. Novozymes strive to catalyze partnership that drive collective action on SDG's and enable a **sustainable bioeconomy**. Like most social enterprises that are based on bioeconomy, Novozyme keeps its focus on constant research and development of new solutions, with higher social value. R&D is at the center of the company activities, with around 23% of its employees working with R&D, taking part in a number of EU funded projects (FP7 and H2020), related to development of industrial enzymes and novel applications of enzymes in various industries: food, medical, and biorefinery. The research and development of lipase enzymes, including Lipex® has been funded internally. Each of the company's divisions has an application development unit, with the purpose of keeping the R&D and commercial sides close together. In 2002, **Lipex®** was introduced to the market, and it represented a result of company's high focus on research and development and 10 years of research effort. It is used as an ingredient in detergents. As a component in the detergent, Lipex® degrades edible fats and oils. It is effective across a temperature range 30–60°C. The product replaces a part of surfactants (cleaning agents) or other ingredients in the detergent composition. These can be produced from vegetable or mineral oils. Lipex® is produced using a microorganism Aspergillusoryzae. Sugar is used to feed the microorganism, which ferments producing the required enzyme. Lipex® is **100 % bio-based and is biodegradable**[132]. At the time of market entry, Lipex® was the first product on the market which enabled removal of fat stains at the first wash. According to the company, it is currently the only lipase enzyme on the detergent market[133].

The main characteristics of Lipex® are:

[130] https://www.novozymes.com/en/about-us
[131] https://report2019.novozymes.com/#last-section – The Novozymes report 2019 PDF
[132] "Bio-based products from idea to market", Ecologic Institute, Berlin - https://www.ecologic.eu/
[133] https://www.novozymes.com/en

- ClassiÞed as Readily biodegradable (OECD 301)
- Patent protected
- Trademarked

Lipex® is an enzyme preparation containing a lipase. Lipases are enzymes that catalyze the hydrolysis of fats. The main industrial application of this product, produced using the microorganism *Aspergillus oryzae,* is as an ingredient in detergents. Within R&D activities, the genetic changes were made to the microorganism, in order to improve fermentation process, but also modifications to the enzyme protein itself have been introduced[134]. Current process of production involves two main steps: **fermentation and formulation** (final product can be in granulated or liquid form, have a specific color, etc.). Lipex® is an alternative to petroleum and vegetable oil-based surfactants, which manufacturing uses chemical processing, while Lipex® production involves bioprocess, that reduces the need for toxic chemical catalysts. It also generates lower amounts of waste and by-products. Positive environmental impacts are seen at the stage of the use of final product (detergent), through improving washing performance and lowering the amount of energy used during the wash, resulting in CO_2 savings[135].

According to the International Association for Soaps, Detergents and Maintenance products[136], the total market value of the household care and professional cleaning and hygiene sector in **Europe was estimated at €38 billion in 2019**. The global enzymes market size was valued at USD 9.9 billion in 2019 and is expected to grow at a compound annual growth rate (CAGR) of 7.1% from 2020 to 2027[137]. Mentioned figures, together with the fact that when Lipex® is used in an enzyme solution designed to replace a portion of surfactants, it can be done in a cost-beneficial or cost-neutral way, are clear signs that the product will have a great success on the market. Key market segment for Lipex® is detergents that seek to **obtain CO2 emissions of green labeling** – there are two labelling schemes for laundry products in EU, called Ecolabel and Nordic Ecolabel. **Laws and regulations** regarding the use of chemical and biochemical products are different across countries, but none of them is creating barriers for Lipex®.

7.2.1 The S.W.O.T. analysis

One of the main drivers of success in case of Novozyme is definitively **the financial strength of the company,** enabling it to continuously finance R&D from a high dedicated budget, since the company's strategy is focused on innovation. Novozyme puts direct customers first, which

[134] https://report2019.novozymes.com/#last-section – The Novozymes report 2019 PDF
[135] "Bio-based products from idea to market", Ecologic Institute, Berlin - https://www.ecologic.eu/
[136] The International Association for Soaps, Detergents and Maintenance Products - https://www.aise.eu/
[137] https://www.grandviewresearch.com/industry-analysis/enzymes-industry

is not such a common case when it comes to large enterprises, understanding their demands and developing specific product formulations to fit their needs. This is the second big driver of success for Novozyme, representing at the same time company's biggest strength – **adaptability**. Triple bottom line (TBL)[138] is important for company's strategy, giving **profit, people, and the planet** the same importance in its research activities. Within the household care sector, Novozyme impacts SDG 6 (*Clean water and Sanitation*) an SDG 14 (*Life Below Water*), by contributing to reducing aquatic pollution; within the Food and Beverages sector, company impacts SDG 2 (*Zero Hunger*) by contributing to food production system's sustainability; within the Bioenergy sector, they are directly impacting SDG 7 (*Affordable and Clean Energy*) and SDG 13 (*Climate Action*), by promoting the development and deployment of low-carbon transportation fuels, reducing emissions in the transport sector, etc[139].

Main strengths, weaknesses, opportunities, and threats are given in the following table:

Strengths	Weaknesses	Opportunities	Threats
Detergent producers cansave costs by replacing other ingredients withenzymes Documented improved performance of detergentswhen using Lipex® asingredient Documented lower impacton the environment First-mover advantage	Detergent formulation with enzymes requires know-how and attention to raw material storage and transportation	Drive towards innovation among detergent produc-ers with the purpose to improve wash performance at low temperatures and improve sustainability profile of their products Improving living standards in emerging markets creating demand for better per forming products	Sustained low costs of competing products, reducing the adoption rate of high-performance enzymes Traditional consumerhabits, e.g. washing at high temperatures Pressure on detergent prices in regions where the market is more saturated, e.g. the US

Table 8 Novozyme's Lipex® SWOT analysis

[138] https://www.investopedia.com/terms/t/triple-bottom-line.asp
[139] https://report2019.novozymes.com/#last-section – The Novozymes report 2019 PDF

7.3 Annex 3 - Case Study: Arkema (France)

Arkema S.A. is a specialty chemicals and advanced materials company headquartered in Colombes, near Paris, France. Arkema was introduced to the market in 2006, when French oil major Total[140] restructured its chemicals business, and today is structured into three coherent and complementary segments dedicated to **Specialty Materials** (Adhesive Solutions, Advanced Materials, and Coating Solutions) accounting for some 80% of its sales, and an Intermediates segment leveraging competitive and global product lines. Sustained by the collective energy of its 20,500 employees, Arkema operates in some 55 countries and reports sales of €8.7 billion.[141] One of company's main product family is Rilsan® polyamide 11 (PA11) – a family of high-performance polyamides derived from renewable feedstock (castor oil). It is a high-performance polymer in the family of nylons, used in e.g. the automotive industry, sports equipment, and electrical applications. Two of most recent sub-products within this family, are Rislan® HT and Rislan® Invent, whose R&D started in mid 2000s. With the realization that Rislan® can be modified to withstand high temperatures, Arkema's R&D department developed **Rislan® HT (High Temperatures),** with enhanced performances which allows it to compete with metal as a raw material, for car parts near the engine. As it was 50 % more expensive per kilogram than the metal alternative, this presented a potential initial barrier, but the company successfully demonstrated that the overall costs of using this material are lower than using metal. Since 2012–2013, a number of large European vehicle manufacturers have started using the product. Currently, US and Asian markets are starting to follow this example. Arkema's R&D department saw the potential in early 3D printing market and accelerated the development of **Rilsan® Fine Powders** specifically for 3D Printing in 2009, which evolved into **Rilsan® Invent** two years later[142].

The development and commercialization of the products has **been funded internally**. The company has applied profits from existing sales to finance further R&D and commercialization efforts related to the new Rilsan® based product applications. But, Arkema's R&D divisions are included in different funding mechanisms, trough participation in different European (FP7 and H2020) and national collaborative projects with bio-based contents, within three main areas: development of biotechnology for reusing CO_2 in chemicals and plastics, development of

[140] https://www.total.com/
[141] https://www.arkema.com/global/en/arkema-group/profile/
[142] "Bio-based products - from idea to market", Ecologic Institute, Berlin - https://www.ecologic.eu/

crops suitable for industrial processes, and conversion of waste into chemicals and biorefinery.[143]

Main characteristics of products are[144]:

- Rilsan® – 100 % bio-based
- Rilsan® HT – 70 % bio-based
- Rilsan® Invent – 95–98 % bio-based
- Net CO_2 emissions of Rilsan® production 41 % lower than fossil-based polymer
- Patent protected and trademarked
-

Rilsan® originates from **100 % bio-based feedstock**, castor oil, which geographical origin is predominantly India. Feedstock for producing PA-11 and its associated products is derived from the castor oil plant, which is grown in tropical areas. To secure a steady and reliable supply, in 2013, Arkema partnered with a castor oil producer in India. Arkema has a CSR strategy in place, with the Code of Conduct for suppliers, which includes items regarding human rights and labor standards, environment, business ethics and transparency. Also, total gross energy required to produce PA-11 is 22% lower than comparable petroleum-based plastic PA-12, with more than 40% lower CO_2 emission of production. Further impacts across the life-cycle depend on the application, but overall estimation is that 30-40% less CO2 is generated over the life-cycle of (pure) PA-11 compared to PA-12[145]. With this much focus on the environment, it is clear that Arkema **business model must be based on the pursuit of the social goals.**

Regarding the **regulations**, those related to transport emissions and requirements related to LCA, stimulates the demand for Arkema's product. In terms of **transport emissions**, regulations influence demand positively by requiring car manufacturers to reduce their CO_2 footprint. In respect of the requirements for performing **life-cycle assessments (LCA),** such as green or eco-labelling, Rilsan® HT and Rilsan® Invent offer added-value to the automotive and spare parts (3D printing) industry. EU regulations that have such elements include: End of Life of Vehicles

[143] https://www.arkema.com/global/en/arkema-group/our-materials/innovative-magazines/ - Annual and sustainable development repors
[144] "Bio-based products - from idea to market", Ecologic Institute, Berlin - https://www.ecologic.eu/
[145] "Bio-based products - from idea to market", Ecologic Institute, Berlin - https://www.ecologic.eu/

Directive (2000/53/EC)[146], Waste Framework Directive (WFD, 2008/98/EC)[147], and EU Ecolabel (Regulation no 66/2010)[148].

7.3.1 The S.W.O.T. analysis

As we may conclude, the outlook for the Rilsan® product line is very positive as sales volumes are expected to continue to increase. The main drivers behind this development are sustainability commitments among customers and emission regulations. Working with customers to develop products to meet desired specifications and ability to **reduce overall costs to customer in using the product**, despite higher product sales price than competition, provides Arkema a very high market position. Company has a strong focus on R&D. Also, it is a large company with a long track record, Company has a strong focus on R&D. Also, it is a large company with a long track record, and it relies on internal finance, product development experience, network, supply chain management, and market access. All of the above are main driver of success in the case of Arkema Group.

Main strengths, weaknesses, opportunities, and threats distilled from this analysis are given in the following table:

Strengths	Weaknesses	Opportunities	Threats
Documented higher performance than competing products Lower cost of processing material into parts	Sustainability is not the main customer priority Higher costs compared to fossil fuel alternatives	Interest from large customers (Auto-industry), increased in emerging-markets (China) Favourable policy agenda (e.g.	Oil or feedstock price fluctuations Strong competitor pricing Possible changes in national regulations

[146] Directive 2000/53/EC of the European Parliament and of the Council, of 18 September 2000 - https://eur-lex.europa.eu/resource.html?uri=cellar:02fa83cf-bf28-4afc-8f9f-eb201bd61813.0005.02/DOC_1&format=PDF

[147] Directive 2008/98/EC of the European Parliament and of the Council, of 19 November 2008 - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

[148] Regulation (EC) No 66/2010 of the European Parliament and of the Council, of 25 November 2009 - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010R0066&from=EN

Global presence, hedging risks in different markets Long R&D tradition		emissions reduction, LCA requirements)	

Table 9 Arkema's Rilsan® SWOT analysis

7.4 Annex 4 - Case Study: Acqua e Sole (Italy)

Acqua & Sole (Neorurale group) is a demonstration plant, located in Vellezzo Bellini (Northern Italy), in an area dedicated to cereal cultivation, mainly rice. It is constructed in 2016 and operates under the Systemic Project (H2020)[149], together with 4 more demonstration sites. The plant is treating **more than 120 000 ton of sewage sludge and agro-industrial waste** per year. Besides biogas, Acqua e Sole produces various ammonium sulphate, organic fertilizers and organic soil improves with a range of nutrient contents.

Neorurale group[150] develops renewable energy and circular economy plants around the world, with its strategic partner MORE with patent technology. Also, they offer an innovative solution that allows the production of unique digestate which **provides back to the soil** what has been extracted during agricultural activities, thus preserving soil quality, promoting biodiversity, boosting soil fertility, and fighting desertification, with their NRC (Nutrient Recovery Center) patent.

The Acqua e Sole business case is quite special and has not much in common with the other SYSTEMIC demonstration and outreach plants due to[151]:

- Not depending on subsidies – electricity is sold at market prices
- 90% of revenues are generated from gate-fees for processing municipal sewage sludge and only 10% on energy supplies
- Technically depending on NRR[152] – operating the plant without ammonia stripping is not possible
-

The main driver behind the investment was the **desire for recycling organic waste flows and particularly urban waste flows to organic fertilizers**. For this purpose, anaerobic digestion was chosen for producing renewable energy used on site and partly fed to the grid and simultaneously offering the opportunity to mix the feedstock for a balanced nutrient composition and eliminating pathogens by thermophilic operations. The business model does not aim at revenues from energy conversion but on closing the nutrient and organic materials loop. Recycling of organic matter was considered of high importance due to the progressing degradation of the peri-urban, industrially managed farmland south of Milano.

[149] https://systemicproject.eu/
[150] https://www.neoruralehub.com/
[151] Factsheet – Acqua e Sole, SYSTEMIC Project - https://systemicproject.eu/wp-content/uploads/2018/06/Factsheet-3-AS.pdf
[152] https://enrd.ec.europa.eu/sites/enrd/files/tg2_resource-efficiency_nadeu.pdf

Regardless of independence from the subsidy, **plant's business model requires digested sludge being allowed for application on cropland**, which is can be a big challenge. More efficient removal of organic pollutants (like hormones, pharmaceuticals and microplastics) from wastewater will transfer larger fractions to the sludge leading to increased concentrations and potentially calling for restrictions. Swedish government has launched an enquiry to assess sludge application on agricultural soils and intends to replace this practice by technical nutrient recycling, but the European Commission (EC) has not yet shown any signs of stopping the most common nutrient and organic carbon recycling route for sewage sludge.

Apart from the risks related to **policies and regulations**, the risk of restrictions from food industry must also be considered, since several relevant food industry stakeholders prohibit the use of sewage sludge-based fertilizers on farmland where contract products, for instance sugar beet are grown[153].

Acqua e Sole is, in close collaboration with UMIL[154], implementing and demonstrating a **novel N-recovery absorber** which enables Acqua e Sole plant to recover N in a mineral form and to reduce the N content of the organic fraction. Two enhanced organic products are being tested: **a soil fertilizer with adjusted nutrient contents**, in order to meet criteria of rice producers **and a soil amendment** enriched with rhizobacteria that promote plant health. Acqua & Sole has an ambition of improving soil fertility without any use of synthetic fertilizer over an area of 5000 hectares (ha) and ensuring the nutrient requirements of the surrounding farms for their annual crop production. The replacement of conventional fertilizer with digestate over a surface area of 5000 ha can generate a maximum saved economic cost of about 2.3 million €/y. Beside savings, main drivers for nutrient recycling are environmental issues, such as eutrophication of surface waters and nitrate accumulation in groundwaters, which emerged from excess production of Nitrogen and Phosphorous, and recycling of disposed waste became a great opportunity for the recovery of nutrients[155]. Nutrient Recovery and Reuse process in the plant looks like the following:

- Organic waste is collected in basins located in a closed building to prevent the release of odour. A bio-filter placed on the roof of the building purifies the exhausted air.
- Substrates are moved to a mixing unit where they are heated and homogenized with biomass coming from the third digester.

[153] BC Evaluation Report – SYSTEMIC (D2.2)

[154] https://www.nffa.eu/about/consortium/umil/?section=how_to_reach

[155] Factsheet – Acqua e Sole, SYSTEMIC Project - https://systemicproject.eu/wp-content/uploads/2018/06/Factsheet-3-AS.pdf

- Homogenized and inoculated feedstock is fed to the thermophilic process (minimum retention time of 20 days and temperature of 55°C) which ensures full sanitation of the incoming sludge and better agronomic properties of the digestate.
- The process is equipped with an ammonia stripping unit, whereby biogas acts as stripping agent. Ammonia is extracted from biogas by adding acid (H2SO4) resulting in inorganic ammonium sulphate (AmS) production.
- Both digestate and AmS are stored in steel tank facilities.
-

The NRR technology does not directly contribute to the financial result of the plant – in terms of accounting, it reduces the profit, but without NRR the plant would not be operable in thermophilic mode. Hence, the cost of NRR could be attributed to hygienisation, i.e. a relevant improvement for safe use of the digestate. This technology is enabling many benefits, like safe elimination of most pathogens, odor free operations and direct injection of digestate, balanced nutrient concentration in the digestate product, effective nutrient recovery – nutrient value can be accounted to 100%. Following figure (5) illustrates the complete technology's process:

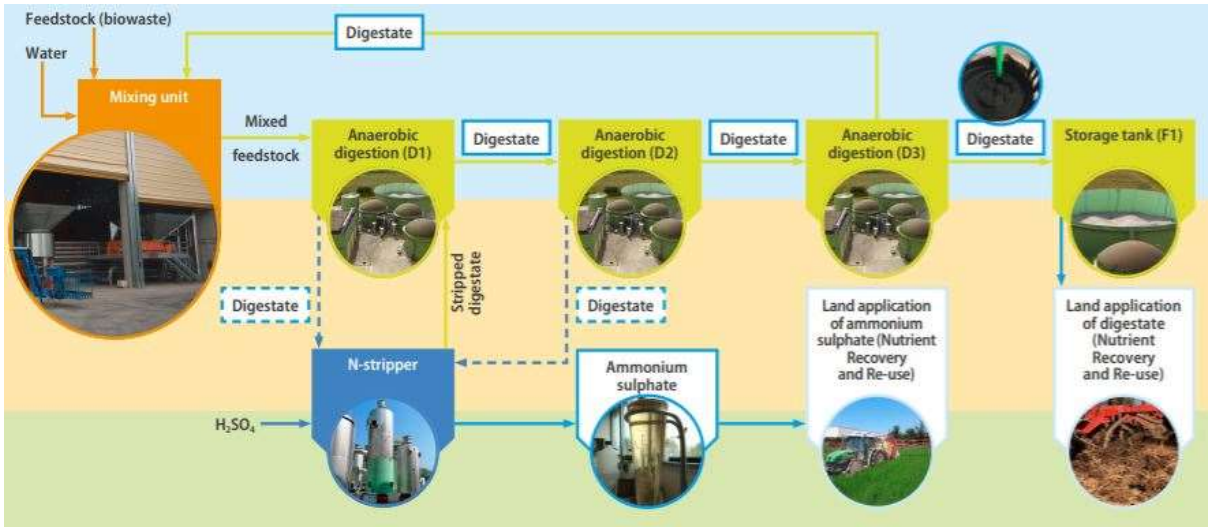

Figure 20 Acqua e Sole: an illustration of the technology, process and products

Source: [Acqua&Sole, Italy - Systemic (systemicproject.eu)]

Plant's **sustainability goals** are related to soil quality increasement and contribution to sequestration of carbon in soil, reduction of greenhouse gas emissions, ammonia, nitrate, and nitrous oxide emissions, as well as promotion of the nutrient recycling and this circular

economy model in the region as an effective solution for waste management[156]. Acqua e Sole will also improve the image of bio-waste by demonstrating that its products are free of undesired contaminants and pathogens and by demonstrating the agronomic performance of the products in large-scale field trials.

7.4.1 The S.W.O.T. analysis

The business case of Acqua e Sole is highly positive and has a low short-term risk since wastewater treatment plants will continue to produce sewage sludge and are in need for disposal/use routes. Although the plant has comparatively high operating expenses, compared to the company size and activity, the prices for taking-off sewage sludge tend to rise and further contribute to the profit of the plant. **Producing bio-methane instead of electricity may be a strategic option for higher earnings from energy**. Acqua e Sole receives an average gate-fee of € 63/t of organic waste, with NRR improving the financial results by 340,000-1.6 M€ per year, since NRR technology costs are between 0% and 16% of the revenues. Revenues based on gate-fee in the case of Acqua e Sole, are both main strength and threat for the plant's business model. Any biogas businesses will generate relevant returns from cost savings, as mentioned earlier, even without explicitly marketing the recycled products to higher end markets. However, much better results may be achieved if markets can be found/developed where the products are in demand.

The **EU Policy Framework** is largely in conformity with the recommendations of the SYSTEMIC Report on regulations governing AD and NRR in EU member states[157]

In the table below, the main strengths, weaknesses, opportunities and threats for Acqua e Sole demonstration plant are summarized:

Strengths	Weaknesses	Opportunities	Threats
Revenues largely based on gate-fee	Sludge management in Italy is regulatory	A relevant CO2 tax may be introduced	The gate-fee for sewage sludge may

[156] Business case Evaluation model – Acqua e Sole, SYSTEMIC D2.2

[157] Report on regulations governing AD and NRR in EU member states, SYSTEMIC, 2018 - https://systemicproject.eu/wp-content/uploads/2018/07/D-2.1_Reg_governing_AD_and_NRR_in_EU_MS_final_report.pdf

Business not dependent on subsidies Fertilising product performance can be demonstrated on own farmland Effective nitrogen recovery: Ammonium sulphate can be blended with other end products to tailormade fertilisers No waste streams	driven and regulations change frequently Currently no relevant revenues from energy conversion No AD without NRR	opening an additional source for revenues. New regulations may offer a new revenue stream from bio-methane conversion If farmers in the vicinity can be convinced of the benefits of the digestate based fertilising products, additional revenues will be generated in the future Marketing and raising awareness may lead to higher revenues for fertilising products High substrate flexibility due to NRR	come under pressure due to alternative disposal routes or more confidence in direct use Revenues largely based on gate-fee Legal or customer restrictions for use of sewage sludge based fertilising products Unforeseeable regulatory changes

Table 10 Acqua e Sole SWOT analisys

7.5 Case Study 5 - Biotrem (Poland)

Biotrem is a Polish technology company developing an innovative production process of bio-based tableware and packaging. Biotrem was founded in 2012 to capitalize on the prototype (TRL 1-6), which was developed by a professional miller in the 1990s. As a result of company's product and process development, commercial production plant was established in 2015 (TRL 7-9). The inventor of the initial prototype took up the responsibility for R&D and technology development, utilizing public funds for the establishment of the production plant and branding. Today, Biotrem's modern production facility offers a wide range of fully bio-based and biodegradable disposable tableware, including plates, bowls, and cups, produced from compressed wheat bran. Company's technologies are protected by numerous international patents, as they design and develop – in cooperation with many Polish R&D centers – machines used in the manufacturing facility. Their production process does not require significant amounts of water or mineral resources, or chemical compounds. Bioterm's products are:

- 100 % bio-based
- Biodegradable in 30 days (certified by DIN Certo)
- Production process certiÞed at food production safety level by BRC
- Patent protected technology
- Trademarked (global)

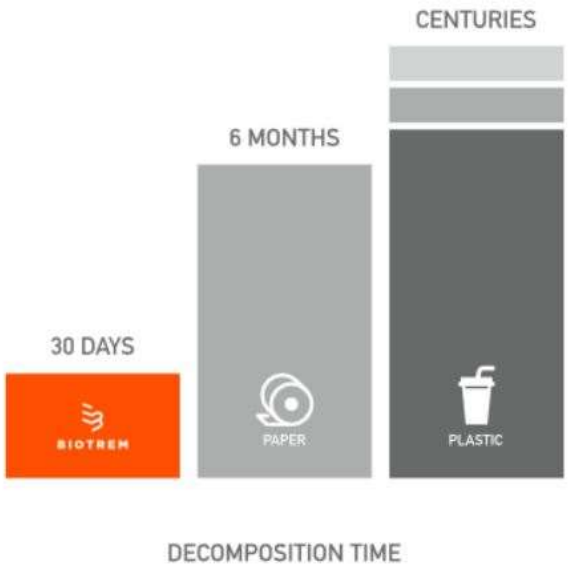

Figure 21 Decomposition time of different materials

Source: https://biotrem.pl/

Biotrem tableware has been commercially available since 2016. Until now, **demand has been lower than expected**. One reason for this is the different properties of the products compared to "traditional" disposable tableware made from paper or plastic. To address this, the company has dedicated resources to **influencing consumer perceptions** and has **engaged in certification efforts**. The consumer perceptions are targeted by involving video bloggers who act as ambassadors, and by engaging people at events and schools. Safety concerns have been addressed by conducting tests and consequently obtaining certifications. Another challenge for Biotrem is the price competitiveness since their products are more expensive

than the "traditional" ones. It is required to reduce costs through the economies of scale, but Biotrem is also focused on expanding their presence in the most promising international markets, where sustainability concerns play a significant role in consumer choices. Currently Biotrem sells its products in 40 countries, to the clients like restaurants, caterers, bars, organisers of large events (e.g festivals), and wholesalers. **Production capacity is currently at 15 million pieces of disposable plates or bowls a year**. Modern production plant in Zambrow – located in an ecologically clean, traditionally agricultural region of Poland – have a permanent access to high quality raw material. The plant is supplied by local mills in North-Eastern Poland (the region of Podlasie), a traditionally agricultural region. This allows a stable access to high quality, GMO free, raw material (bran) from nearby mills.

Biotrem's **mission** is to solve the problem of the plastic pollution, harmful to the environment, mostly created by single-use plastic-based packaging and takeaway containers. This is the reason Biotrem decided to go one step further and extend its technology to start producing takeaway containers. This requires ensuring waterproofness of products, while maintaining full biodegradability and low negative impact on the natural environment. Bringing this type of the product to the market at the small scale will not give the desired environmental results, which is the reason why Biotrem plans to introduce the scaled-up production (by licensing) and commercialization[158].

The biodegradable packaging market was valued at USD 89.57 billion in 2019 and is expected to reach a value of USD 121.38 billion by 2025 at a CAGR of 5.3% over the forecast period (2020-2025).[159] **EU funds** have a huge and direct impact on the success of the Biotrem project. The company has taken part in publicly funded projects (EU-funds, governmental-funds) covering the different stages of commercialization, including research projects, a project supporting the investment for building the production plant, a feasibility study with recommendations on how to successfully commercialize their technology, and more recently funding for promotional/branding activities and for implementing R&D improvements in the production process. The company has already spent over EUR 6 million on **R&D and production facilities** to date and is continuously working on new innovations in terms of shapes, raw materials and the production process. Of these EUR 6 million, the building of the production facilities at commercial scale required EUR 3.5 million. With Branbox products Biotrem also enters the fast-growing market niche as the global market of biodegradable take-away containers is worth €0.5 billion and is growing at CAGR 8%, (€1 billion in 2027).[160]

[158] https://ec.europa.eu/futurium/en/women-led-innovations-2019/biotrem
[159] https://www.reportlinker.com/p05917977/Biodegradable-Packaging-Market-Growth-Trends-and-Forecasts.html?utm_source=GNW
[160] https://ec.europa.eu/futurium/en/women-led-innovations-2019/biotrem

Legislation that provides favorable conditions for Biotrem includes waste-related legislation and initiatives aimed at reducing food losses along production chains. Initiatives in terms of waste legislation play a role in influencing demand. Speciþc initiatives on the table include EU Strategy for Plastics[161], the proposed EU Directive on Packaging Waste[162], and programs on plastics in national and regional waste management plans in specific countries. According to Biotrem, the French ban on plastic disposables (from 2020) and a ban on plastic in New Delhi have generated large interest in Biotrem products in these markets. Initiatives to reduce food losses could play a role in encouraging investment in Biotrem technology. **Relevant initiatives** in this area stem from UN Sustainable Development Goal (SDG) 12.3 'to […] reduce food losses along the food production and supply chains, including post-harvest losses'[163].

7.5.1 The S.W.O.T. analysis

The ability to move the product from research to commercialization, combined with inventor's commitment, knowledge on the feedstock and his network in the milling industry, represents one of the main drivers of success for Biotrem. Also, the availability of public funds and company's capacity to attract them, plays a very important role in keeping the R&D successful. The company is currently investigating into alternative types of feedstocks, e.g., algae, cassava, or other agri-food industry by-products. The feedstock choice will depend on the availability at the market where investments in new production facilities will be realized. At the same time, feedstock flexibility will allow addressing consumer trends towards gluten-free products, which is a way forward to keeping the company on top of the market.

The main strengths, weaknesses, opportunities and threats for Biotrem are summarized in the table below:

Strengths	Weaknesses	Opportunities	Threats
Founder's readiness to provide in-kind	Product is very differentfrom the "traditional"products it competes with	Market preferences – mainstreaming of sustainability demands (SDG)	A market with an increasing number of 'sustainable' and/or

[161] https://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy-brochure.pdf
[162] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31994L0062&from=EN
[163] https://sdgs.un.org/goals/goal12

contribution inthe early phases Patents and technology flexibility regarding feedstock Access to low-cost feedstock (wheat bran,corn bran, cassava by-products, seaweeds)	High production cost and price	Favourable policy agenda in relation to waste and food loss reduction	bio-based choices for consumers Sustainability/acceptability of feedstock may be questioned in the future

Table 11 Biotrem SWOT analysis

7.6 Case Study 6 - RIKA Biofuels (UK)

Rika Biofuels is a developer of European Anaerobic Digestion (AD) projects. Rika is developing a pipeline of large volume manure and agri-waste projects in the UK, Holland, Denmark and Russia.

While looking out for attractive business opportunities suitable for RIKA Biofuel's anaerobic digestion solutions, their team identified large amounts of poultry litter that were not in the focus for conversion to biogas, due to its high nitrogen content inhibiting conversion in standard Continuous Stirred-Tank Reactor (CSTR) anaerobic digesters. After the British government agreed on the legal and economic framework for biomass-based renewable energy, RIKA started to develop the project based on converting poultry litter and straw to 900 m³/h of biogas, most of which (670 m³/h) **being upgraded to biomethane** and 230 m³/h **converted to electricity** to cover the heat and power requirements of the plant and feed-in to the grid the subsidized – albeit small - fraction[164]. RIKA's team has developed and operated biogas plants in the UK in partnership with farms and agricultural estates, providing debt and equity investment packages to fund the projects, either as the sole investor or in a joint venture partnership, tailoring the partnership structure to each individual project to ensure that all partners benefit from the plants' success.

Together with Green Create W2V LtD, RIKA constructed a **mesophilic anaerobic digester (AD)** at Fridays' Knoxbridge Farm, Frittenden, Cranbrook, Kent, United Kingdom, with a total annual substrate treatment capacity of 60,000 tonnes. The plant technology's key elements are based on DVO's patented Linear Vortex™ digester technology and it **presents Europe's first-of-its-kind Green Create W2V plant.** The selected digestion process not only enhances the nutrient value in the manure, it also removes the odor, kills most pathogens (including E-Coli) and changes the state of the nutrients so they can be taken up by a growing crop. Particular advantages of the DVO process are[165]:

- More effective digestion of manures
- Effective nutrient recovery without chemicals
- Competitive pricing
- No moving parts in digester
- Near-complete bacterial (pathogen) kill

[164] BC Evaluation Report, SYSTEMIC project, D2.2
[165] https://mrec.org/files/2016/06/2016.Dvorak.WhereAreWeTodayWithDigesters.pdf

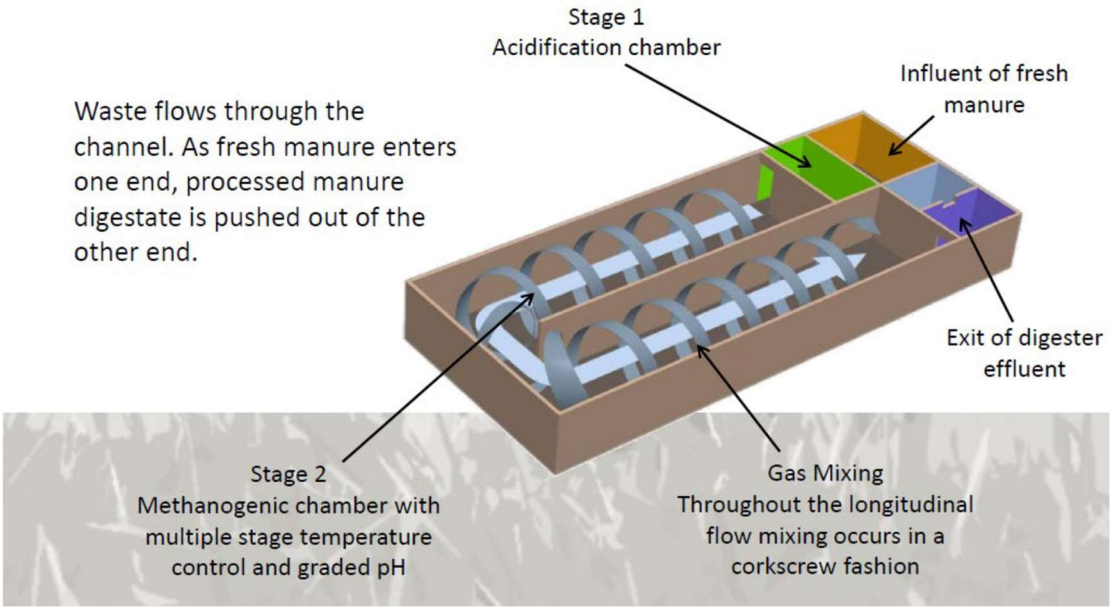

Figure 22 Process and layout of the DVO digester at Green Create

Source: https://mrec.org/files/2016/06/2016.Dvorak.WhereAreWeTodayWithDigesters.pdf

Neither RIKA nor Green Create have their own R&D departments. All companies we analyzed earlier keep R&D ant the center of their organizations, striving the environmental preservation and developing innovative solutions with high social value. Both RIKA and Green Create nurture innovative ideas, discussing them with the technical partners and solutions are developed by partners R&D departments, in cooperation with universities and during RIA projects like SYSTEMIC. The solution we are analyzing in this document, has been created by technical partners: AD and NRR technology: DVO Inc., (USA)[166], DMT Environmental Technology (The Netherlands)[167], Lehmann Maschinenbau GmbH (Germany)[168] and Rika Biogas Technologies (UK)[169].

Capital expenditures for equipment and associated development fees for the Green Create W2V anaerobic digestion plant, including the equipment for biogas upgrading to pipeline grade biomethane and nutrient recovery and recycling is € 15,185,000[170]. The funds were sourced from bank loans and promoter's funds. Today's 4.15 M€ of plant's total revenues are

[166] https://www.dvoinc.com/
[167] https://www.dmt-et.com/
[168] http://lehmann-umt.de/
[169] http://www.rikabiofuels.com/
[170] BC Evaluation Report, SYSTEMIC

based on revenues from biomethane supplies (3.2 M€), power supplies (0.3 M€), gate-fees (0.37 M€) and fertilizing product sales (0.27 M€).

The plant is converting 55,000 tonnes per annum of poultry manure and 2,500 tonnes of straw to about 900m³ biogas per hour, which is upgraded and injected into the gas grid with around 230m³ per hour, used to run an onsite CHP engine that provides the required process heat and electricity requirements. As part of the plant's design **Nutrient Recovery and Recycling (NRR)** technologies are employed, producing valuable by-products from the installation, such as concentrated digestate as organic fertilizing product and a mineral ammonium sulphate solution. The opportunity to improve plants business case, lies in the sale of the nutrient rich byproducts. Potential off-takers have been identified from the local farming and contracting community for the digestate and ammonium sulphate and these discussions have informed the design of the nutrient recovery equipment. In future, higher value markets should be realized by further processing and/or packaging of the by-products. A good example for a recycling product from DVO digesting plants is Magic Dirt™[171], a certified organic premium potting soil that was introduced by Cenergy USA, in 2014, as a sustainable alternative to peat moss. Potting soil is apparently a good choice for getting added value from digestate-based products.

7.6.1 The S.W.O.T. analysis

Biomethane can be injected into the gas grid, compressed or liquefied and used as fuel for cars, trucks, and buses. In the present case biomethane is injected to the gas-grid through a contract with an established gas trader: Barrow Shipping[172], which holds a UK Gas Shipper License and creates value for biomethane producers. Biomethane potential and partnership with gas trader are main drivers of success for this plant. DVO's technology package is giving this plant a competitive advantage through removing up to 90% of phosphorus and 75% of nitrogen ammonia (limiting ammonia emissions) from organic waste, converting it to a stable, commercial N-P-K fertilizer. A higher N-P-K product allows farmers to apply required fertilizers with fewer field passes, which adds value for end-users. The RIKA Biofuel and Green Create W2V demonstration plant shows that by providing a stable economic and regulatory framework with relatively modest incentives, highly profitable business cases could be developed and effectively contribute to a stable renewable energy supply, a transport fuel for heavy duty vehicles with low or zero greenhouse gas emissions and production of recycled

[171] https://www.magic-dirt.com/
[172] https://www.barrowgreengas.co.uk/

fertilizing products that reduce the environmental burden of livestock farming. All plant's strengths, weaknesses, opportunities, and threats are summarized in the table below:

Strengths	Weaknesses	Opportunities	Threats
Low CAPEX for NRR and low OPEX No moving parts within Digester Revenues from input and output All products are used in the vicinity Up to 99,9% pathogen removal High input flexibility	No AD without NRR	Sale of high quality, nutrient rich, pathogen free digestate and ammonium sulphate Added value through packaging digestate from the plug flow reactor design that is not available to CSTR technologies	Total dependency on local poultry farm Unforeseeable regulatory changes

Table 12 RIKA and Green Create W2V plant SWOT analysis

7.7 Conclusions

The bio-based sector is among the key players in the European bio-based economy. It contributes to an innovative, resource-efficient and competitive society. The bio-based industry in Europe is, however, still a fairly small and nascent industry under development. Looking across the 6 case studies given in this chapter, some general key insights emerged:

- There is often a considerable lead time from the early investment to a break-even point as a profitable business. All mentioned companies invested years in R&D before the end product entered the market.
- Access to public national or EU level finance has played a significant role in some cases, helping the mitigation of early-stage challenges. In other cases, where an already established, large company launched an innovative product/solution, internal funding sources were a crucial driver of success.
- In most cases, bio-based products were not price-competitive vis-à-vis the alternative traditional products.
- Perceptions and attitudes of customers are a challenge at the later stages of the development path, as customers must be willing to pay the higher price for the bio-based product compared to the traditional product.
- The appropriate technology and a sufficient production capacity are crucial factors to achieve success in the market. Most of analyzed case studies concern new technologies or processes, which involve significant uncertainty and risks.
- All of the analyzed business cases were built on the current trend of a 'greening of society', reflected in a growing consumer preference for green products, in CSR and purchase policies of large brands and buyers, and in a focus of investors and public funds on SDG investments.

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