

# Biomimicry as a Design Approach to Generate Successful Sustainable Business Models

*What are the (sustainability) characteristics of the business models of start-ups and already established businesses that implemented a biomimicry design approach?*

*An Explorative Research.*

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## Abstract

### **Biomimicry as an Approach to generate Successful Sustainable Business Models**

*What are the (sustainability) characteristics of the business models of start-ups and already established businesses that implemented a biomimicry design approach?*

Today, drastic changes in the business environment are necessary to counteract economic, social and environmental problems. Businesses experience pressure to transit towards more sustainability (along the triple bottom line). Incorporating triple bottom line sustainability within a business holds some challenges, and attempts often fail. A possible explanation of this failure is that businesses do not succeed to incorporate sustainability within their business model.

One promising identified approach to counter the economic, social and environmental problems, and to incorporate sustainability within business models is Biomimicry. Biomimicry is “*a new science that studies nature’s models and then imitates or takes inspiration from these designs and processes to solve human problems*” (Benyus, 2002:I). Nature is an inspiring source of knowledge, and instead of dominating and exploiting nature biomimicry focuses on learning and exploration from nature (Blok and Gremmen, 2016). Current literature however lacks information explaining the impact a biomimicry design approach has on the sustainability of business models. Therefore, the general objective of this research is *to assess and identify the (sustainable) characteristics of business models of businesses that apply a biomimicry design approach and to analyze the different ways of sustainability operationalization used within these business models.*

This study is a qualitative research and is conducted using a multiple case study design. Semi-structured interviews with 15 general managers of start-ups and already established companies that incorporated a biomimicry design approach were conducted. The interviews provided in-depth information about three included models. The first model assessed is The Four Phase Model of Sustainable Entrepreneurship (van Tilburg et al., 2012), which is used to identify the position of included cases towards sustainability. The phase of a company determines the (non) existence of a Sustainable Strategy and a Sustainable Business Model. After this assessment the Sustainable Business Models were assessed upon successfulness based on a model that includes the elements that characterize Successful Sustainable Business Models (Upward & Jones, 2016). Finally, cases were assessed upon the operationalization of sustainability by researching the elements of the Eight Archetypes Model (Bocken et al., 2014).

Overall case results on the three different models resulted in the identification of three categories based on the role that application of biomimicry has on the business model. These three categories are: Transforming, Supporting, and Instrumental. Businesses in the transforming category build their business model based on biomimicry and Nature’s Life Principles. In the Supporting category biomimicry played a supporting role in creating sustainable business model characteristics. In the Instrumental category biomimicry only played a role in the product design and product innovation parts of the business model.

The outcomes and the classifications function as best practice information for potential future biomimicry appliers. The results of this research function as roadmap and show which activities, perspectives, decisions, and ways of operationalization lead to which sustainability outcomes. In order to achieve sustainable results it is recommended to apply a biomimicry design approach on more than one level, and to use Nature’s Life’s Principles as common thread during the creation/adaptation phase of a (new) business model.

**Keywords:** Biomimicry, Business Models, Sustainable Business Models, Success, Sustainability, Eight Archetypes Model, Elements Sustainable Business Model, Four Phase Model, Life’s Principles

## Preface

This research is part of the final proof of proficiency for an MSc in Management, Economics and Consumer Studies Student at Wageningen University. I have a BSc in Management and Consumer studies and I specialized in Management, Sustainability, Strategy, and Innovation. For me as a student this is the next-to-last phase of finishing my Master of Science degree at Wageningen University. The last phase will be an internship.

The Wageningen University has supervised this research project and I executed this research in The Netherlands. In this Preface I would like to take the opportunity to thank the many people that supported this research project.

First of all, I want to thank the direct supervisors of this project: Vincent Blok and Saskia van den Muijsenberg. Thank you for your valuable and constructive support, insights, feedback and brainstorm sessions. Both of your inputs, time and effort can be seen as one of the key success factors of this report. You were both great coaches and your support contributed to my personal development as a researcher. In addition, you challenged me to think about my future goals and to reflect upon possible job positions and to include these goals and reflections within my research project.

Secondly, I would like to thank all the participants of this research. I would like to thank them for their valuable input, time, effort, and openness. Without them this research could not have been conducted. In addition, I would like to mention that I appreciate their enthusiasm and support towards this research. I hope they enjoy reading it.

Furthermore, I would like to thank my friends and family. I appreciate their continuous interest in my subject and their unconditional support.

In addition, I would like to thank my fellow students for their constructive feedback during the execution of this research. And I would like to thank them for their notes, remarks and questions during the proposal and final presentation.

And of course I would like to thank the reader for being interested in this research. It means a lot to me, and I hope you enjoy this report about Biomimicry and Sustainable Business Models.

Enjoy!

Iris Boom

Wageningen, The Netherlands  
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## Executive Summary

**The aim of this research is to assess and identify the (sustainable) characteristics of business models of businesses that apply a biomimicry design approach. Start-ups as well as Established companies from different industries are included in this research.**

The global (environmental) challenges and economic crisis led to a critical attitude towards business models, especially focused on the real impact of companies on sustainability. Many articles describe the importance of Sustainable Business Models and Sustainable Business Strategies: Businesses can only become more sustainable if the sustainability initiatives are visible and successfully incorporated in the business model (Boons & Lüdeke-Freund, 2013; França, Broman, Robèrt, Basile, & Trygg, 2017; Schaltegger, Hansen, & Lüdeke-Freund, 2016; Schaltegger, Lüdeke-Freund, & Hansen, 2011). This research starts with a thorough literature review, investigating Sustainable Business Model theories. Traditional Business Models lack a sustainability component and are only concerned with product and service offerings that satisfy their customers to generate economic returns (Laasch, 2017). However, Traditional Business Models are currently transitioning, and more deep CSR strategies become visible. Sustainability is no longer seen as an independent component; sustainability becomes embedded in multiple business model components. The aim of Sustainable Business Models (SBM) is to generate profit by providing products and/or services that directly and/or indirectly reduce the pressure on the (social) environment. At the same time the businesses aim to generate profits equal to or preferably greater than profits achieved with traditional business models. In a SBM profit is not only defined in terms of financial gain, but also in terms of social gain (e.g.: increased employment) (Bohnsack, Pinkse, & Kolk, 2014; Chun & Lee, 2013).

Businesses are trying to find ways to become more sustainable and to create sustainable business models to tackle the environmental, social and economic challenges. A biomimicry design approach is seen as a promising approach to fight global ecosystem challenges. Biomimicry is *“a new science that studies nature’s models and then imitates or takes inspiration from these designs and processes to solve human problems”* (Benyus, 2002: I). When applying a biomimicry design approach nature is an inspiring source of knowledge that functions as a fuel for nature-based innovations. Biomimicry introduces businesses to a new and ecosystem-friendly approach to nature, which is characterized by learning and exploration instead of domination and exploitation of nature (Blok & Gremmen, 2016).

This report combines the latest articles about Business Models, Sustainable Business Models, Sustainability Strategies, and Biomimicry in order to analyse the characteristics related to Sustainable Business Models of businesses that implemented a biomimicry design approach. The acquired theories are combined into a conceptual model that provided guidance during this research. In order to see if the developed conceptual model helps to answer the main research question, the author conducted fifteen semi-structured interviews with different companies that applied a biomimicry design approach. The author included start-ups (n=8), and established companies (n=6) in this research (one of the interviewed companies is not yet an officially founded company).

The different compared and combined theories resulted in three different models that are each assessed in this research. The author used the Four Phase Model of Sustainable Entrepreneurship (FPM) to assess whether companies included in this research are proactively involved in sustainability (Van Tilburg et al., 2012). When businesses are in the proactive phase their business strategy is closely connected to sustainability. Companies in the proactive phase have a Sustainable Business Model. Presence of the proactive phase can be assessed based on eight constructs: Vision on sustainability, Orientation towards external developments, Business case elements, Transparency, Reporting, Stakeholders, Supply chain approach, and Dominant functional discipline. The results of the interviews indicate that all included cases have an Orientation towards external developments. Thirteen out of fourteen companies have a Vision on sustainability and focus on Dominant functional discipline. Eleven out of fourteen companies focus on Business case elements and Transparency. Ten

out of fourteen companies focus on Stakeholders and a Supply chain approach. In addition, only 2 companies focus on sustainability Reporting. The conclusion about the Four Phase Model is that companies can be divided into three phases based on their scores on the constructs: proactive phase (N=6), active phase (N=6), and reactive phase (N=2). Differences in the amount of positive scores between start-ups and established companies are really small. However, it should be noted that differences in the amount of positive scores between companies that use the Biomimicry's framework of Life's Principles<sup>1</sup> of nature and companies that do not use the Life's Principles are big. In addition, the level on which biomimicry is applied also influences the amount of positive scores; businesses that applied biomimicry on more than one level scored positive on more constructs.

After assessing the presence of a sustainable strategy and business model, the successfulness of this business model is evaluated based on the elements identifying a successful sustainable business model in general. Literature provided twelve elements as key factors indicating a successful sustainable business model in general (And Jones, 2016). These twelve elements can be divided into four categories of the business model: Boundaries and Goals, Stakeholders, Value Proposition and Firms' processes. The conclusion about the elements of success is that cases could be divided into three different groups based on their scores: businesses that successfully fulfilled the elements (N=9), businesses that semi-successfully fulfilled the elements (N=3), and businesses that unsuccessfully fulfilled the elements (N=2). The two companies that unsuccessfully fulfilled the elements are the same companies classified in the reactive phase of the Four Phase Model. Again the difference between the scores of start-ups and established companies are unnoticeable. And there are again differences in the amount of positive scores between companies that use Life's Principles and companies that do not use Life's Principles. This indicates that embedding the Life's Principles in companies' strategies, practices, designs and decisions-making processes will positively influence the successfulness of a company. The same applies to companies that applied biomimicry on more than one level. It should be noted that only time is able to prove the real successfulness of companies' Sustainable Business Models.

The Eight Archetype Model is a model to check how businesses operationalize sustainability within their company. The different archetypes are: Maximize material and energy Efficiency, Create value from Waste, Substitution with Renewables and Natural Processes, Deliver Functionality rather than Ownership, Adopt a Stewardship Role, Encourage Sufficiency, Repurpose for society/environment, and Developing Scale-up solutions. The assessment of the Eight Archetypes revealed that thirteen out of fourteen companies focus on encouraging efficiency. Twelve companies focus on the repurpose, Scale-up, and Efficiency archetypes. Eleven companies focus on adopting a stewardship role. And finally, eight companies focus on the waste, substitution, and functionality archetypes. Based on the interviews it can be concluded that businesses with a biomimicry design approach operationalize sustainability in many different ways and the execution of the operationalization differs per company. The conclusion about the elements of success is that cases could be divided into three different groups based on their scores: cases operationalizing seven or eight archetypes in different ways and in different parts of the business models (N=9), cases operationalizing five archetypes in different ways and in different parts of the business model (N=3), and cases operationalizing one or two archetypes within the product part of their business models (N=2). Also for this model it can be concluded that differences between start-ups and established companies are small. Differences between companies that use and do not use the Life's Principles are bigger, and also businesses that apply biomimicry on more than one level score positive on more archetypes.

In order for other potential businesses to apply biomimicry and to understand its potential best practice information and experiences of others are crucial. The interviews revealed that a biomimicry design approach can impact businesses in 3 different ways: Biomimicry can function as an sustainable idea

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<sup>1</sup> Life's Principles are design lessons from nature, Life has evolved a set of strategies that have sustained over 3.8 billion years. Life's Principles represent these overarching patterns found amongst the species surviving and thriving on Earth. (<https://biomimicry.net/the-buzz/resources/designlens-lifes-principles/>)

generator, biomimicry provides examples of sustainability since nature is sustainable, and applying biomimicry can create entire sustainable and holistic mind-sets within businesses. The influence of a biomimicry design approach depends on the execution of it. The more a biomimicry design approach is embedded in different parts of the business, the more it influences the mind-set of employees. The businesses that use the Life's Principles as guidance indicated that biomimicry impacted their perspectives and mind-sets. In some cases applying biomimicry indirectly influenced the sustainability of business models; biomimicry created a vision towards sustainability and sustainability impacted the business model. In cases where Life's Principles are used, biomimicry directly influenced the sustainability of business models; in these cases biomimicry and its principles provided guidelines during the creation and design of the entire business model. None of the included cases indicated that they ever felt restricted by biomimicry and its principles. The cases provided two reasons for this: they appreciate the guidance that biomimicry and its principles set and define this as beneficial, and others are not fixed on just applying a biomimicry design approach and implementing its principles.

The included cases could be classified into three groups based on cases' overall score on the different models. Analysis of these three groups and their characteristics, scores, answers, examples, similarities and differences, resulted in three categories based on the role application of biomimicry has on the business model of the companies. These three categories are: Transforming, Supporting, and instrumental and are summarized in Table 1.

**Table 1 Overview of categories based on role of biomimicry on business model**

	<b>Transforming</b>	<b>Supporting</b>	<b>Instrumental</b>
<b>Phase</b>	Proactive	Active	Reactive
<b>Fulfilment elements sustainable business model</b>	Successful	Successful/semi-successful	Unsuccessful
<b>Archetypes</b>	Operationalize 7 or 8 archetypes	Operationalize 3 to 6 archetypes	Operationalize one or two archetypes
<b>Life's Principles</b>	Often conscious use of Life's Principles	Life's Principles are used in some cases	No use of Life's Principles
<b>Impact biomimicry design approach</b>	Directly impacted sustainability of business model	(In) directly impacted sustainability of business model	No sustainable business model
<b>Restrictions caused by biomimicry</b>	Appreciate nature's rules and guidelines, do not feel restricted	Are not bounded to using biomimicry design approach, do not feel restricted	Only use biomimicry design approach for the creation of product, do not feel restricted.

In general businesses in the Transforming category build their business model based on biomimicry and its principles. In this category biomimicry transforms a traditional business model into a sustainable business model. Companies in this category are in the proactive phase of the Four Phase Model and successfully fulfil the elements that identify a Successful Sustainable Business Model. In cases where biomimicry played a transforming role sustainability has been operationalized in multiple ways and within products, processes, systems, and relations. In this category biomimicry directly impacted the entire business model, and biomimicry provides an appreciated normative framework to the companies.

In the Supporting category biomimicry played a supporting role in creating sustainable business model characteristics. Overall, sustainability is important to businesses in this category, but it is not the main focus in all characteristics of the business model. However, the business models of businesses in this category do differ from traditional business models. Companies in this category are in the active phase of the Four Phase Model, and fulfil the elements of success successfully or semi-successfully. Sustainability is operationalized in multiple ways; but less thorough and detailed as in the Transforming category. Some of the sustainability characteristics are based on the Life's Principles,

however they are not often considered. Most business models of businesses in this category are indirectly influenced by the biomimicry design approach. In general biomimicry supported a general view on sustainability, this general view directly impacted their business models. Businesses in this category are not restricted by the biomimicry design approach since they do not have a fixed focus on applying it.

In the Instrumental category biomimicry played a role in product design and product innovation. But aside from the role on the product part of the business model businesses in this category do not apply biomimicry or its principles in any other part of their business models. Companies in this category are in the reactive phase of the Four Phase model, and have traditional business models. Since they have traditional business models, businesses in this category are unable to fulfil the elements of successful sustainable business models. In this category businesses only operationalize sustainability within their products, and therefore businesses do not feel restricted by their biomimicry design approach.

These outcomes and the classifications function as best practice information for potential future biomimicry appliers. The results of this research function as roadmap and show which activities, perspectives, decisions and operationalizations lead to which sustainability outcomes. In order to achieve sustainable results it is recommended to apply a biomimicry design approach on more than one level, and to use nature's Life's Principles as common thread during the creation/adaptation of a (new) business model. In order to solve global challenges the world is in (desperate) need for next generation companies that do not only focus on economic value generation and have linear take-make-waste economies but businesses that have a strong successful sustainable business model with a holistic focus and true social and environmental goals.

Because all the constructs of the models are generally applicable and there were no constructs specifically for a biomimicry design approach, one could state that this research might be applicable to other approaches applied to create more sustainable business models.



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## 1. Introduction and problem statement

This research focuses on the relation between a Biomimicry design approach and Sustainable Business Models (SBM's). First an introduction and the problem statement related to this focus will be provided in Chapter 1. Chapter 2 explains the research overview and elaborates upon the research objective and research framework. Chapter 3 provides the theoretical framework of this research, and this framework resulted in the conceptual framework displayed in Chapter 4. Chapter 5 states the Main and Sub Research Questions of this research. Chapter 6 explains the Research Methodology used in this research. Chapter 7 provides the results of the conducted interviews. A discussion of the results is given in Chapter 8. In addition, Chapter 8 reflects upon the limitations of this research. Chapter 9 elaborates upon the conclusions of this explorative research. And Chapter 10 provides recommendations for future research.

Currently, there exists pressure for all kind of businesses to transit to more sustainable sociotechnical systems. A wide range of environmental problems, such as biodiversity loss, water, air, and soil pollution, excessive land use, global warming, and resource depletion are increasingly putting the earth's life support at risk (Meadows, Randers, & Meadows, 2004). Furthermore, the current growth in the world population strengthens these environmental problems. These risks have been systematically researched since the 1960s, raising questions about whether present prosperity trends like: ozone depletion, climate change, alteration of the nitrogen cycle, and biodiversity loss, can be maintained in the future (W. C. Clark, Crutzen, & Schnellhuber, 2005).

The environmental challenges also induce social and economic challenges. Economic challenges include for example deregulated markets, supply risk, problematic ownership structures, and damaged incentive structures which lead to increasingly frequent financial and economic instabilities for individual companies and entire economies. The economic challenges that arose from the environmental challenges caused sustainability concerns being incorporated in the agendas and strategies of companies (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). There exist around 300 definitions of sustainability, which makes it a vague and broad concept (Johnston, Everard, Santillo, & Robèrt, 2007). Broadly summarized, *"sustainability can be defined as a situation in which human activity is conducted in a way that conserves the functions of the earth's ecosystem, a transformation that optimises the likelihood that living conditions will continuously support security, well-being, and health, particularly maintaining the supply of non-replaceable goods and services, or an indefinite perpetuation of all life forms"* (Geissdoerfer et al., 2017: 758). According to Keeble (1988) companies should strive towards developments that meet the needs of the present without compromising the ability of future generations to meet their own needs (Keeble, 1988).

Strong sustainability is a concept explaining that business intentions to become sustainable are important in a first phase, but more important are the actions that are concretely incorporated. Strong sustainability goes beyond general declarations of intents (Del Baldo & Baldarelli, 2017). Incorporating strong sustainability does not only entail becoming more environmental friendly, businesses change their practices to become sustainable along the triple bottom line: people, profit, and planet (Elkington, 1999). In the triple bottom line, social, economic and environmental performances are being balanced in order for a business to become as sustainable as possible.

Integrating strong sustainability within a business challenges companies to thoroughly think through their vision, strategy, practices, culture, products, marketing, inputs, process and output. Businesses interpret sustainability in different ways, which causes sustainability to be implemented in different levels. In some cases sustainability has truly been institutionalised into agendas, business models and strategies of organizations, which causes sustainability to be embedded in the everyday practice, behaviour, mission and vision of the organization (Geissdoerfer et al., 2017). These companies view incorporating sustainability as a moral mandate which is supportive towards strong sustainability (Del Baldo & Baldarelli, 2017; Rajala, Westerlund, & Lampikoski, 2016). While other businesses did not

incorporate sustainability within their business models and only try to meet the legal sustainability requirements to maintain legitimacy and the right to operate (Rajala et al., 2016). When embedding sustainability within a business model, the organisation will face contradictions and in particular contradicting interests of different stakeholders. Even after incorporating sustainability within a business model, maintaining it is a challenge (Turner, 1993).

Aside from the different levels, businesses also use a variety of design approaches to implement sustainability. Companies try to implement sustainability by incorporating a circular economy within their business, for example. The concept of circular economy has gained interest among researchers, policymakers and business as a way to address the above mentioned sustainability issues (Brennan, Tennant, & Blomsma, 2015). Circular economy offers multiple opportunities for businesses to create potential value for themselves and their stakeholders (EMF, 2013). A circular economy can be described as a loop economy that includes strategies for waste prevention, regional job creation, resource efficiency, dematerialisation of the industrial economy and recycling (Stahel & Reday, 1979). EMF (2013:14) introduced the circular economy as *“An industrial economy that is restorative or regenerative by intention and design”*. Similarly, Geng and Doberstein (2008:231) described it as: *“realization of a closed loop material flow in the whole economic system”* (Geng & Doberstein, 2008). Webster (2015:6) adds to this that *“a circular economy is one that is restorative by design, and which aims to keep products, components and materials at their highest utility and value, at all times”* (Webster, 2015). A circular economy is aiming at closed loops, eliminating all resource inputs and waste and emission leakages of the system, the goals of sustainability are open-ended and have a multitude of goals, which also shifts depending on the considered agents and their interests (Geissdoerfer et al., 2017). Circular economy is benefiting the economic system of businesses since resources are used more efficiently and waste and emission are reduced. Although the economic system is often prioritised in circular economy, the environmental system can also benefit from it. A circular economy can be faced as a necessary condition for maintaining economic growth in a sustainable way (UNEP, 2006). However, there exists a great deal of scepticism about the effectiveness of this approach. And sustainability performances are often only related to resource efficiency. *“We simply do not know to what extent corporate greening actually contributes to ecological sustainability or whether it does at all”* (Kallio & Nordberg, 2006).

The incorporation of sustainability within a business model possesses some challenges for businesses and failure is around the corner. Implemented sustainability initiatives might not always have the desired impact on the sustainable performance of the business. Therefore, businesses become reservedly towards sustainable business models. This will not only pose a challenge on the legitimacy to operate and trustworthiness of the company, but also on the environment, the society and the economy. This problem does not only occur when implementing the circular economy design approach, also other design approaches fail to lead to more sustainable performance (Kallio & Nordberg, 2006). Failure mostly arises because sustainability is not incorporated and operationalized (correctly) in the business model of an organization (Schaltegger et al., 2016). Businesses can only become more sustainable if the sustainability initiatives are visible and successfully incorporated in the business model (Boons & Lüdeke-Freund, 2013; França et al., 2017; Schaltegger et al., 2016, 2011).

Since many attempts to create more sustainable business models fail, research towards other promising design approaches is valuable. One promising alternative design approach to fight ecosystem-destruction is biomimicry. Biomimicry is *“a new science that studies nature’s models and then imitates or takes inspiration from these designs and processes to solve human problems”* (Benyus, 2002: I). In biomimicry nature is an inspiring source of knowledge that functions as a fuel for nature based innovations. Biomimicry introduces a new and ecosystem-friendly approach to nature, which is characterized by learning and exploration instead of dominations and exploitation of nature (Blok & Gremmen, 2016). The implementation of biomimicry happens at different levels: product, process, organization, and system level (Mead, 2014a). After millions of years of evolution it is not surprising that nature has created mechanisms and systems that are highly efficient, avoid waste and are highly sustainable in their virtually closed systems (Ivanić, Tadić, & Omazić, 2015). Nature is

a model of strong sustainability that does not irreversibly damage the ecosystem (Cohen & Reich, 2017). Nature's systems consist of closed loop designs that are focused on enriching and sustaining the ecosystem. Mankind can learn from 3.8 billion years of evolutionary development. Mimicking nature, as is the ideal of biomimicry, is therefore a promising path to transition businesses towards strong sustainable practices and to address some of the major sustainability challenges faced by humanity (Cohen & Reich, 2017). The Life's Principles as presented in Figure 1 represent patterns used by nearly all species to survive and thrive on earth. The Life's Principles can function as design lessons to companies and show businesses what they can learn from nature. Nature optimizes all these principles to create conditions conducive to life (Biomimicry 3.8, 2013).



**Figure 1 Life Principles of Nature**

Biomimicry can represent a major turn in everyday business practices in the 21st century by creating a bridge between environmental and economic interests. Biomimicry can lead to more green products, services and sustainable systems, which relate to the environmental interests. Biomimicry has the ability to improve efficiency, create products that perform better than those now available, and sell at lower costs than competitors, which relate to the economic interests (Ivanić et al., 2015).

The promising potential of biomimicry has not been unnoticed. In the year 2000 the Da Vinci index has been designed to measure activity relating to biomimicry and bio-inspiration. The Da Vinci index



is a database that keeps track of four areas of data: number of scholarly articles, number of patents, number of grants, and dollar value of the grants. The Da Vinci index provides signs that interest and application of biomimicry grows. In the period from 2000 to 2010 patents related to biomimicry and bio-inspiration grew from three to 41. And in the same period the number of scholarly journal articles grew from 285 to 1507. The number of grants rewarded to work related to biomimicry and bio-inspiration grew from 71 to 224. The value of the grants in 2000 was \$24 million and \$93 million in 2010 (Ivanić et al., 2015). The growth has two drivers: innovation and sustainability (Cohen & Reich, 2017), which correspond to the bridge biomimicry creates between environmental and economic interests identified by Ivanić et al., (2015). It is estimated that biomimicry will represent about \$1.6 trillion of the worlds' total output by 2030 (Fermanian business & Economic Institute, 2013). Besides the promising potential of biomimicry, it also faces some obstacles. The promises and obstacles are listed in Table 2.

**Table 2 Promises and obstacles of biomimicry (Cohen & Reich, 2017)**

<b>Promises biomimicry</b>	<b>Obstacles biomimicry</b>
Millions of solutions are waiting to be studies	Scalability, some biological mechanisms/system work on small scale but fail to work at large scale
Make biological data growth applicable and productive	Material constraints, sometimes there is no artificial substitute for the biological material
Bridge between environmental and economic interests*	Manufacturing constraints, manufacturing or technical issues restrict the mimicking of natures' systems
Address major sustainability challenges	Irrelevant, the complexity of natures' systems might not always be relevant to businesses
Learning from nature	Relation between biomimicry and sustainability is questionable **

\* Source: (Ivanić et al., 2015)

\*\*Source: (Cohen & Reich, 2017; Ivanić et al., 2015; Mead, 2014a)

Besides all the promising elements of biomimicry some critical notes have to be taken into account. Media displayed biomimicry as an approach to become sustainable, which caused businesses to implement biomimicry without a realistic sense of the sustainability embedded in the outcomes (Mead, 2014a). Imitating nature, without an intention to implement the sustainable design principles of nature, will not guarantee sustainability. And research has not yet discovered a relation between biomimicry and sustainable business models (Cohen & Reich, 2017; Mead & Jeanrenaud, 2017). In case of biomimicry at product level for example, a product may be designed based on nature innovative mechanism but during the manufacturing toxins or large amounts of energy may be used during production (Cohen & Reich, 2017).

Although biomimicry sounds as a promising and specific design approach for businesses to apply in order to create a sustainable business model, still a lot of uncertainty exists. There is no literature or empirical data that explores and explains the relationship between biomimicry and sustainable business models. There is no best practice information available for businesses and they do not know how biomimicry must be incorporated in order to create a successful sustainable business model. Research in this field is necessary; otherwise biomimicry can be seen as another failing design approach. Businesses need certainty about whether or not incorporating biomimicry principles within the business model will lead to a successful sustainable business model.



## 2. Research overview

### 2.1 Research objective

This thesis report will combine research about Business Models, Traditional Business Models, Sustainable Business Models, Successful Sustainable Business Models, Elements of successful sustainable business models, and Biomimicry. The researchers aim is to explore whether businesses that implemented a biomimicry design approach have a sustainable strategy and a sustainable business model. Furthermore, the aim is to assess the successfulness of these sustainable business models and to investigate how sustainability is operationalized in those business models. By doing so, the researcher investigates the characteristics of business models of companies that apply a biomimicry design approach. And the researcher can analyse those characteristics on sustainability. This explorative empirical research might function as best practice information to businesses, adds to the limited amount of already existing information and literature, and provides characteristics of businesses models of businesses that implemented a biomimicry design approach. In short, the overall general objective of this research is: *to assess and identify the (sustainable) characteristics of business models of businesses that apply a biomimicry design approach and to analyze the different ways of sustainability operationalization used within these business models.*

The objects that will be addressed during this research are: biomimicry, business models, sustainable business models, elements of success, operationalization of sustainability

### 2.2 Research Framework

This research consists out of four phases represented by (1), (2), (3) and (4). The phases are visually displayed in figure 2.

- (1) The first phase that has been executed is the theoretical phase in which desk research is performed regarding the objects of this research. Theories and scientific literature regarding the objective of this research are examined and analysed. This phase combined findings from literature that eventually lead to the theoretical framework of this research.
- (2) The second phase is the empirical phase of this research. In this phase empirical data was gathered by conducting semi-structured interviews with established firms and start-ups. Interview questions were based on the theoretical framework, conceptual model and the research questions. In this phase primary data regarding the research objective and research questions was gathered. The methods for empirical data gathering, and sample selection are described in the methods section provided in Chapter 6.
- (3) In the third phase the gathered primary data has been analysed and compared. The analyses from the different interviews and the scientific literature are transformed into the results. This phase helped the researcher to gain answers to the sub research questions (SRQ's).
- (4) The final phase provides an answer to the main research question (MRQ). This phase gives a conclusion, summarizes the findings and provides limitation and recommendations for future research.

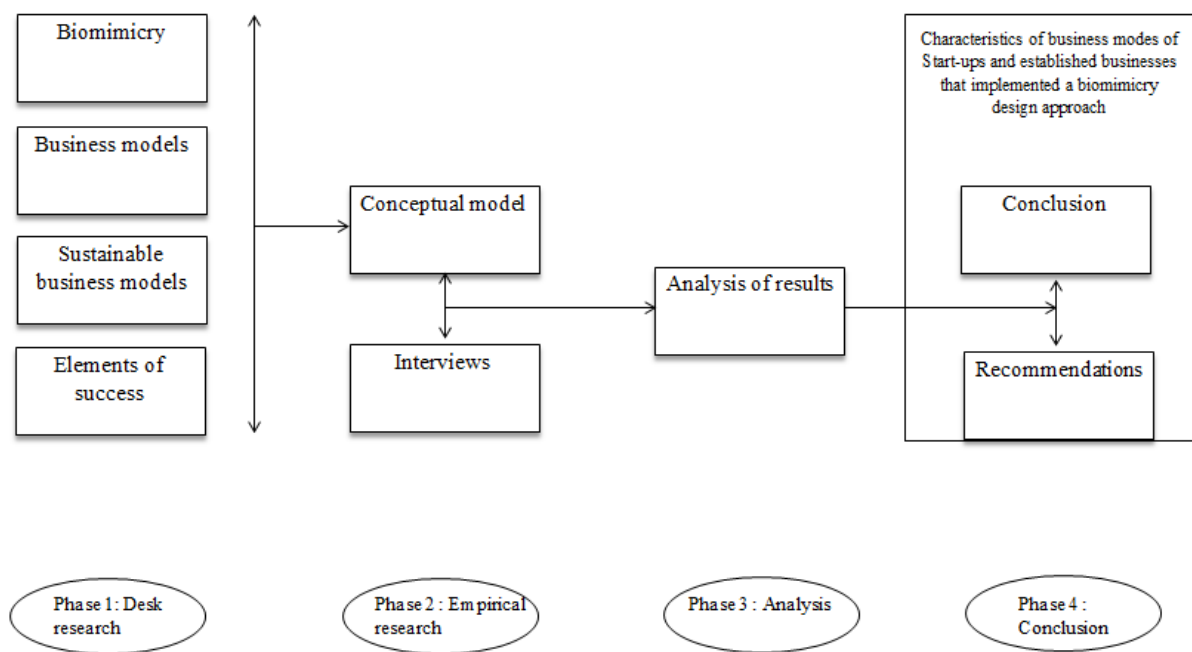


Figure 2 Research framework

### 3. Theoretical framework

This section consists out of 4 different parts. In the first part, 3.1, Sustainable Strategies, Traditional Business Models (TBM's) and Sustainable Business Models (SBM's) will be defined. These definitions are used throughout this research. In the second part, 3.2, theories that assess the presence of a sustainable strategy and a sustainable business model are provided. In the third part, 3.3, elements that define the success of general sustainable business models are researched. And in the fourth part, 3.4, the ways in which sustainability can be operationalized in a business model are investigated based on theory. This theoretical framework is based on theories retrieved from scientific literature.

#### 3.1 Sustainable strategy and Business models

##### 3.1.1 Sustainable strategies

As mentioned in the introduction, environmental, social and economic challenges cause changes in the business environment. Businesses are looking for strategies to fight these challenges. Problems the world faces today will most likely not be solved with solutions that have been successful in the past. Or as Einstein phrased it: *"We cannot solve problems by using the same kind of thinking we used when we created them"*. This quote indicates that out of the box strategies are required to solve the unique problems the world faces. Sustainability strategies should be seen as an opportunity to think outside the box, to solve problems in a different way than we created them. Sustainability strategies are called into life to *"meet the needs of the present without compromising the ability of future generations to meet their own needs"* (United Nations, 1987).

Corporate Social Responsibility (CSR) is a leading principle for entrepreneurs and managers to manage sustainability. CSR focuses on the triple P and its aim is to contribute to the challenges the world faces, and to prevent unwanted impact of our actions. Implementing CSR might result in solutions for the challenges (Garriga & Melé, 2004; van Tilburg, van Tulder, & Francken, 2012). CSR combines having sustainability strategies and being a sustainable business. Sustainable strategies are implemented in different degrees. In this research two types of degrees are being considered: Shallow CSR and Deep CSR.

##### **Shallow CSR strategy**

In a shallow CSR strategy the companies' aim is to optimize environmental and social aspects independently of economic aspects and business priorities. In this sustainability strategy sustainability policies are often in conflict with the short term financial goals of the company, which causes tensions during decision making processes (Opensap, 2014).

##### **Deep CSR strategy**

In a deep CSR strategy the companies' aim is to manage the triple p aspects across all strategic platforms. The financial, social, and environmental strategies overlap, and are adjusted to each other. This strategy is not only focused on sustainability as in the triple P, but also on the sustainability of the business. In this sustainable strategy sustainability is the key-driver of the long-term success of the company (Opensap, 2014). Figure 2 the differences between the two CSR strategies.

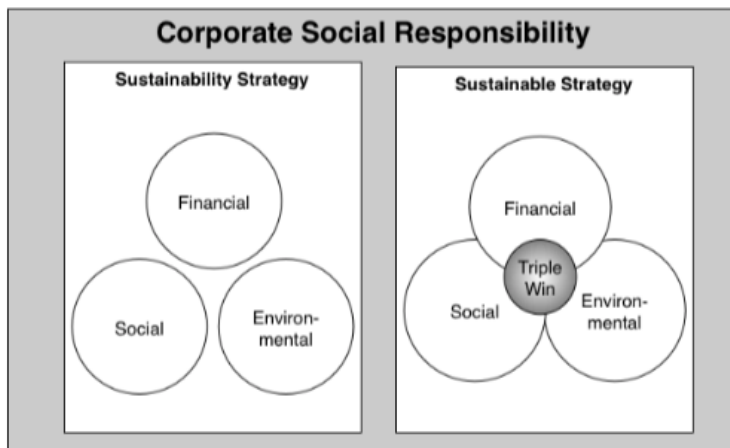


Figure 2 Sustainability strategy versus sustainable strategy (Opensap, 2014)

### 3.1.2 Business models

As described in the introduction business models (BM's) are conceptual tools to understand how a company organizes its business (Bocken et al., 2014). A business model can be used for analysis, comparison, performance assessment, communication, innovation and management (Osterwalder, Pigneur, & Tucci, 2005). A business model explains the underlying structure of how a company creates and captures value (Clinton & Whisnant, 2014). A BM can be seen as the architecture of a business in the organizational and the financial way (Teece, 2010). According to Teece (2010) a BM includes assumptions about customers, their needs and the behaviour of competitors, customers, costs and revenues. Others face a BM's as series of elements. Osterwalder and Pigneur (2010) for example claim that the value proposition, activities, resources, partners, distribution channels, cost structures and revenue model are the elements of success for a good BM (A Osterwalder & Pigneur, 2010). Others claim that the key for successful BM's is the quality of management (Beltramello, Haie-Fayle, & Pilat, 2013). There exists different Business model Frameworks (BMF's) that support business models.

### 3.1.3 Traditional Business Models

Traditional BM's are concerned with product and service offerings to generate economic returns. Laasch (2017) defined the characteristics of the traditional business model in the following way: “describes what kind of products or services are to be proposed to the customer on which market; what the company needs to create these products and services; how these are exchanged with the customers and the wider value creation network including suppliers and distributors; and how the company ensures economic viability, grows and captures a profit for its owners and investors.” (Laasch, 2017; P.13). In this BM the value proposition is geared towards offering an attractive product or service on the market. The proposition is focused on targeting the customers. The value exchange is centred on the marketplace, since the BM is meant to deliver value to the customers. In the traditional BM's customers are seen as a focal point, all flows of goods, services, and information are directed towards them. The customers play such an important role in these BM's since they provide economic benefits to the companies. The ultimate goal of companies with a traditional BM is to make profit in order to capture as much economic value as possible. The BM is also focused on growth and economic viability in the long run (Laasch, 2017).

Economic, environmental and social challenges led to changes in the traditional BM's (Laasch, 2017). Businesses innovate their BM's as a response to the global pressure to become more sustainable, and to implement sustainable strategies. Minor sustainability changes can be implemented in traditional BM's. But radical innovations need a new BM, and sustainable business models (SBM's) appeared (Schaltegger et al., 2011). Businesses can choose to innovate their business model into a SBM in order to become more sustainable.

### 3.1.4. Sustainable Business Models

In comparison with the aim of traditional BM's, SBM's aim is to generate profit by providing products and/or services that directly and/or indirectly reduce the pressure on the (social) environment. At the same time the businesses aim to generate profits equal to or preferably greater than profits achieved with traditional business models. In a SBM profit is not only defined in terms of financial gain, but also in terms of social gain (e.g.: increased employment) (Bohnsack et al., 2014; Chun & Lee, 2013).

According to Laasch (2017) a SBM: “describes the social, environmental, and economic value proposition to multiple stakeholders as a contribution of an organization to sustainable development; what is needed to create this value in a sustainable way; the systematic exchange of value through relationships with multiple stakeholders; and how the value is captured and distributed as social, environmental and economic impacts over time, defining the optimum scale of an organization” (Laasch, 2017; P.14). In comparison to the traditional BM definition the value proposition, value creation, value exchange and the value capturing elements of the definition differ a lot. The traditional BM only focuses on customers and economic value, while the SBM takes other stakeholders into account and focuses on the triple p. Table 3 provides an overview of the tensions between the traditional BM and the SBM regarding the value proposition, value creation, value exchange and value capturing.

**Table 3 Tension between traditional BM's and SBM's (adapted from: (Laasch, 2017))**

	<i>Characteristics traditional BM</i>	<i>Tensions</i>	<i>Characteristics SBM</i>
<i>Proposition</i>	The value proposition has to be optimized for customers only	Customer vs. wider stakeholders	A value proposition has to address the needs of multiple stakeholders
<i>Creation</i>	Economic value creation has to be governed to achieve maximum customer value (effectiveness), with minimum resource use (efficiency)	Economic vs. blended value creation	Social, environmental and economic value creation must be blended, which involves meticulous attention to social and environmental issues and opportunities in value creation
<i>Exchange</i>	Exchange is a mere means for economic value creation	Exchange as a means vs. relationships as an end	The welfare of exchange partners is an end in itself as part of the social value creation imperative of sustainable development
<i>Capture</i>	Businesses have to grow to ensure continuously increasing value capture  + Economic value captured for the company and its owners has to be maximized	Growth vs. optimum scale  + Maximum profit vs. redistribution	Social, environmental and economic value created has to be redistributed among stakeholders and only the amount that is necessary to achieve or maintain optimum scale should be captured for the organization

### 3.2 Presence Sustainable Strategy & Business Model

Companies with and without sustainable strategies claim to be sustainable. It is important that the companies included in this research are assessed on the sustainability of their Business Model.

### 3.2.1 Phase Model of Sustainable Entrepreneurship

The Phased Model of Sustainable Entrepreneurship (FPM) helps to identify a company's position regarding CSR and sustainability, and to assess whether their sustainability beliefs are implemented in their business model (van Tilburg et al., 2012). The FPM consists of four phases: inactive, reactive, active, and proactive. In general the more proactive a business is, the more sustainability is implemented in the operations, which leads to incorporation of sustainability in the business model of an organization. Businesses that transit towards a sustainable business model go through all four phases. Their beliefs, business case, acknowledged stakeholders and codes of conduct describe those phases specifically. Table 4 provides an overview of the Phases Model of Sustainable Entrepreneurship. In addition, Table 5 provides a summary of each phase.

**Table 4 Phase Model of Sustainable Entrepreneurship (van Tilburg et al., 2012)**

Societal Responsiveness	Attitude				
	Intrinsic	Liability		Responsibility	
		Inactive		Active	Pro-Active
			Reactive		
	Business Case	1: Classic	2: Defensive	3: Strategic	4: Societal

**Table 5 Conduct of Phases Model of Sustainable Entrepreneurship (van Tilburg et al., 2012)**

Phase	Inactive	Reactive	Active	Pro-Active
Theme	Conduct			
Vision on Sustainability	None	General statements	Focus on societal contribution	Holistic, strategic
Orientation external developments	None	External adduced, business, location	Market and products or services	Cosmopolitan, society
Business case Elements	Costs, clients and law	Costs, clients, law and reputation	Costs, clients, law, reputation and identity	Costs, clients, law, reputation, identity, long-term continuity
Transparency	None	On request	Product and chain	Full transparency
Reporting	None, or legally obliged environmental reporting	Separate sustainability report focused on process	Sustainability reporting with focus on core-themes and products	Integrated with intertwined strategy
Stakeholders	Government, important clients	Government, clients, suppliers, some NGO's	Government, clients, suppliers, NGO's, employees	Society
Supply Chain approach	No sustainable aspects	Minor conduct codes for suppliers	Engagement and broad codes of conduct	Co-creation
Dominant Functional Discipline	Operations, legal	Public affairs	Corporate communication and HR	Management/Board and strategy

### 3.2.2 Inactive phase

Organizations in this phase see sustainability as a task for the government. Sustainability is faced as something that puts restrictions on entrepreneurship. Organizations in this phase are only compliance oriented; they only meet regulation regarding environmental and social issues. Most of the companies in the inactive phase implement traditional business models. In a traditional business model a company sells a product or service as an independent, repeatable transaction, without trying to

incorporate and integrate sustainability within the business. Furthermore, companies in this phase are focused on cost reduction, cost efficient measures, optimisation. In addition, they have a closed attitude towards society. However, they do acknowledge customers, owners, and employees as involved primary contract stakeholders (van Tilburg et al., 2012).

### 3.2.3 Reactive phase

Organizations in the reactive phase feel responsible towards sustainability since other organizations around them are also “reacting”. The beliefs in this phase are based on moving along with the flow of sustainability. They believe that preventing is better than curing. Sustainability measures of companies in this phase tend to be extrinsic. They have a classic business model that is based on reputation and active market demand. In addition, they do acknowledge customers, the governments and NGO’s as stakeholders. In comparison to the inactive phase, companies in the reactive phase start stakeholder dialogues where they give answers to the demand and questions of all different stakeholder interests.

Another typical characteristic of businesses in the reactive phase is that they start with reporting their CSR measures in their annual reports. Other characteristics are that they standardize basic CSR level within the firm, set targets regarding sustainability, develop a supplier code of conduct to meet certain CSR requirements, create key performance indicators, and design management systems with ISO-certificates. The main difference with the inactive phase is that companies in the reactive phase are more transparent towards their sustainability measures (van Tilburg et al., 2012).

### 3.2.4 Active phase

Organisations in the active phase implement sustainability measures because they believe that sustainability is a market opportunity. Companies in this phase no longer see sustainability as a constraint to business practices. They believe sustainability is a driver for innovation and that it contributes to society in a positive manner. In the active phase the business model significantly differs from the traditional BM’s in the inactive and reactive phase. Companies in the active phase have a (sustainable) strategic, market-driven, reputational and active/latent market demand business model. This business model shows the characteristics of a sustainable business model. The model is moral, ethical, strategic and society driven. In this phase entrepreneurs implement sustainability because “it is the good thing to do” and it can be told and sold as a “story”. Companies in the active phase acknowledge, customers, the governments, suppliers, clients, and NGO’s as stakeholders. All these stakeholders are involved in the discussion of sustainability within the company’s operations.

Companies in this phase focus on the societal contribution of their products/services. In addition, companies in the active phase are known for their commitment to improve the actors in the supply chain by focussing on a cooperative supply chain. In a cooperative supply chain companies implement a strategy of cooperation and engagement. All suppliers in the supply chain get audits, and the suppliers collectively look for pragmatic solutions when shortcomings or problems occur. Furthermore, companies in the active phase implement balanced reporting where they state their dilemmas, targets, and challenges regarding sustainability.

Businesses in the active phase are implementing sustainable innovations to improve their products and/or services. The increase in sustainable innovations indicates that it becomes easier for customers to choose for sustainability. Companies in this phase should implement the sustainability aspects of their products and/or services within their marketing strategy. In this phase there is more stakeholder dialogue than in the inactive and reactive phase (van Tilburg et al., 2012).

### 3.2.5 Proactive phase

In the proactive phase sustainability is closely connected to business strategy. Similarly to the active phase, companies in this phase act from a sense of responsibility. However, this phase takes the responsibility to the next level. In the active phase Shallow CSR is implemented, while in the proactive phase sustainability challenges are intertwined with the strategy of the company, and thus Deep CSR is implemented as illustrated in Figure 2. The proactive phase is characterised by active portfolio managements that focuses on sustainability issues. Companies in a proactive phase do not



only take social developments that affect the firm into account, they also take developments that are not directly firm related into account.

Companies in this phase have a social, sustainable business model. Companies in this phase make decisions regarding strategy and investments even when no financial proof can be presented. The decisions are based upon visionary leadership. In this phase all possible stakeholders are acknowledged. This can be retrieved from the key partners and customer segments in the business model. There is an open and collaborative dialogue with the external stakeholders; they are not hesitant to approach each other with problems and dilemmas (A Osterwalder & Pigneur, 2010; van Tilburg et al., 2012).

Companies in the proactive phase see themselves as stakeholders as well. They contact other organizations and participate actively in stakeholder dialogues of other organizations. The stakeholder dialogues are characterised by equality and reciprocity. Well-known codes of conduct for organizations in this phase are the systematic approach, the visionary approach, the ability to cross-connect different sectors, the long-term vision development, commitment, and the industry and sector initiatives. Other important characteristics of companies in this phase are, the implementation of new (sustainable) business models; more focused on services, circular economies and leasing, change from business case to value creation, and the companies are not sector oriented but society oriented (van Tilburg et al., 2012).

The Phase Model of Sustainable Entrepreneurship is used in this research to assess whether a company has a SBM. Businesses in the proactive phase require a SBM (van Tilburg et al., 2012). The phase in which a business is operating can be assessed on the basis of some criteria (van Tilburg et al., 2012). Table 6 describes the criteria for businesses in the proactive phase.

**Table 6 Criteria for an organization with a SBM** (van Tilburg et al., 2012)

Phase	Proactive
Criteria	Conduct
Vision on sustainability	Holistic, strategic
Orientation external developments	Cosmopolitan, society
Business case elements	Costs, clients, law, reputation, identity, long-term continuity
Transparency	Full transparency
Reporting	Integrated with intertwined strategy
Stakeholders	Society
Supply chain approach	Co-creation
Dominant functional discipline	Management/Board and strategy

### 3.3 Elements of a Successful Sustainable Business Model

In this sub section the elements that define a successful Sustainable Business Model are researched based on literature. First reasons that cause businesses to fail in their attempts to become sustainable are provided in 3.3.1. In section 3.3.2 elements that define the successfulness of Traditional Business Models and Sustainable Business models are analysed.

#### 3.3.1 Failure

Sustainable Business Models have the potential to generate competitive advantages for firms, while simultaneously delivering environmental and social benefits (Boons & Lüdeke-Freund, 2013). Many businesses have realized the need for change and incorporated 'sustainability' in some way (França et al., 2017). An important but often neglected aspect of the change and incorporation is the innovation and design of business models (Schaltegger et al., 2016). In order to support systematic and on-going creation of business cases for sustainability, business model innovation needs to go well beyond traditional BM designs (Schaltegger et al., 2011). This is in line with the propositions of Boons et al.



(2013) and Visser (2014), that transformative, instead of incremental, changes are needed in order to strive for sustainable development. Other research even indicated that business model innovation is a critical lever for overall organizational sustainability, and that integrating sustainability is not only possible but required for businesses to be competitive (Kiron, Haanaes, Reeves, & Goh, 2013; Osterwalder & Pigneur, 2010). In addition, current innovations on the business model and design generally fail to sufficiently embrace the sustainability dimension (França et al., 2017).

On the one hand businesses fail in their attempts to become more sustainable because they do not radically change the business model, and on the other hand business fail to integrate sustainability successfully in the business model (França et al., 2017). This is mainly caused by the lack of understanding of the business case of sustainability (Stubbs & Cocklin, 2008). Businesses lack information on where to incorporate sustainability within their business model in order to become more sustainable. When businesses do not incorporate sustainability in the main elements defining a SBM, the implementation is doomed to fail. The next sections will analyse the elements of successful sustainable business models.

### **3.3.2 Successful Business Models**

The elements of successful Traditional and Sustainable Business Models will be researched in order to assess how businesses with a biomimicry design approach give meaning to these elements. First the elements of successful traditional business model will be research, and after that an extensive literature research will provide the elements that define successful sustainable business models in general.

#### **3.3.2.1 Successful Traditional Business Models**

Traditional businesses measure economic performance (operating profit and corporate value) and claim the enterprise is successful. In traditional BM's success has been broadly defined by monetary returns to shareholders via a share of profits and increases in firm valuation. This focus on economic performance, rather than on an integration of economic, environmental, and social performance contributed to numerous financial, environmental, and social problems. Generally, sustainability metrics are not incorporated into accounting practices, decision-making, and the business model. Therefore, traditional businesses cannot represent themselves as successful sustainable businesses (Upward & Jones, 2016).

Since social and environmental elements are not taken into account in traditional BM's and traditional business model frameworks (BMF's), they might impede a broader transition to flourishing or strongly sustainable business models (Upward & Jones, 2016). Using traditional BM's and traditional BMF's expose businesses in the transition to material risks and missed opportunities, due to overlooking the inherent ecological, social and economic elements. The traditional models might inadequately conceptualize the complexity required to describe a proposal for successful sustainable businesses. In addition, traditional models fail to include the long-duration temporal, cultural and the relational context of conducting sustainable business. The elements and contexts cannot simply be bolted on the traditional models. Successful (strongly) sustainable business models require improved ontology for business models based on the wider system thinking natural, social, economic, management and physiological science (Upward & Jones, 2016).

#### **3.3.2.2 Successful (Strongly) Sustainable Business Models**

There is no comprehensive view of how sustainability should be embedded in SBM's (Bocken et al., 2014). Different scientific articles have been reviewed in order to come up with the key elements and criteria for successful (strong) SMB's (Bocken et al., 2014; Boons & Lüdeke-Freund, 2013; Morioka, Bolis, Evans, & Carvalho, 2017).

### **Normative requirements to successfully incorporate sustainability (Boons & Lüdeke-Freund, 2013)**

Boons and Lüdeke-Freund (2013) proposed a set of basic normative requirements that need to be met in order for businesses to successfully incorporate sustainable innovations. They identified four main elements of a business model based on (Doganova & Eyquem-Renault, 2009; A. Osterwalder, 2004),

and created normative requirements that relate to the elements. These requirements do not specify a sustainable business model per se. They proposed the following four requirements (Boons & Lüdeke-Freund, 2013):

1. The *value proposition* provides measurable ecological and/or social value in concert with economic value. The value proposition reflects the dialogue between business and society concerning the balance of economic, social, and ecological needs as such values are temporally and spatially determined. For new products or services, such a balance is struck among participants in the evolving alternative network of consumers, producers, and other actors. For already existing products and services this balance is embedded in existing practices of all actors in the production and consumption systems.
2. The *supply chain* includes suppliers that take responsibility towards their own stakeholders, as well as towards the focal company's stakeholders. The focal company should not shift its own socio-ecological problems and burdens on its suppliers. For this condition to hold suppliers should be actively engaged in the sustainable supply chain management. Examples of sustainable supply chain management include for example social issue management and materials cycles that avoid/reuse waste.
3. The *customer interface* motivates customers to take responsibility for their consumption and for the focal company's stakeholders. Again, the focal company does not shift its own socio-ecological problems and burdens on its customers. Sustainability challenges as well as company-specific challenges play a key role in the customer relationships.
4. The *financial model* reflects on the appropriate distribution of economic costs and benefits among all stakeholders involved in the business model. In addition, the financial model also accounts for the company's ecological and social impacts.

Although these requirements do not specify a sustainable business model per se, they are important first steps in the development of SBM's. Other authors used elements comparable with these requirements, therefore these definitions of the requirements are important.

### **Operationalize Sustainable Business Models (Morioka et al., 2017)**

Morioka et al., (2017) agree that developing SBM's can be challenging in practice, since there are different and challenging trade-offs that need to be made in the attempt of achieving sustainability goals. On the basis of an extensive literature review Morioka et al. (2017) conclude that corporate sustainability principles include: (i) multiple objectives, including economic, environmental and social goals, (ii) a proactive engagement with organizations' various stakeholders, such as shareholders/investors, employees, customers, suppliers, environment, community, society and government, and (iii) a broad view of the impacts for the short, medium, and long term, in order to consider future generations. These principles can guide businesses during decision-making processes by providing a more tangible and yet holistic approach of corporate sustainability.

Morioka et al. (2017) define that a SBM is a representation of business elements, their interrelation and the context that allows sustainable value exchange with stakeholders to achieve corporate sustainable performance. They identified three key sustainable business elements: (1) value proposition (product/service, customer segments and relationships), (2) value creation & delivery system (key activities, resources, technologies, etc.), and (3) value capture (cost structure, and revenue streams).

1. The *value proposition* is directly associated to company's offerings (products and/or services). But more importantly the value proposition is the main foundation of SBM conceptualization and implementation. This is due to the fact that the value proposition represents the company's economic, environmental and social added value. This makes defining a sound value proposition a key criterion for an SMB existence and survival. However, considering the triple p (People, planet, and profit) only makes sense when goals are not only focussed on short term but also on the medium and long run. Consideration of the long run goes beyond the timeframe for strategic planning, but it implies that businesses also take next generations, and their needs and environment, into account.
2. The *value creation and delivery* system comprises the company's resources, capabilities, and inter-organizational network, having strong connection with generating competitive



advantage. Sustainability initiatives may be implemented in different areas of the organization like operations and production, management and strategy, organizational systems, marketing and procurement, assessments and communication. All different initiatives need to be integrated into company's systems. Companies can for example implement initiatives towards promoting sustainable supply chain management, eco-design, sustainable operations managements, sustainability reporting, sustainable work design, etc. This indicates that businesses may use different mechanisms to implement their value creation and delivering systems to realize and achieve the value proposition.

3. The *value capture* element in traditional business models restricts this element purely to financial aspects in terms of cost structure and revenue model. A SBM includes forms of non-monetary value capture. The value capture element of a SBM seeks to capture economic value for itself, and at the same time, reduces depletion and/or increases natural, social, and economic capital beyond its boundaries. In order to achieve this, various stakeholders need to be addressed in the SBM. The stakeholders included should not only be customers and shareholders/investors, but also suppliers, employees, society, natural environment etc. (Morioka et al., 2017).

Furthermore, these authors justified the incorporation of sustainability in business models, since SBM's; can contribute to the United Nations' Sustainable development goals (SDG's) (United-Nations, 2015); can lead to competitive advantages; are influenced by external context and are able to proactively influence institutional structures towards behaviour is favour of sustainability. Table 7 summarizes the main constructs to operationalize SBM, including sustainable value proposition, value creation and delivery system, value capture, competitive advantage, contribution to SGD's and SBM's context.

**Table 7 Aspects to operationalize SBM's adapted from (Morioka et al., 2017)**

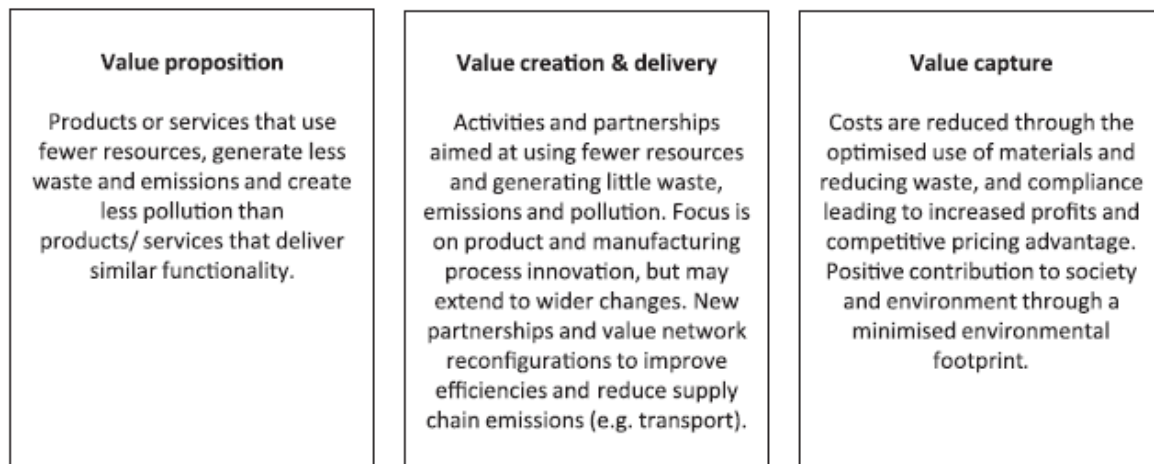
SBM aspect	Example of elements from literature	Synthesis for SBM
Value proposition	Represents the expected economic, environmental, and social value added by the organizations.  Addresses short, medium and long term aspects of sustainability	SBM's value proposition summarizes the organizations' meaning of existence in terms of the sustainable value it aims to create and deliver, includes offerings (products and services) and seeks to address short, medium and long-term aspects.
Value creation and delivery system	Firm's resources, capabilities and inter-organizational network  Sustainability initiatives can be incorporated into operations/production, management, strategy, organizational systems, marketing and procurement, assessment and communication.  These initiatives include: sustainable supply chain management, eco-design, sustainable operations management, sustainable reporting, sustainable work design and ergonomics, amongst others.	SBM's value creation and delivery system represents how the organization manages its resources, capabilities and partners to enable its sustainable value proposition.
Value capture	Companies' value capture include cost structure and revenue model  SBM's enable financial value captured by the organization, but also depletion and/or increases	Each stakeholder captures sustainable value created and delivered by the focal organization

Competitive advantage of SBM	natural, social, economic capital beyond its boundaries. There are win-win solutions, sweet spots, and shared value creation, by exploring corporate sustainability to build competitive advantage SBM can be a strategic choice to increase competitive advantage.	SBM have potential to promote competitive advantage and, at the same time, contribute to SDG's.
Contribution to SDG's	Institutional theory can serve to justify firms' engagement to sustainable development, given laws and regulations (coercive pressure), competitors' imitation (mimetic pressure), or ethical motivations (normative pressures).	
Context factors	Factors include: natural environment and social general context, legislation, industry-specific competitive dynamics and market, public opinion, and technology level.	The organization is a node of a complex system, so things outside of its boundaries affect the inside.

### The Eight Archetypes in the value proposition, value creation & delivery and value capture element of BM (Bocken et al., 2014)

Bocken et al. (2014) also identified *value proposition*, *value creation & delivery*, and *value capture* as important elements of a SBM. All of the Eight Archetypes, which will be further elaborated upon in section 3.4, are translated into these three elements. The following figures will summarize how the Eight Archetypes are represented in the value proposition, value creation & delivery and, value capture elements of a SBM.

#### (1) Maximizing material and energy efficiency



**Figure 3 Representation of 'maximizing material and energy efficiency' archetype in elements of SBM (Bocken et al., 2014)**

#### (2) Create value from waste



Figure 4 Representation of 'create value from waste' archetype in the elements of SBM(Bocken et al., 2014)

(3) Substitute with renewables and natural processes

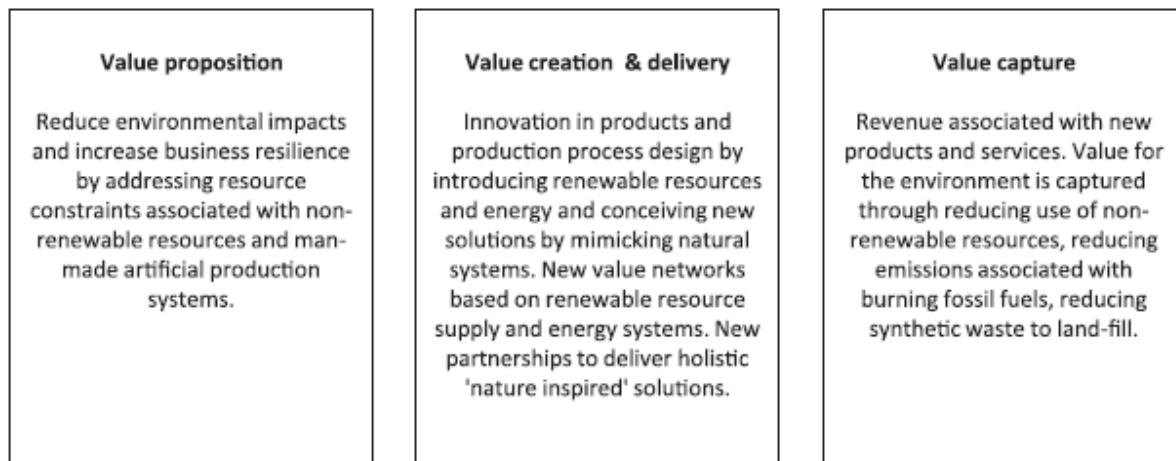
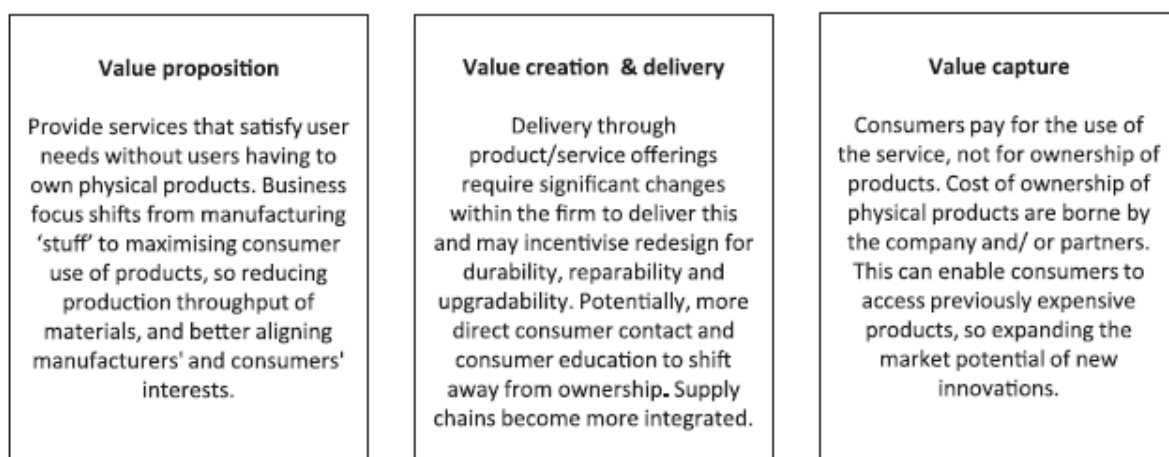


Figure 5 Representation of 'substitute with renewables and natural processes' archetype in the elements of SBM(Bocken et al., 2014)

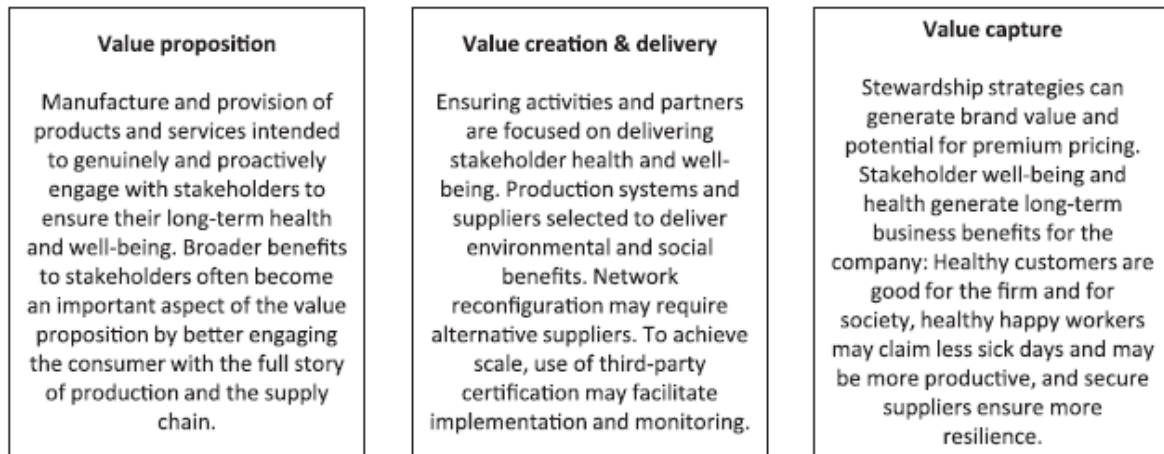
(4) Deliver functionality rather than ownership





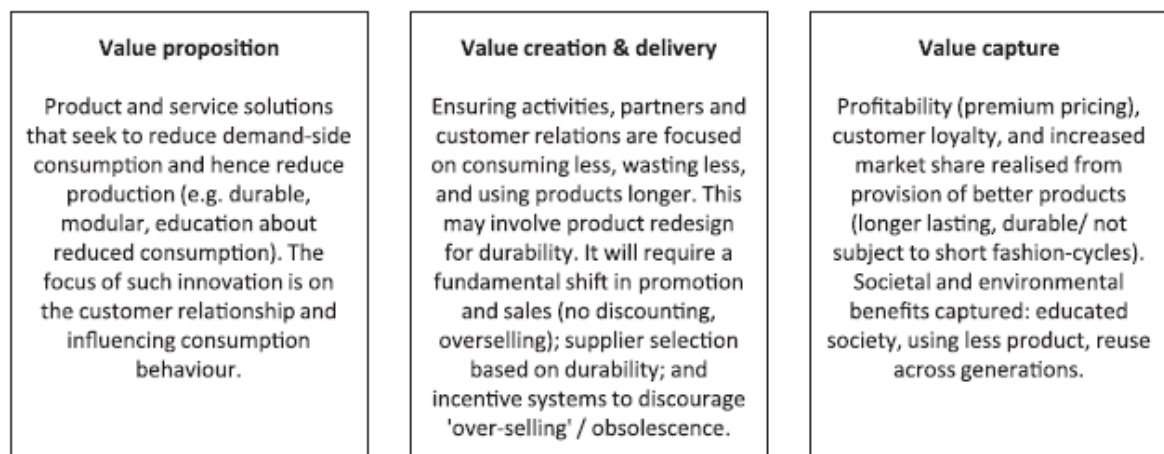
**Figure 6 Representation of ‘deliver functionality rather than ownership’ archetype in the elements of SBM(Bocken et al., 2014)**

(5) Adopt a stewardship role



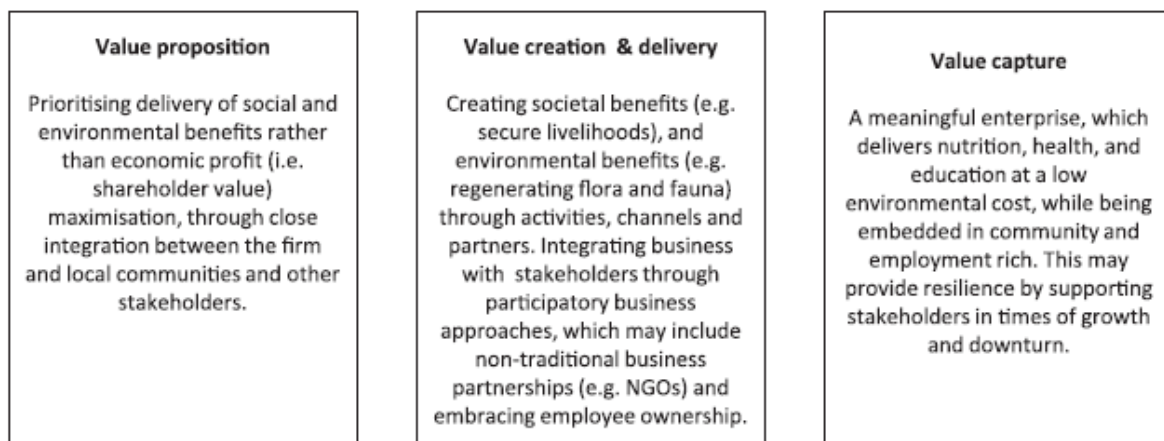
**Figure 7 Representation of ‘adopt a stewardship role’ archetype in the elements of SBM(Bocken et al., 2014)**

(6) Encourage sufficiency



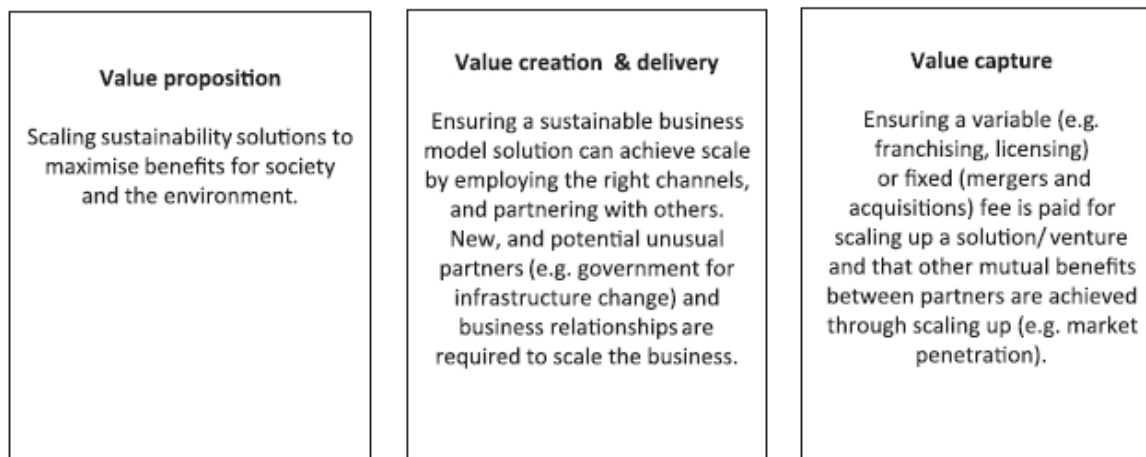
**Figure 8 Representation of ‘encourage sufficiency’ archetype in the elements of SBM(Bocken et al., 2014)**

(7) Repurpose the business for society/environment



**Figure 9 Representation of ‘repurpose the business for society/environment’ archetype in the elements of SBM**(Bocken et al., 2014)

(8) Develop scale-up solutions



**Figure 10 representation of ‘develop scale-up solutions’ archetype in the elements of SBM** (Bocken et al., 2014)

These figures function as examples of how the sustainable initiatives incorporated in the SBM can be operationalized. These examples can guide the researcher during the interviews with biomimetic businesses, and simplify the identification of sustainable practices.

### **Framework of Strongly Sustainable Business Model Propositions and Principles (Upward & Jones, 2016)**

Upward & Jones (2016) performed an extensive transdisciplinary literature review in order to create a framework of successful strongly sustainable business model propositions and principles. Their research is a first step in formulating a foundation for strongly sustainable business models (SSBM's). They define strong sustainability as an understanding of the macro-economy as a sub-system of the finite ecosystem. And weak sustainability assumes that if investment in man-made and human capital is big enough to compensate for the depreciation of natural capital, then sustainability is quasi-automatically guaranteed. The definition of business success in case of strong sustainability appears towards the opposite end of profit driven traditional business success. They identified biomimicry as a concept that could potentially lead to strong sustainability. They designed a new framework because they believe that the current BMF used to build SBM's are not sufficient in incorporating sustainability. It is for example hard to include sustainability in the business model canvas (BMC); the BMC is not designed to represent complex social and ecological systems. The SSBM framework consists of four formative propositions (FP 1-4) and five instrumental propositions (Upward & Jones, 2016).

#### **Formative propositions**

Ontologies of SSBM's should adhere the four proposed formative propositions.

**FP1: Definition of a strongly sustainable firm.** A business that strives towards strongly sustainable outcomes creates positive environmental, social, and economic value throughout its value network and sustains the possibility that human and other life can flourish in this planet forever. Such a business will not only do no harm, it would also create benefits for society while regenerating the environment (“doing good”) to be financially viable. This definition implies that a single business can no longer declare itself as being sustainable without any references to its whole value network. This is driven by mutual interdependencies of a business towards society and the environment (Upward & Jones, 2016).

FP2: *Definition of value.* All important elements of a SBM mentioned in the researches described above are related to value. A strongly sustainable business model must provide the organization a foundation that guides the co-creation of value with all its stakeholders: shareholders, customers, social and environmental systems, and all actors in the value constellation of a business (Upward & Jones, 2016).

FP3: *Definition of a business model.* A business model is a systemic model of necessary and sufficient concepts that both describe and guide the business as a social system within the economic, social and environmental systems it operates. To be a successful strong sustainable business, a business model must recognize the functional integration of required critical components of those systems. The business model of a strong sustainable business gives a description of the logic behind an organization's existence: who it does it for, to, and what; what it does now and in the future; how, where and with what does it do it; and how it defines and measures its success (Upward & Jones, 2016).

FP4: *Definition of tri-profit.* A successful SSBM cannot only measure its success on the basis of profit. Although the concept of profit is intertwined with business success, value, and the business model, it is hard to change it towards a measurement for sustainable businesses. Tri-profit is an inclusive conceptual metric to replace the traditional profit metric. The Tri-profit metric differs from triple bottom line accounting. In triple bottom line accounting the definition of profit is not altered, but an attempt is made to apply its existing meaning outside the economic field. The tri-profit on the other hand is calculated as the conceptual net sum of the revenues (benefits) and costs (harms) arising from the firm's activities in each of the economic, social, and environmental contexts in a given time period measured in units appropriate to each. A business that is tri-profitable creates sufficient social benefits, financial rewards, and environmental regeneration, to the standards set by stakeholders with governance rights (power) (Upward & Jones, 2016).

#### Instrumental principles

Ontologies of businesses must fully conceptualize the following five critical instrumental principles, while adhering to the contextual formative propositions.

IP1: *Conception of an SSBM.* A SSBM must describe all ethically and practically appropriate decisions (choosing the "right") things to do, and actions (doing things "right"). There are different actors who choose the "right" things, and are engaged with and by an organization in numerous ways at the same time and overtime. There are three perspectives related to the possible relationships between actors and their stakeholders. First, the actors for whom an organization exists. The stakeholder roles of these actors need and define the value a business creates. Second, the actors that are affected by the organization. The stakeholder roles of those actors can be positive (value created, meeting the actor's needs) or negative (value destroyed, impeded the actors from meeting their needs). Third, are those actors involved in the on-going processes of value creation (and destroying) of the organization. Furthermore, in order to describe the "right" actions the value proposition of the company needs to be conceptualized. A value proposition describes the positive and negative value that the organization creates and destroys for the actors taking the various stakeholder roles. In order to define how the "right" things are to be "done right" in the short term and in the long run, an understanding of how the organization acts to create the value is required. This means that a business must describe where things are done and how decisions are made about any and all aspects of the business. In addition, there need to be guidelines, standards or principles for choosing "right" things, and to determine whether these "right" things are "done right". This includes how actors with governance rights define success, and how this success is being measured (Upward & Jones, 2016).

IP2: *Boundaries of an SSBM.* A successful SSBM must describe the relationships between the following:

- The social definition of a firm's boundary is based on the agreement of the firm's purposes made by all stakeholders who have power in the decision-making process. The purpose is based on the value the firm will create (or destroy) for the stakeholders.



- The legal definition of a firm's boundary is based on the concept of ownership, and the concept of the firm as a legal person (with rights and obligations)
- The systems outside a firm's boundary are based on the systems of which the business is a part (this includes; the biophysical environment, the human constructed social and monetary domains, and all stakeholders).
- The systems within a firm's boundary are based on the firm's business processes that create (and destroy) value through interaction with the containing systems.
- The conceptual (knowledge), social (relationships) and physical objects inside a firm's boundary are objects that need to be owned or controlled for its processes to create (and destroy) value. This can be broadly defined as the firm's capabilities and resources.
- The conceptual, social (relationships) and physical objects that are shared with other social constructs via the financial, social, and environmental systems. These are embedded in (formal) agreements with stakeholders and are realized in various types of flows: biophysical material flows to and from biophysical stock and ecosystem services, as well as energy flows to and from the biosphere, and monetary flows with stakeholders.

These boundaries collectively define the boundaries of a SSBM (Upward & Jones, 2016).

IP3: *Validation of a SSBM*. To be successful a SSBM must consider the requirements for sustainability over as long time as possible. Only focussing on the short term will not enable a business to guarantee sustainability in the long run, and secure the needs of future generations (Upward & Jones, 2016).

IP4: *Necessary financial viability of a business model*. A successful SSBM must describe the elements of financial viability (e.g. Costs, revenue, profit). In addition, financial and nonfinancial measures are required to record current and desired values (goals) (Upward & Jones, 2016).

IP5: *Modelling social benefits and environmental regeneration*. A successful SSBM must describe how a business meets needs (value creation, value propositions), and how it fails to do so (value destruction), in order to make judgements about the value. Furthermore, a SSBM should describe; which stakeholders are to be involved in which conversations (decisions), what value is to be created/destroyed for which stakeholder (value propositions), how that value is created and destroyed (process). And a SSBM must define and measure tri-profit. This implies that a SSBM must describe:

- The actors and their needs that the business may or may not acknowledge as legitimate stakeholders.
- Actors who are acknowledged play one or multiple stakeholder roles, and the SSBM describes which subsets of each actor's needs are satisfied by the firm's value propositions.
- The steps by which the environmental, economic, and social positive values and negative values are determined.
- The relevant pieces of the BM's of all firms within the firm's value network so as to include all ultimate stakeholder's needs and all connections to the ultimate sources and sinks of all biophysical materials.
- The geographic location and locality of all biophysical components.

Based on the formative propositions (FP1-4) and the instrumental principles (IP1-5), four overarching concepts that are important for the success of an SSBM are identified: *the boundaries and goals of such a model, the need to include concepts of stakeholders, positive and negative (value destroying) value propositions, and all aspects of a firm's processes* whether or not they relate to money. The newly created framework for Strongly Sustainable Business Models is displayed in Figure 11 (Upward & Jones, 2016).

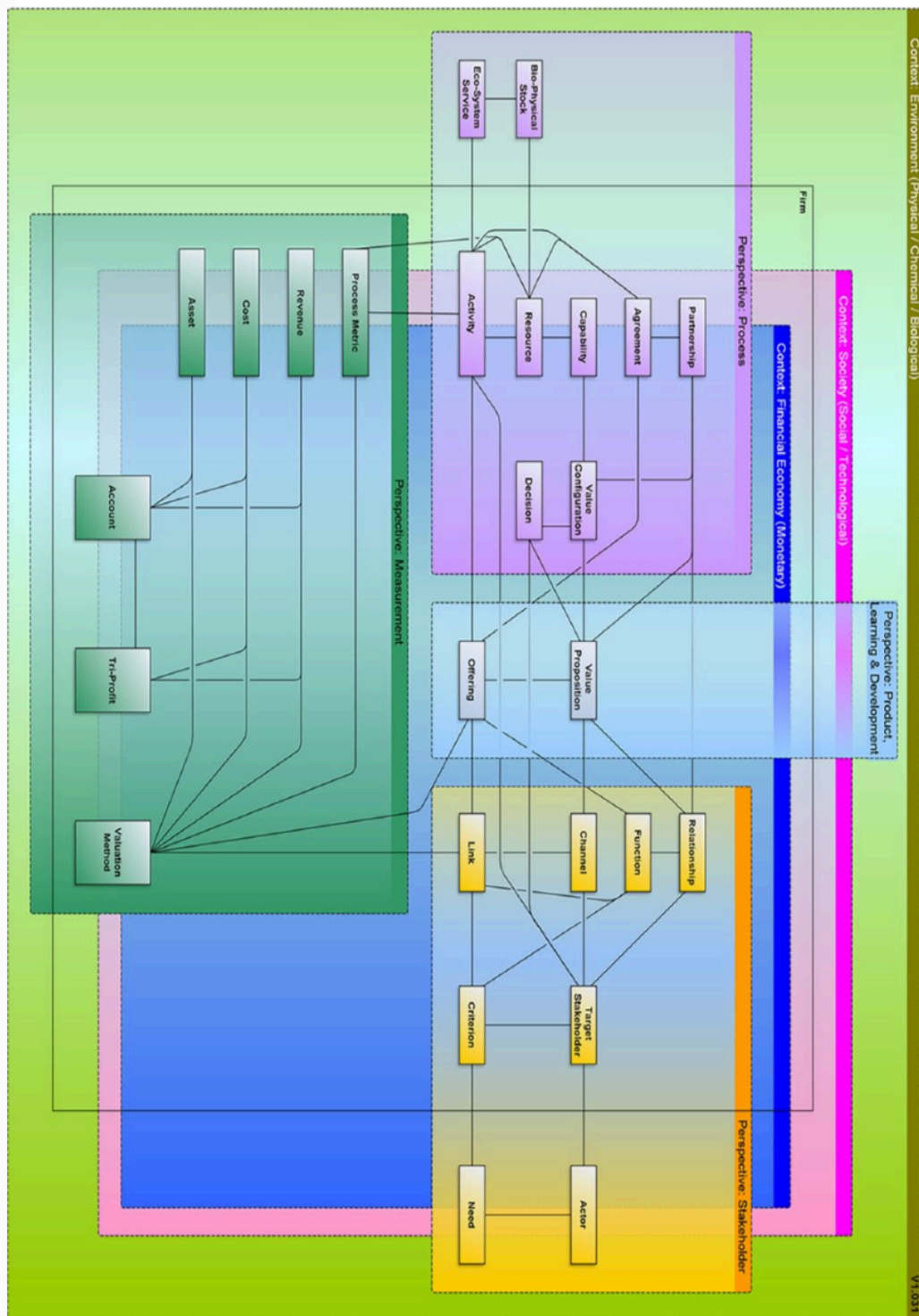


Figure 11 Strongly Sustainable Business Model Ontology (Upward & Jones, 2016)

### 3.3.2.3 Elements of a Successful Sustainable Business Model

Since traditional BM ontologies and framework (e.g. Business Model Canvas) inadequately conceptualize the complexity of the social, ecological and economic systems the following elements should be represented in the SBM in order for that business model to be successful regarding sustainability. A successful SBM must incorporate deep sustainable strategies, as indicated in Figure 2. The identified key elements of a successful SBM are adopted from Upward & Jones 2016, since they performed an extensive literature research and combined scientific literature and academic knowledge from different related disciplines. Definitions of the elements are complemented with definitions and



examples from other researches (Bocken et al., 2014; Boons & Lüdeke-Freund, 2013; Morioka et al., 2017; Laasch, 2017).

### Boundaries and goals

The primary purpose of a successful SBM is not to be monetary profitable. The primary concern of business' stakeholders is broader than exclusively monetary profitability. Successful sustainable outcomes only emerge when environmental, social and monetary values are integrated. The intentional and unintentional impact of a firm on the society, the environment and the economy should be taken into account. Not only the impact within firm's systems is considered, since firm's systems are part of bigger systems it is also important to include the impact beyond its boundaries. The tri-profit metric is a good measurement to identify whether or not a SBM is tri-profitable and integrated the environment and the society within its value capturing process. This boundaries and goal element is related to the financial model proposed by Boons & Lüdeke-Freund (2013), and the value capture element as described by Bocken et al. (2014), and Morioka et al. (2017). A successful SBM creates sufficient social benefits, financial rewards and environmental regenerations, based on the standards set by stakeholders. Figure 12 summarizes the features of the boundaries and goals element of a successful SBM.

Boundaries and goals
<ul style="list-style-type: none"> <li>• Integrates environmental, social and monetary values</li> <li>• Intentional and unintentional impacts</li> <li>• Impacts outside the firm's systems are considered</li> <li>• Tri-profit metric is used</li> <li>• Goals are based on standards of stakeholders with sufficient power</li> </ul>

**Figure 12 Boundaries and goals elements of successful SBM**

### Stakeholders

Businesses must incorporate a wide range of stakeholders in order to be successful. Only focussing on customers and suppliers as stakeholders will not be sufficient. Stakeholders are not only human actors, but also nonhuman actors need to be involved (e.g. ecosystems). Eventually, the needs/purposes of all the human and nonhuman actors need to be taken into consideration during the decision-making processes of a business. The amount of power and legitimacy of all human and nonhuman actors at current state need to be considered in the business model, but it is also important to consider the power and legitimacy of actors in a future state (Upward & Jones, 2016). This is in line with one of the corporate sustainable principles identified by Morioka et al. (2017), successful sustainable businesses must have: a proactive engagement with organizations' various stakeholders, such as shareholders/investors, employees, customers, suppliers, environment, community, society and government. In a Successful SMB each stakeholder captures sustainable value created and delivered by the focal organization. The Suppliers of a business should take responsibility towards their own stakeholders and towards the stakeholders of the focal business.

Figure 13 summarizes the features of the stakeholder element of a successful SBM.

Stakeholders
<ul style="list-style-type: none"> <li>• Human and nonhuman actors</li> <li>• Needs/purposes of multiple stakeholders (not only customers and suppliers) are considered</li> <li>• Stakeholder are proactively engaged in processes of focal organization</li> <li>• Stakeholders' legitimacy and power is considered in current and future state</li> </ul>

**Figure 13 Stakeholder element of successful SBM**

### Value proposition

All above analysed researches identified the value proposition as a main element of a SBM. A SBMs' value proposition represents the expected economic, environmental and social value added by an organization (Morioka et al., 2017). A successful SBM does not only describe the positive value it creates towards its stakeholders, but also describes the negative value generation (value destroyed) for various stakeholders. It is important to describe how an organization creates the positive and negative values, so a SBM must describe where and how things are done and how decisions are made (Upward & Jones, 2016). The SBM displays a trade-off between positive and negative value generation for all included stakeholder, and explains how the business decided upon these trade-offs. Considering and describing the economic, social and environmental value only makes sense when the SBM does not only focus on the short term. Medium and long-term aspects of sustainability must be considered, even if they go beyond the time frame of strategic planning. Figure 14 summarizes the features of the value proposition element of a successful SBM.

Value proposition
<ul style="list-style-type: none"> <li>• Considers economic, social and environmental value</li> <li>• Describes positive and negative value generation</li> <li>• Explains how decisions are made, and where decisions are based on</li> <li>• Short, medium, and long run consideration</li> </ul>

**Figure 14 Value proposition element of successful SBM**

### Firms' processes

The firms' processes represent how the organization manages its resources, capabilities and partners to enable its sustainable value proposition. This firms processes elements as identified by Upward & Jones (2016), relates to the value creation& delivery element as described by Bocken et al. (2014), and Morioka et al. (2017). In successful SBM's the resources required in the processes to generate the value propositions are acceptable if limitations regarding the ultimate biophysical stocks (sources and sinks), the ecosystem services, and any social costs involved in obtaining, moving or transferring these



resources are taken into account (Upward & Jones, 2016). Decisions regarding resources cannot only be based on monetary costs and legality. Sustainability initiatives like sustainable supply chain management, sustainable reporting, eco-design, and sustainable work design and ergonomics are incorporated in the firms processes (Morioka et al., 2017). In successful SBM's decisions regarding the resources, capabilities and partners/ inter-organizational network should consider the impacts of the decisions on other human and nonhuman users of the ecosystem services (Upward & Jones, 2016). Figure 15 summarizes the features of the firms' processes element of a successful SBM.

Firms' processes
<ul style="list-style-type: none"> <li>• Relates to resources, capabilities and partners.</li> <li>• Limitations regarding ultimate biophysical stock, ecosystem services and social costs are taken into account</li> <li>• Considers impact of processes on human and nonhuman users of ecosystem services</li> </ul>

Figure 15 Firm processes element of successful SBM

### 3.4 Operationalization of Sustainability in Sustainable Business model

There are multiple ways in which businesses can operationalize sustainability within their sustainable business model. Figure 3 till 10 provided examples of how sustainability can be operationalized based on the Eight Archetypes of a Sustainable Business Model. The eight Archetypes of a Sustainable Business Model indicate how a business operationalizes sustainability in their business model. Short et al., (2012) developed eight archetypes to describe innovations for sustainability, in order to have a practical approach to the development of sustainable business models. Bocken adapted those eight archetypes in 2013 (Bocken, Short, Rana, & Evans, 2013). A company does not have to be in the proactive phase to meet one of the archetypes; the archetypes are non-phase dependent. The eight archetypes are divided into three categories: technological, social and organisational (Bocken et al., 2014). The technological category consists of three archetypes: (1) Maximize material and energy efficiency, (2) Create value from waste, (3) Substitute with renewables and natural processes. The social category also consists of three archetypes: (4) Deliver functionality rather than ownership, (5) Adopt a stewardship role, (6) Encourage sufficiency. Finally, the organisational category consists of two archetypes: (7) Repurpose for society/ environment, (8) Develop scale up solutions (Bocken et al., 2014; Bocken et al., 2013). A short description of the archetypes will be provided below:

- (1) **Maximizing material and energy efficiency** focuses on doing more with fewer resources. In this way the company generates less waste, and the emissions and pollution will decrease. Companies in each of the four phases of the four phases model can implement this archetype.
- (2) **Creating value from waste** implies that waste streams, emissions and discarded products should be processed into other processes and products. In this way the under-utilised capacity is used in the best manner. Companies in each of the four phases of the four phases model can implement this archetype.
- (3) **Substitute with renewables and natural processes** is about reducing the impact on the environment and concurrently increase business resilience by tackling resource constraints associated with fossil fuels and contemporary production systems. Companies in each of the four phases of the four phases model can implement this archetype.
- (4) **Deliver functionality rather than ownership** means that a company provides services that satisfy stakeholders' needs without having to own physical products. Companies in the active and proactive phase of the four phases model can implement this archetype.



- (5) **Adopt a stewardship role** occurs when a company proactively engages with all stakeholders to ensure a long-term relationship with long-term health and well-being. Companies in the active and proactive phase of the four phases model can implement this archetype.
- (6) **Encourage sufficiency** includes solutions that actively seek to reduce production and consumption of all involved stakeholders. Companies in the active and proactive phase of the four phases model can implement this archetype.
- (7) **Repurpose for society/environment** indicates that the business is focused on delivering social and environmental benefits, instead of being focused on economic profit maximisation. Companies in the proactive phase of the four phases model can implement this archetype.
- (8) **Developing scale up solutions** means that a company aims to deliver sustainable solutions at a larger scale to maximize environmental and social benefits rather than delivering benefits for the company itself. Companies in the proactive phase of the four phases model can implement this archetype.

Figure 16 provides an overview of examples of the different archetypes.

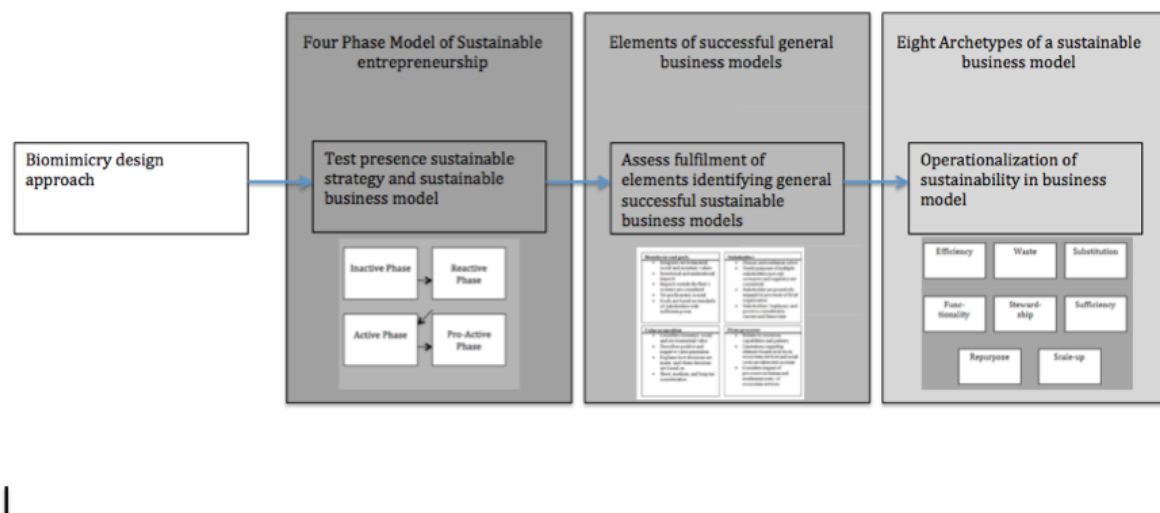
Groupings	Technological			Social			Organisational	
	Archetypes			Archetypes			Archetypes	
Examples	Maximise material and energy efficiency	Create value from waste	Substitute with renewables and natural processes	Deliver functionality rather than ownership	Adopt a stewardship role	Encourage sufficiency	Repurpose for society/environment	Develop scale up solutions
	Low carbon manufacturing/ solutions Lean manufacturing Additive manufacturing De-materialisation (of products/ packaging) Increased functionality (to reduce total number of products required)	Circular economy, closed loop Cradle-2-Cradle Industrial symbiosis Reuse, recycle, re-manufacture Take back management Use excess capacity Sharing assets (shared ownership and collaborative consumption) Extended producer responsibility	Move from non-renewable to renewable energy sources Solar and wind-power based energy innovations Zero emissions initiative Blue Economy Biomimicry The Natural Step Slow manufacturing Green chemistry	Product-oriented PSS - maintenance, extended warranty Use oriented PSS- Rental, lease, shared Result-oriented PSS- Pay per use Private Finance Initiative (PFI) Design, Build, Finance, Operate (DBFO) Chemical Management Services (CMS)	Biodiversity protection Consumer care - promote consumer health and well-being Ethical trade (fair trade) Choice editing by retailers Radical transparency about environmental/ societal impacts Resource stewardship	Consumer Education (models); communication and awareness Demand management (including cap & trade) Slow fashion Product longevity Premium branding/ limited availability Frugal business Responsible product distribution/ promotion	Not for profit Hybrid businesses, Social enterprise (for profit) Alternative ownership: cooperative, mutual, (farmers) collectives Social and biodiversity regeneration initiatives ('net positive') Base of pyramid solutions Localisation Home based, flexible working	Collaborative approaches (sourcing, production, lobbying) Incubators and Entrepreneur support models Licensing, Franchising Open innovation (platforms) Crowd sourcing/ funding "Patient / slow capital" collaborations

Figure 16 The sustainable business model archetypes (Bocken et al., 2013)

The archetypes are used to assess how businesses with a biomimicry design approach operationalize sustainability. In this way sustainability characteristics specific for the biomimicry design approach can be investigated and patterns can be found. This assessment is useful in order to investigate if a biomimicry design approach leads to a specific way of operationalizing sustainability that characterises Business Models of businesses with a biomimicry design approach.

## 4. Conceptual Model

The conceptual model combines the different elements of the theoretical framework. Figure 17 displays the simplified model of this research. Since many attempts of businesses to incorporate sustainability fail, this research is focused on whether or not implementing a biomimicry design approach leads to successful sustainable business models with specific operationalization characteristics. First of all, the cases included in this research are assessed on the presence of a sustainable strategy and a sustainable business model based on the Four Phase Model of Sustainable Entrepreneurship. Next, the researcher analysed how the businesses give meaning to the elements that define a general Successful Sustainable Business Model. And the last part of the conceptual framework relates to the operationalization of sustainability within the business models based on the Eight Archetypes of a sustainable business model. All together this will result in the Characteristics of the business models of start-ups and already established businesses that implemented a biomimicry design approach.



Characteristics of the business models of start-ups and already established businesses that implemented a biomimicry design approach

**Figure 17 Conceptual Model**

The four key elements of success are adapted into the ontology of Upward & Jones (2016), and lead to Figure 18. The adaptations in this figure are straightforward, and simplify the original ontology displayed in Figure 11. This simplification is required in order for the ontology to be used in this research. Figure 18 guided the researcher during the assessment of the successfulness regarding sustainability of the included cases. Questions are based on the descriptions and features of the four elements. The theoretic framework will be used to specify and define the questions. Figure 3 to Figure 10 (representations of archetypes in SBM) will function as examples of how the elements of success can be operationalized in the SBM. A successful sustainable business model of biomimetic businesses creates positive environmental, social and economic value throughout its value network, and sustains the possibility for human and other life to flourish on this planet forever (Upward & Jones, 2016).



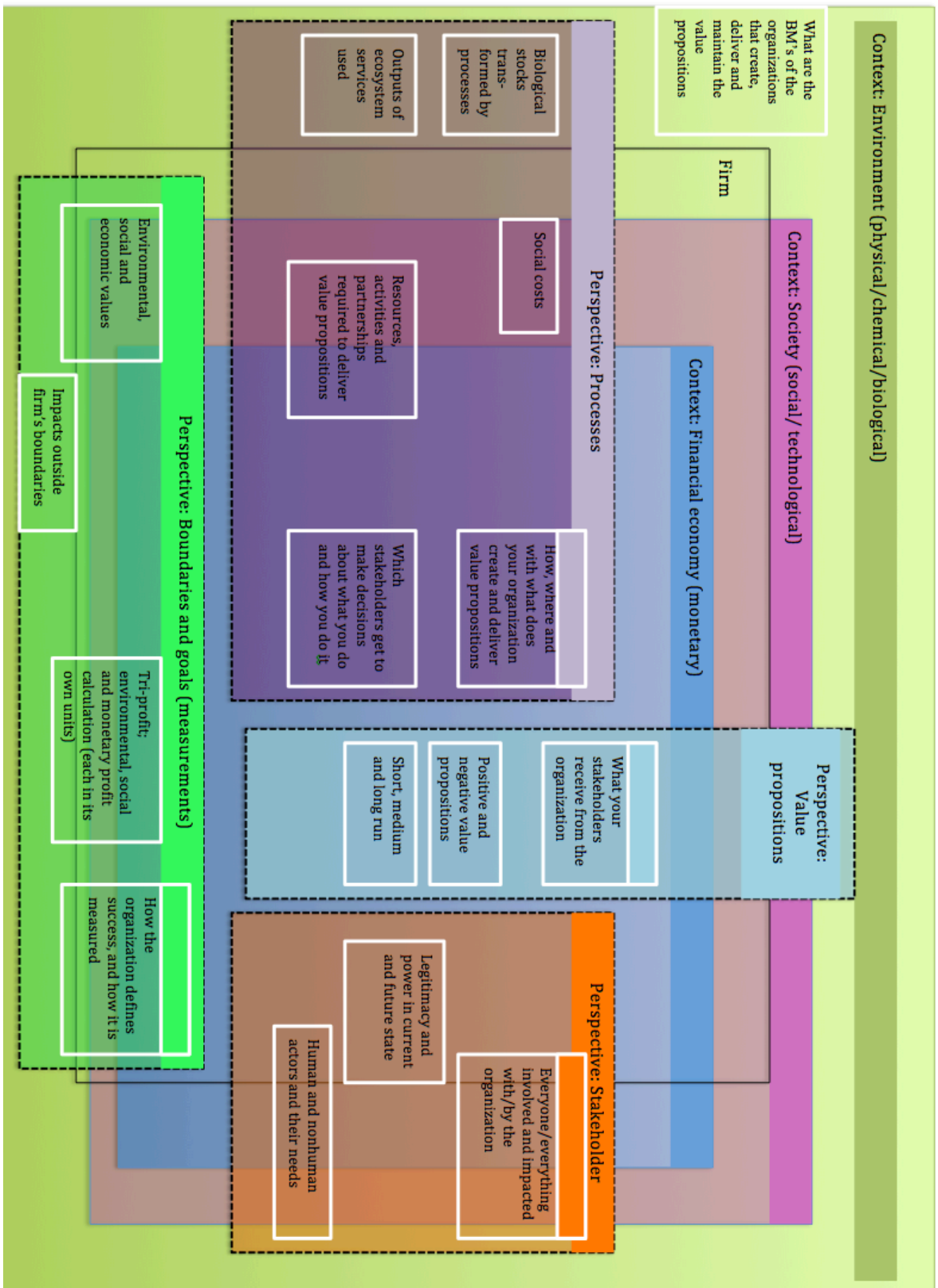


Figure 18 Four elements of success included in the successful sustainable business ontology of Upward & Jones (2016)

## 5. Research Questions

### 5.1 Main Research Question

The earlier described research objective and the conceptual framework resulted in the following main research question (MRQ):

*What are the characteristics of the business models of start-ups and already established businesses that implemented a biomimicry design, and how is sustainability operationalized?* The researcher made a distinction between established businesses and start-ups to investigate whether or not there are any differences between them.

### 5.2 Sub Research Questions

In order to answer the MRQ the researcher developed the following sub research questions (SRQ's):

- *What are the positions of businesses that implemented a biomimicry design approach on the Four Phase Model of Sustainable Entrepreneurship?*
- *What are the characteristics of businesses that implemented a biomimicry design approach based on the Elements identifying a Successful Sustainable Business Model?*
- *In what way is sustainability operationalized by businesses that implemented a biomimicry design approach?*
- *What are the barriers and restrictions of biomimicry encountered by businesses that implemented a biomimicry design approach?*

## 6. Research Methodology

This chapter explains the methodology the author used in order to achieve the objective of this research. In section 6.1 all used research methods are discussed. Section 6.2 describes which cases are included in this research. Section 6.3 provides a description of all companies included in this research, and describes how they implemented a biomimicry design approach. Section 6.4 discusses the method of analysis. And finally the validity and reliability of this research is discussed in section 6.5.

### 6.1 Research Methods

#### 6.1.1 Types of research strategies

Figure 1 displays the Research Framework, which included the used research strategies. First of all a desk research has been conducted, and after that the researcher used Case Studies as a strategy to achieve the research objective. The definition and motivation behind both strategies are given in section 6.1.2 and 6.1.3 respectively.

#### 6.1.2 Desk Research

When performing Desk Research existing material is used in combination with reflection to create a fundament on which the research is based. The desk research method performed in this research is a Literature Review. This literature review is conducted to bring clarity and focus to the research problem, to improve the methodology, to broaden knowledge regarding the research area, and to contextualise the findings. The author chose to review and analyse literature on the following subjects: biomimicry, business models, sustainable business models, elements of success, operationalization of sustainability. Literature is searched using different scientific databases (e.g. Scopus) accessed through the Wageningen University (online) library. A variety of search words and queries are used to find relevant literature. Mainly used search terms are: biomimicry, business models, sustainability, green business models, sustainable business models and success. The search terms were used in different setups and orders: (biomimicry OR biomimetic) AND (“sustainable business model\*” OR “green business model”). The search results were assessed on appropriateness by screening the title, abstract, number of citations, and key words of the found articles. Eventually, a list of relevant literature has been made. The relevant literature is read and important theories, and findings are marked. When reviewing the relevant literature the snowballing technique was used to find similar, relevant sources from the reference lists. In addition, the academic supervisors of this research have also provided relevant literature. After marking all the relevant articles, the marked parts are analysed on relationships, similarities, and differences. Eventually, the marked parts formed the content of the theoretical framework of this research that eventually led to the conceptual framework.

#### 6.1.3 Case Studies

The lack in already existing literature regarding biomimicry and successful sustainable business models makes empirical research necessary. Literature alone cannot provide answers to the research questions. The empirical data collection is based upon a multiple case study design. A case study is a predominantly qualitative research design. A case could be an individual, a group, a community, a subgroup of a population, an event, an instance, an episode, a city, or a town (Kumar, 2014). Businesses, selected as cases in this research, can be seen as an instance. The cases selected are the basis of a thorough, holistic and in-depth exploration of *characteristics of the (sustainable) business models of start-ups and already established businesses that implemented a biomimicry design approach, and how a biomimicry design approach contributes to the operationalization of sustainability*. Case study design is useful when exploring an area where little is known, and when you want to have a holistic understanding of a phenomenon. A case study provides in depth understanding of the cases included and an overview of processes and interaction dynamics (Kumar, 2014). This design has been chosen since it is a flexible and open-ended technique of data collection and analysis. In addition, as described in the introduction there exists a research gap related to the relation between biomimicry and successful sustainable business models. Little research has been done combining these specific topics, and therefore this research explores these topics in- depth. This design made it possible



to gain the missing information and to provide answers to the research questions. Qualitative research is necessary before quantitative research can be done. The multiple Case Study design made it possible to compare the different businesses, and analyse the patterns and relations.

#### 6.1.4 Interviews

Data is gathered from the cases by conducting comparative semi-structured interviews with general managers of businesses that implemented a biomimicry design approach. *“An interview involves an interviewer asking questions to respondents and recording their answers”* (Monette, Sullivan, & DeJong, 1986, P: 156). The advantages of conducting interviews are that they: are appropriate in complex situations, are useful for collecting in-depth information, questions can be explained, and can be used with almost any type of population. The disadvantages of conducting interviews are: the quality of data depends on the quality of interaction, it is a time-consuming method, the quality of data depends on the quality of the interviewer, and the possibility of researcher bias (Kumar, 2014). There are two types of interviews: unstructured and structured interviews. The advantage of an unstructured interview is the almost complete freedom of the interviewer. The interviewer is free to decide upon the structure, contents, questions, the wording, and the order of question. This freedom is extremely useful in exploring and dig deeper into a phenomenon, situation, problem or issue. Unstructured interviews are best suited for identifying variety and diversity. One disadvantage is that the interviewer needs a high level of skills in order to conduct unstructured interviews. And comparing multiple unstructured interviews is difficult (Kumar, 2014). In a structured interview the interviewer predetermines the set of questions, the wording, and the order, and creates an interview schedule. Structured interviews provide uniform information, which makes it easier to compare data. Furthermore, it requires less interview skills in comparison with unstructured interviews (Kumar, 2014). Since on the one hand comparisons needs to be made and on the other hand exploring and digging are important, using semi-structured interviews in the best method of data collection for this research. In the semi-structured interview method the advantages of unstructured and structured interviews can be combined to collect comparable explorative in-depth information. Semi-structured interviews are also suitable if the respondent will only be interviewed once. Most questions asked during the interview were open-ended questions, since they provided the best in-depth information. Open-ended questions allow respondents to express themselves freely and to find new ways of seeing and understanding an topic. The interviews consisted of four parts. The first part was specifically about sustainability and biomimicry, and what kind of biomimicry design approach the company implemented and how it affected the business. The second part related to the presence of a proactive Phase. The third part was related to the elements that define a successful sustainable business model. And the final part was related to the operationalization of sustainability in a business model. The complete interview guide and its operationalization are displayed in Appendix A. Five of the conducted interviews were face-to-face interviews, and eight of the interviews were conducted via Skype, and two interviews are done by phone. The interviews lasted between 35 minutes and one hour and 30 minutes. Interviews with Dutch businesses were conducted in Dutch, the other interviews were conducted in English.

#### 6.1.5 Analysis

The third phase of the Research Framework consist of the analysis of the Conceptual Model and the Case Studies. In this phase the researcher compares the outcomes of the Conceptual Model and the Case Studies. The outcomes of the Case Study went through a specific processing procedure. The semi-structured interviews were recorded, and transcription has been done based on the recordings. Microsoft Word was used to transcribe the interviews. Transcription was done in the language the interview was held. The transcriptions were read a couple of times in order to identify main themes. Examples of main themes are: biomimicry, stakeholders, value propositions, barriers and goals etc. These main themes were translated into colour codes that identify matching subjects. All the interviews were analysed and coded according to a colour code scheme. The colour code scheme describes which colour relates to which subject. After all coding was performed, the interviews were analysed to find relationships, and matches and mismatches between: the themes, the codes and the different cases. This analysis will be used to answer the research questions. Figure 19 summarizes the

primary data processing procedure. The summarized quotes of the transcripts can be found in the Appendices, the full transcripts are digitally available via the author.

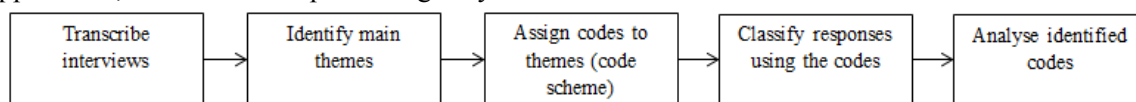


Figure 19 Primary data processing procedures

## 6.2 Study Population

Before businesses were included as cases in this research they had to meet certain criteria. First of all, the businesses needed to be start-ups or already established companies that implemented a biomimicry design approach. Since experience and a thorough search showed that it was impossible to include only Dutch cases the researcher decided to expand her focus from just the Netherlands to businesses worldwide that implemented a biomimicry design approach. The included cases practise different levels of biomimicry. The three different levels are product, process and system level biomimicry. In product level biomimicry nature is mimicked in a product (e.g. tape based of geckos footpad). In case of process level biomimicry nature is mimicked in a product and produced with sustainable resources. And in case of system level biomimicry a business is mimicking natures ecosystems, and treats a business as an ecosystem (Rajala et al., 2016). In this research genetic modification is not considered as a biomimicry design approach, since there is a lot of debate about whether genetic modification should be considered as one manner of biomimicry or not. Established companies as well as start-ups are included in this research. It is possible for mainstream established businesses to integrate sustainability within their business model when they transform their business model. And start-up companies can pursue a sustainable business model from the outset (Bocken et al., 2014). The global increase in awareness towards sustainability resulted in a lot of sustainable start-ups. The start-ups are interesting to include in this research because they did not transit, but started with what they believe is a sustainable business. In sustainable start-ups sustainability is part of the company's genetics. Both established firms and start-ups are included to analyse if there are any differences in the role biomimicry has on the business model between the two. The established businesses selected in this research are established before 2008. The start-ups included in this research are founded after 2008. The industries in which the companies operate differ from architecture, to boat industry, to the carpet tile industry, and so on. The researcher decided to incorporate businesses from different industries since the implementation of a biomimicry design approach is still a rare phenomenon, and therefor it is almost impossible to focus on one particular industry.

### 6.2.1 Sampling design

The included cases were found through the companies' websites, and through the networks of the supervisors of this thesis. This sampling technique is called judgemental sampling. In this kind of sampling technique the judgement of the researcher about who can provide the best information to achieve the objectives of the study will primarily determine which cases will be included (Kumar, 2014). This sampling technique is especially useful when researching a phenomenon like biomimicry, where little information is available. Since, there is little known about biomimicry in relation to the elements of success for sustainable business models the judgemental sampling technique is most suited.

### 6.2.2 Sampling Size

Eventually 15 cases are studied. Six of these cases qualify as established companies and eight qualify as start-up businesses, the other case included was not (yet) a founded company. Most of the businesses implemented a product level biomimicry design approach (N=6), companies that implemented biomimicry on process and system level (N=1), (N=3) companies implemented biomimicry on product and system level and the other companies implemented biomimicry on product, process and system level (N=4). Table 8 displays the company type, industry and level(s) on which the biomimicry design approaches are implemented for all the included cases. Section 6.3 will provide a detailed overview of the different cases.

**Table 8 Overview included cases**

<b>Company</b>	<b>Company Type</b>	<b>Industry</b>	<b>Level of Biomimicry</b>
<b>Company 1</b>	Start-up	Shipbuilding industry	Product
<b>Company 2</b>	Established	Construction	Product, and System
<b>Company 3</b>	Established	Variety of industries	Product
<b>Company 4</b>	Established	Manufacturing	Product, Process and System
<b>Company 5</b>	Start-up	Shipbuilding industry	Product
<b>Company 6</b>	Established	Electronics	Product and Process
<b>Company 7</b>	Established	Variety of industries	Product
<b>Company 8</b>	Start-up	Construction	Product
<b>Company 9</b>	Established	Electronics	Product and Process
<b>Company 10</b>	Start-up	Construction	Product, Process and System
<b>Company 11</b>	Start-up	Agriculture	Product and Process
<b>Company 12</b>	Start-up	Agriculture	Product
<b>Company 13</b>	No Company	Agriculture	Product, Process and System
<b>Company 14</b>	Start-up	Agriculture	Product, Process and System
<b>Company 15</b>	Start-up	Computer industry	Product, Process and System

### 6.3 Company Cases

In this section all cases included in this research will be introduced and the biomimicry design approaches used by the cases will be elaborated upon.

#### 6.3.1 Company 1

Company 1 is a start-up company, founded in 2017, which operates in the pleasure market of the boat industry. This company produces a kind of wrap that is placed around boats to prevent foiling, like algae and mussels. Previously, boat owners applied a toxic type of paint on the boat to prevent foiling. Most of the time this paint is so toxic that it kills everything it comes across. Furthermore, the paint pollutes the ocean. The wrap that company 1 produces is non-toxic and does not harm the organisms that try to attach to the wrap. Furthermore the wrap does not release any materials into the ocean.

A biomimicry design approach is used during the creation of this anti-fouling wrap. The creators of the wrap looked at how other organisms prevent foiling. They eventually took inspiration from a sea urchin, a rose and other stingy organisms. They noticed that other organisms like algae and mussels are not able to attach themselves to the surface of a sea urchin for example. In general nature is using stings to keep other animals off. In first instance, company 1 was coping the stings found in nature. The wrap they applied on boats contained out of a lot of small stings. The creation of the stingy wrap has been the basis of the company. Eventually they developed the anti-fouling wrap even further and tried to optimize its efficiency. After conducting test with al sort of different wraps they concluded that a wrap based on hairy fur was even more effective. So, during the start of the creation of the anti-fouling wrap they copied nature on product level, and after further developing the product they found that the most effective wrap was more comparable with a hairy fur. Company 1 used a biomimicry design approach to find a sustainable substitute for the toxic paints. The founders noticed that a lot of nature's surfaces are able to protect themselves from fouling, and they wondered whether they could use nature's surface designs to create a sustainable alternative.

#### 6.3.2 Company 2

Company 2 is an established architectural bureau founded in 2006. They design a variety of project, ranging from landscape design to buildings. This company is founded because the owners wanted to incorporate sustainability in the architectural industry.



When designing, company 2 always keeps the Life Principles of biomimicry in mind and they try to incorporate the principles in all the designs they create. Company 2 uses system level biomimicry design approach in order to eventually create a product, like a building. A building must become part of an ecosystem, for company 2 it is impossible to put nature apart from people. People and there building must fit into existing ecosystems. Company 2 analyses the ecosystems; social, economic, cultural and ecologic, a building is placed in, and based on the budget and wishes of the commissioner they create a design must suitable in those systems. In addition, company 2 includes product level biomimicry in the types of products they put in the designs.

### 6.3.3 Company 3

Company 3 is an established fluid dynamics and design firm founded in 1997. The company designs industrial equipment and other technologies, which are highly efficient and innovative. Company 3 is licencing the designs to big multinational companies. The products they design range from fans and blowers to mixers to water technologies and water purifications. Company 3 owns one producing company.

The founder of Company 3 recognized that nature always uses spiralling treats in its movements, and de founder tried to include and systematically apply those natural geometries in the designs. Company 3 applies a biomimicry design approach on product level; they copy nature's design shapes in its pure forms. During the design phase all designers constantly ask themselves what would nature do in order to design efficient and innovative technologies. Company 3 is also using a system level biomimicry approach in terms of business systems and operations. Company 3 systematically applied the 10 principles for running your company as a forest, developed by Janine Benyus.

### 6.3.4 Company 4

Company 4 is the world's largest manufacturer of commercial carpet tile, founded in 1973. Company 4 is developing modular carpet using materials and processes that take less from the environment. The company wants to contribute to positive spaces; inspiring interiors with a healthy indoor climate. Most of their carpet tiles are sold to businesses.

Biomimicry forms the base on which the strategy of company 4 is based. Biomimicry principles helped company 4 in the '90s to formulate its business strategy. The business strategy of the company comes forward from the 10 Life Principles of Janine Benyus. Company 4 applies a biomimicry design approach on product, process, and system level. An example of biomimicry on product level is a carpet floor design based on the different colours of foliage in a forest during autumn. On process level company 4 is focused on closed loops and recycling. Currently company 4 is designing a factory as a forest, which is an example of a biomimicry design approach at system level. The business strategy is build around the principle that a company should work as an ecosystem, and with other ecosystems.

### 6.3.5 Company 5

Company 5 is a start-up company, founded in 2013, which designs boat stabilizers for big container ships and yachts. The fact that boats are getting bigger and bigger caused troubles for the yacht owners; yachts are not able to sail al the way to the harbours and they have to use their anchors in deeper water. Big waves in the deeper waters cause the boats to swing a lot, which is unpleasant and uncomfortable for the persons on board. Bigger boats also experience more resistance, which also makes the boat swing while sailing. Other stabilizers in the market use a lot of energy and are inefficient according to company 5.

The founders of company 5 wanted to create a good, more efficient and comfortable stabilizer that created less resistance when used. Company 5 designed two types of stabilizers; one for big container ships and one for yachts, and a third one for speedboats is in the making. Company 5 used a biomimicry design approach to develop the stabilizers. The stabilizer for the big container ships is based on a whale. A whale is a big animal able to move around stable. The fin of a whale is able to rotate in multiple ways, already available stabilizers were only able to rotate in one way. Company 5

worked together with Marine of the Wageningen University to generate knowledge about stabilization of the whale and how they could use it as an inspiration source in their design. Company 5 created a stabilizer with a fin that was also able to rotate in multiple ways in order to create the efficiency and effectiveness. The stabilizers for the yachts are inspired by a natural phenomenon known as the Magnus Effect. Company 5 recreated the Magnus effect in the design of this boat stabilizer.

### 6.3.6 Company 6

Company 6 is an established company, founded in 1966, which designs and produces technologies and machines for multinational mass (food) production companies. And furthermore, company 6 is more and more engaged in the design and creation of robots. Company 6 designs the machines and technologies together with the R&D department of the multinational, and produces them.

Company 6 tried to apply a biomimicry design approach as functional as possible. About 5 years ago company 6 made the deliberate decision to use biomimicry as a design approach on product and process level. Biomimicry design approach is implemented in different ways, first of all company 6 uses and incorporates already created biomimicry product, materials and parts within their machines. They work together with a big company that produces biomimicry-based innovations. In addition, all engineers working at company 6 are trained on the field of biomimicry. The engineers use biomimicry as a design tool to discover new innovative technologies and designs. Furthermore, company 6 tries to look at nature to gain inspiration for solutions for certain requests. One example that company 6 provided is the design for a machine that makes mini-cheeses. Company 6 took inspiration from how rabbits create droppings. The solution was not to recreate rabbit's intestine, but inspiration was taken from that method. Additionally, company 6 handles the Life Principles as another checklist the designs should meet. By using this method company 6 sees a machine as an organism. Company 6 recognised that they need cooperation of the big mass producers in order to apply a biomimicry design on a system level.

### 6.3.7 Company 7

Company 7 is an established business, founded in 2005, which creates energy efficient rotating devices for a myriad of different applications. Company 7 had patented and developed Tubercle Technology and applied it for clients in a new cooling tower fan, a diesel engine cooling fan, wind turbines, and to fans that cool computer graphic cards. Company 7 licenses the right to use the technology on rotating devices to others, who wish to test, develop, manufacture, and sell such machines.

The founders of company 7 were all interested in the tubercles of the humpback Whale. The humpback whale differs from other whales since it had tubercles on its flippers. In the fluid dynamic science researchers found out that surface have to be smooth and streamlined to create the most efficient airflow designs. However, together with other scientist the founder discovered that humpback whales were more manoeuvrable in comparisons to big whales without tubercles. After this discovery the founders of company 7 conducted experiments to test the tubercle performance. The experiments revealed that tubercles make rotating devices like fans, mixers, blowers and wind turbines more efficient. Company 7 implemented a biomimicry design approach on product level by mimicking the tubercles on the blades of rotating devices.

### 6.3.8 Company 8

Company 8 is a start-up company, founded in 2013, which produces natural fiber that can be used in high-quality composite applications. The founder of company 8 developed a mechanical way to gain the fibers from natural products like Bamboo. If the fibers are obtained in a chemical way the natural fibers will lose the mechanical properties. The biobased fibers can be used as a substitute for carbon, steel, aluminium, and even for optical fiber. The biobased fibers are an alternative for oil-based fibers, production of oil-based fibers requires lots of energy and this alternative requires way less.

The founder of company 8 has a design background and knew that Bamboo and other plants had great qualities. The founder applied a biomimicry design approach on product level by researching the plants and their structures in order to understand how fibers could be obtained in a mechanical way.

#### **6.3.9 Company 9**

Company 9 is an established family owned business, founded in 1925, focused on the production of automation technology. In addition they also provide industrial training and education programs. Company 9 operates globally and has 176 offices and production plants worldwide. Some of the owners of Company 9 have a didactic background and value a life long learning very much, therefore they try to incorporate this into their business. They want to make sure that their employees keep learning and discovering, but they also want to teach others to actively stimulate technical education.

Due to the a life long learning mind-set company 9 started to learn from nature and created a business section for it called bionic learning. Company 9 acknowledged that there is a lot to learn from nature. Company 9 especially looks at and researches nature's shapes and movements and tries to copy those shapes and movements with mechanical technology. Company 9 applies a biomimicry design approach on product level; once they copied nature's shapes and movements company 9 searches for opportunities to apply the technological innovations in products. In addition the new production buildings and offices of company 9 are more and more being built by using a biomimicry design approach on system level. One of the new production facilities in Germany is even the most sustainable building in Germany.

#### **6.3.10 Company 10**

Company 10 is an established architectural bureau founded in 2006. The focus of company 10 is broad; from interiors to buildings to artwork. Besides designing company 10 provides lectures and workshops to a variety of interested people, businesses and schools.

Company 10 is especially applying a biomimicry design approach on product and system level. During the building phase of the created designs a lot of biomimicry-based materials and products are used. Furthermore, it is key that the designs fit the ecosystems it has an impact on. According to the owner of company 10 biomimicry is also visible on process level; if both parties can benefit from something you do not necessarily have to exchange financial means.

#### **6.3.11 Company 11**

Company 11 is an established company founded in 2003 that designed and produces grow boxes for trees and plants. Company 11 designed two types of grow boxes: a plastic one and a biodegradable one made out of paper pulp. The boxes serve as an incubator to help trees through the initial part of their growing cycle. The smartly designed containers create ideal growing conditions for the protected plant. The boxes protect the young seedlings from wind and excessive sunlight. Users only need to fill the box with water once, and thereafter the box captures additional water through the collection of rainwater and condensation. This eliminates the need for irrigation or additional water input, allowing the boxes to work in regions without access to these resources.

Company 11 applies a biomimicry design approach on product and process level. The founder of the company discovered that plants and trees use water really efficient, and that they can grow with a limited amount of water. The founder researched natural water phenomenon and concluded that even in really dry areas there is condensation water. The founder analysed how nature sows seeds, animals ingest plants and then excrete seed on top of the soil. The surrounding feces function as protection while the seed develops roots and taps into water resources necessary for further development. The analysis of nature resulted in a product. The processes that happen in the product are a copy of how nature sows and grows seeds. Company 11 made use of laws of nature during the design of the boxes. In nature water is transported through capillary function, and the box copies it, so there are no water pumps installed in the boxes. The design of the cover is based on a lotus leaf, which causes water to enter the box as droplets in the centre. The colours of the box are also inspired by nature.

#### 6.3.12 Company 12

Company 12 is a start-up founded in 2016 that design products and technologies to minimize stress of horses and to maximize their water uptake. They operate in the racehorse industry; stressed horses stop drinking water and get injured.

Company 12 applies a biomimicry design approach on product level. Company 12 analyses entire systems in order to find solutions from nature and these analyses result in products. Furthermore, company 12 uses already created biomimicry products (from other companies) in their designs. Company 12 tries to copy or replicate nature, however when this is too expensive they use nature more as an idea generator.

#### 6.3.13 Company 13

Company 13 is not (yet) a founded company. Company 13 can be describes as a team that responded to a challenge about food production. The team designs and establish food systems that are locally attuned, responsive, adaptive, and safe. Their products collect atmospheric water in place to enhance sustainable food production. The team is especially focused on how urban food systems can develop more resilient water management strategies. In order to be self-sustainable on local level this team believes focus should be on water, energy and food nexus.

Team 13 applies biomimicry on product process and system level to make agriculture more resilient, affordable and secure. Nature already solved all problems, therefor team 13 uses nature as a source of inspiration. Everything in nature is connected and therefor team 13 bases their designs on whole systems. Since team 13 is not a founded company the business model cannot be assessed in the result section, however the insights of team 13 on sustainability and biomimicry are included in the result section.

#### 6.3.14 Company 14

Company 14 is a start-up company founded in 2016 that designs systems for indoor urban farming. Company 14 developed a product that is modular, customizable and allows anybody to grow food in indoor spaces. At the moment company 14 is at the piloting phase, when this turns out to be successful company 14 wants to create a network of urban farmers to improve accessibility to local fresh food and to provide economic opportunities to new urban farmers.

Company 14 applies a biomimicry design approach on product, process and system level. On product level company 14 took inspiration from nature strategies to reduce cultivation volume while maximizing yield. Shape wise company 14 took inspiration from beehives, trees and hexagons. The product is customizable and can be expanded by adding extra nodes and braches. In addition, company 14 used the Life Principles to create its business model. Based on those principles company 14 created a circular economy for its products, just like natures processes. The idea to create a network is also originated from nature; nature exists of different systems that are connected and collaborate in a network. The creation of a collaborative network of urban farmers to create social, economic and ecological value is an example of a system level biomimicry design approach.

#### 6.3.15 Company 15

Company 15 is a start-up company founded in 2017 that designed a creative source and communication tool that empowers biomimics all over the world. The tool company 15 designed is connecting interdisciplinary knowledge, visualizing its relationships, and understanding the value that every organism can bring to the ecosystem. The tool was developed so society can use nature's wisdom to inspire a new generation of creators, inventors and entrepreneurs pursuing positive and sustainable impact.

Company 15 applies a biomimicry design approach on product and system level. The business and the tool are designed based on the Life Principles. The tool can map entire ecosystems, and ecosystems can be compared and analysed to understand connections and relationships and to solve problems. The

software that resulted from the use of the Life Principles is showing the product level output of the biomimicry design approach.

#### **6.4 Reliability and Validity**

Inclusion of multiple cases positively influences the reliability of the outcomes. However, external validity of the interview results and the generalization of those results may be questioned due to a limited number of research cases. To assure internal validity the interview results are compared within and across the selected cases. The cases are also assessed from one broader outsider perspective; one of the supervisors critically reflected upon the results and case level conclusions. An outsider perspective is beneficial; comparing interpretations provides a more subjective analysis. However, this research may lack external validity. Nevertheless, before generalizations can be made explorative and in-depth research is necessary and that is why a case study design can be justified for this research.

## 7. Results

This chapter presents the outcomes of the interviews for each participating case and for each model with its constructs. Each participating case and model (phase model, elements of success and archetypes) has its own operationalization matrix. Table 9 presents an overview of the overall results of each case and each construct. The results follow the case order as indicated in section 6.2.2. A green shade indicates that the case scored positive on that construct. A white shade indicates that the case does not focus on the construct. All cases are assessed on their resemblance with the successful sustainable business model as displayed in Figure 18, similarities are indicated with a check mark. Also the interview responses regarding the experienced impact of biomimicry on business models and the restrictive elements of a biomimicry design approach are discussed for each case. The second part (7.2) of this chapter provides cross case analysis of all included cases.

**Table 9 Overview case level results for each model**

Theme	Model	Construct	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sustainable Business Model	Four Phase Model	Vision on sustainability													-		
		Orientation external developments													-		
		Business case elements													-		
		Transparency													-		
		Reporting													-		
		Stakeholders													-		
		Supply chain approach													-		
		Dominant functional discipline													-		
Elements Successful Sustainable Business Model	Elements that define general Successful Sustainable Business Models	Environmental Social and Economic													-		
		Impacts outside boundaries													-		
		Tri-profit													-		
		Legitimacy and power current and future													-		
		Human and nonhuman													-		
		Positive and negative value proposition													-		
		Short, medium long run value proposition													-		
		Which stakeholder which decision													-		
		Resources, activities and partnerships													-		
		Social costs													-		
		Biological stock													-		
		Outputs of ecosystem													-		
Operationalization Sustainability in Business Model	Eight Archetypes of a Sustainable Business Model	Efficiency													-		
		Waste													-		
		Substitution													-		
		Functionality													-		
		Stewardship													-		
		Sufficiency													-		
		Repurpose													-		
		Scale-up													-		

### 7.1 Assessment of models

This part of the result section will elaborate upon the focus of each company regarding the Four Phase Model, the elements of a Successful Sustainable Business Model, and the Eight Archetypes. In addition, responses regarding the experienced impact of biomimicry on business models and the



restrictive elements of a biomimicry design approach are presented. The provided outcomes are supported by quotes from the interviews and presented in tables and figures. Results from all included cases are separately provided, and the main outcomes for each company are summarized at the end of the different sections.

### 7.1.1 Company 1

This section describes the results for company 1. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 1 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 1 is discussed. Table 10 provides an overview of the scores of company 1 on the Four Phase Model.

**Table 10 Scores Four Phase Model Company 1**

Model	Constructs	Company 1
4 Phase model	<b>Vision on sustainability</b>	“Sustainability was the motive for starting this business. Throughout my life I have developed and designed eco-friendly products. I noticed that there was no sustainable alternative for the toxic anti-foiling paint and I wanted to create a more sustainable alternative.”
	<b>Orientation external developments</b>	“I think that we noticed the problem with the toxic anti-foiling paint before rest of society did. Society is more and more concerned about sustainability now, and now they see the harmful impacts of the anti-foiling paint. We basically provided a solution before society noticed the problem.”
	<b>Business case elements</b>	“Our whole business model is based on a sustainability perspective. Sustainability is our most important sales argument. If you explain to society how toxic the anti-fouling paint is, no one justified the use of it any more.”
	<b>Transparency</b>	“We are totally transparent. Everyone who wants to know what is in or product will get answers. We do not secretly put any bad materials in our products, like some paint producers do.”
	<b>Reporting</b>	“No, we are too small”.
	<b>Stakeholders</b>	“We are leaders in the field of sustainable anti-foiling options. We notice that competitors are also trying to develop sustainable alternatives. Which is a good thing. We try to change the current anti-foiling market and make it non-toxic and non-harmful for sea ecosystems and humans. When more companies try to make this change it is only beneficial to society.”
	<b>Supply chain approach</b>	“We work together with the suppliers of our materials and brainstorm about sustainability issues. We develop all of the materials together with our suppliers. However our supply chain partners are not analysed on their sustainability. I do not believe the available suppliers differ that much in their focus and practice of sustainability.”
	<b>Dominant functional discipline</b>	“We want to become even more sustainable by recycling the wraps. However, this has not been executed yet. Our anti-foiling wraps last between 5 and 10 years, considering that we only started this business 4 year ago we could not yet implement recycling within our processes. Besides, we also want to start using recycled materials. But these are long-term goals. The main concern for now is to prevent toxic materials from being applied to boats and negatively impacting the environment.”

Results show that company 1 scored 6 out of 8 on the Four Phase Model. Company 1 does not have any kind of sustainability report, since they are too small. However, they did mention that everyone can acquire transparent information by contacting company 1. Company 1 also does not have a proactive supply chain approach; they work together with their suppliers on the sustainability of their products, however they do not collaborate to make the supply chain more sustainable. Based on the scores on the Four Phase Model company 1 appears to be in the active phase towards sustainability,

which indicates that they did implement sustainability measures and that they believe that sustainability creates market opportunities. Especially the product they offer causes them to score positive, while the other constructs of the Four Phase Model, like the stakeholder approach, are not focused on sustainability. This outcome implies that the business model of company 1 does show characteristics of a sustainable business model, however these characteristics are mostly related to the product.

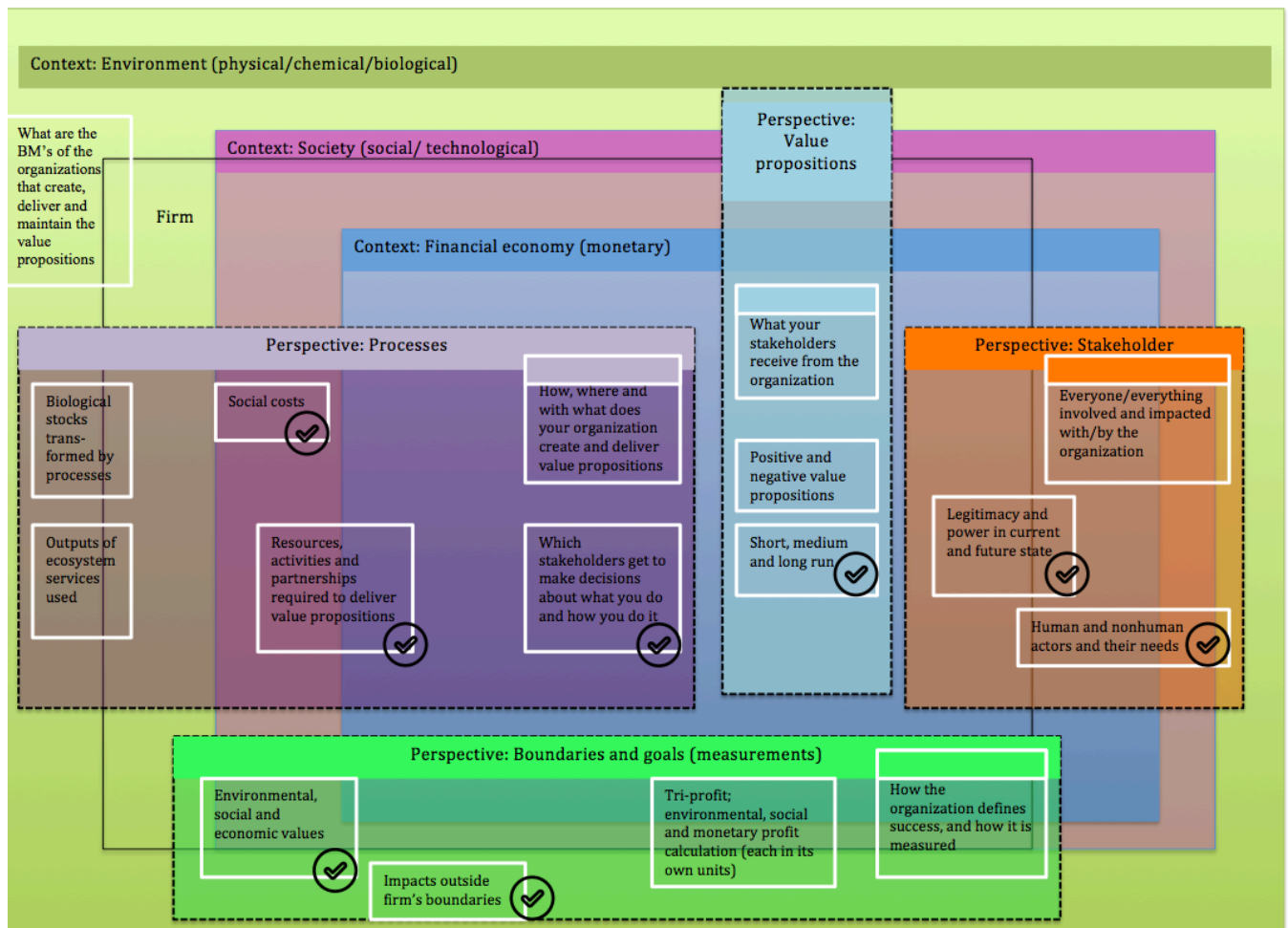


Figure 20 Scores Elements of Successful Sustainable Business Model company 1

The business model in Figure 20 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix B. The results show that company 1 complies with 8 of the 12 elements indicating a successful sustainable business model. Company 1 is not focused on the tri-profit measurement and does not consider doing anything about their negative value generation since *“our product does not cause any harm to the environment, it is effective and the durability is longer in comparison with the toxic alternatives.”* And *“We deliberately choose to have suppliers from the European Union instead of cheaper Asian suppliers, which causes a lower carbon footprint.”* During the interview company 1 stated that they do not focus on negative value generation since they are generating less negative value than companies that offer the alternative products. In addition, company 1 does not focus on biological stock and the use of ecosystem services. However the interviewee stated: *“Decisions regarding materials are primary based upon the functionality and eco-friendliness of the materials.”* The sustainability of company 1 is especially embedded in the product they offer. But by strategically deciding upon the location of their suppliers and manufacturers company 1 tries to consider sustainability during the manufacturing process as well. Nevertheless, company 1 stated that they are not able to influence the manufacturing processes of their supply chain and make the suppliers more sustainable.

Table 11 Scores Eight Archetypes Company 1 shows how sustainability is operationalized in the business model of company 1 based on the Eight Archetype Model.

**Table 11 Scores Eight Archetypes Company 1**

Model	Constructs	Company 1
Eight Archetypes of a Sustainable Business Model	Efficiency	“Yes, our product causes even less fouling than the anti-fouling paints. Therefore the boat experiences less resistance, and thus needs less fuel in order to keep the same speed level. So the anti-fouling wrap makes the boat more energy efficient.”
	Waste	“Not at this moment. But we plan on doing so in the future. We want to recycle the wraps and use recycled materials during the production process.”
	Substitution	“We substitute the conventional anti-fouling paint with a fur-like wrap inspired by nature. We do not have any influence on the energy used during the production processes, since we do not own production plants.”
	Functionality	-
	Stewardship	“We deliberately decided to use non-toxic materials and solvents cause the toxic anti-fouling products directly harm the environment and humans. De toxic materials kill organisms in the sea and the paint can harm the health of the painters applying it to the boat.”
	Sufficiency	“We do not provide information regarding the sufficiency of the used (raw) materials. But we do provide information regarding the lifespan of our products, and how to use it.”
	Repurpose	“We are especially focused on protecting the biodiversity in waters.”
	Scale-up	“In order to expand even further we plan to start a crowd funding campaign this autumn. In addition we want increase our international market share by partnering with local parties and agent ships. In this way we are able to lower our flight costs.”

Results indicate that company 1 scored 5 out of 8 for the Eight Archetype Model. Company 1 does not yet focus on creating value from waste, however they plan on doing this in the future. In addition, company 1 does not focus on delivering functionality rather than ownership, and they do not substitute processes with natural processes and renewable energy. Again, the Eight Archetype model indicates that sustainability is embedded within the product company 1 offers; all green archetypes, aside from the scale-up archetype, are directly related to the product. It could be argued whether the product is protecting the environment or not harming the environment. This could place the Repurpose archetype under discussion. However, the repurpose archetype implies that a business is not only focused on economic profit maximisation. Since company 1 offers an environmentally friendly alternative, and indicated during the interview that the focus is not on profit maximization the author concluded that company 1 focuses on the Repurpose archetype: *“If I look at our value proposition I could have asked I higher price for the products. However, since it is more important to me to quickly gain market share and offer a good sustainable alternative that everyone can afford, we do not ask the higher prices.”*

The interviewee of company 1 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models since nature sets the perfect example of sustainability: *“The basic idea comes from nature and nature is sustainable. However, I do not believe that applying biomimicry on product level will always result in sustainable products.”* Following, the interviewee indicated that the sustainability of their own business model came forward from a sustainability approach in general and that biomimicry did not directly influence the sustainability of their business model: *“Our business model resulted from a sustainability approach in general. I do not believe that biomimicry impacted our business model as such.”* And finally, the interviewee specified that applying a biomimicry design approach did not restrict the company in any way since they do not have

a fixed focus on just applying biomimicry: “ *The use of biomimicry did not influence the company in any negative way and it did not restrain us from making certain decisions. But this might be caused by the fact that we optimized the natural design, and did not truly stick to nature’s design.* ” These quotes relate to the outcomes displayed above. Overall company 1 scores positive towards a lot of the assessed elements, however almost all positive scores are directly related to the product offered. This could be explained by the fact that biomimicry is only used as a design approach on product level, and that business model creation is not based on the Life’s Principles but on a general sustainability approach. Table 12 provides a summary of the outcomes from the assessments of company 1.

**Table 12 Summary findings Company 1**

<b>Four Phase Model</b>	Active Phase
<b>Elements Successful Sustainable Business Model</b>	Semi-Successful sustainable business model; all positive scores relate to product offered and materials used.
<b>Eight Archetype Model</b>	4/5 positive scores, except scale-up, are directly related to the product.
<b>Impact Biomimicry</b>	Biomimicry design approach did not influence the business model; it helped with the creation of a sustainable product. The business model is built around the invention of that sustainable product, which causes sustainable business model characteristics to appear.

### 7.1.2 Company 2

This section describes the results for company 2. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 2 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 2 is discussed. Table 13 provides an overview of the scores of company 2 on the Four Phase Model.

**Table 13 Scores Four Phase Model Company 2**

Model	Constructs	Company 2
4 Phase model	<b>Vision on sustainability</b>	“A documentary about cradle-to cradle inspired us in 2004. We found out that sustainability is not just going on a bike vacation to Texel; you can also take a plane to the Maldives while the plane improves biodiversity in certain areas. We noticed that you can apply sustainability in a variety of field and that everyone is able to contribute to sustainability. We decided to incorporate sustainability in our architect’s profession and to act from a sustainability point of view”.
	<b>Orientation external developments</b>	“We provide answers to problems in society. We apply system thinking during all of our projects. We see the switch to system thinking our duty in order to solve problems in the society”.
	<b>Business case elements</b>	“We never really created a business model. However, everything we do, our acting and our decisions are based on a sustainability point of view. In addition we value the Life’s Principles of Janine Benyus highly and try to integrate them in every part of our business”.
	<b>Transparency</b>	“We do not have any reports or a sustainability section in our annual report, so in that sense we are not fully transparent. However, the things we design are evidence of our sustainability. Society can see how things are made and which materials are used. We noticed that sustainability testing systems can be influenced very simply; therefore we do not generally use them”.
	<b>Reporting</b>	“We do not have any sustainability reports and we are not certified”.

	<b>Stakeholders</b>	“Our role in society is to increase the awareness and use of system thinking (economic, ecologic, social and cultural). The sustainable buildings and projects we are involved in are one thing, but it is way more important to create value for all systems through our designs. The more people think and apply system thinking the better this will be for society. We teach at educational institutes to spread the ideas of system thinking”.
	<b>Supply chain approach</b>	“We work together with suppliers of biological materials in order to make our designs more sustainable. Our suppliers are analysed on sustainability our contractors are not necessarily analysed on sustainability. During all the collaborations it is important that businesses we work with understand how sustainability works, otherwise it is hard to work together with them”.
	<b>Dominant functional discipline</b>	“There is always room for improvement. We continuously want to improve and become more sustainable. All our designs are more sustainable then the previous ones. We are not really focused on growth and profit; we are more content driven. Spreading system thinking is our goal”.

Results show that company 2 scored 7 out of 8 on the constructs of the Four Phase Model. Company 2 only does not focus on sustainability reporting. The founder of the company stated: *“We are not certified in any way, and to be honest I do not believe in certification. The buildings we designed are evidence for our sustainability. Of course not everything is always sustainable; sometimes there are no available alternatives.”* Since company 2 is only lacking the reporting construct of the Four Phase Model company 2 appears to be in the proactive phase towards sustainability, which indicates that sustainability is closely connected to business strategy and that the business model will show sustainable characteristics. Upcoming sections will reveal that only 2 companies score positive on the reporting construct, and the discussion chapter (Chapter 8) will elaborate further on this, therefore companies that lack this construct are still considered as being proactive.

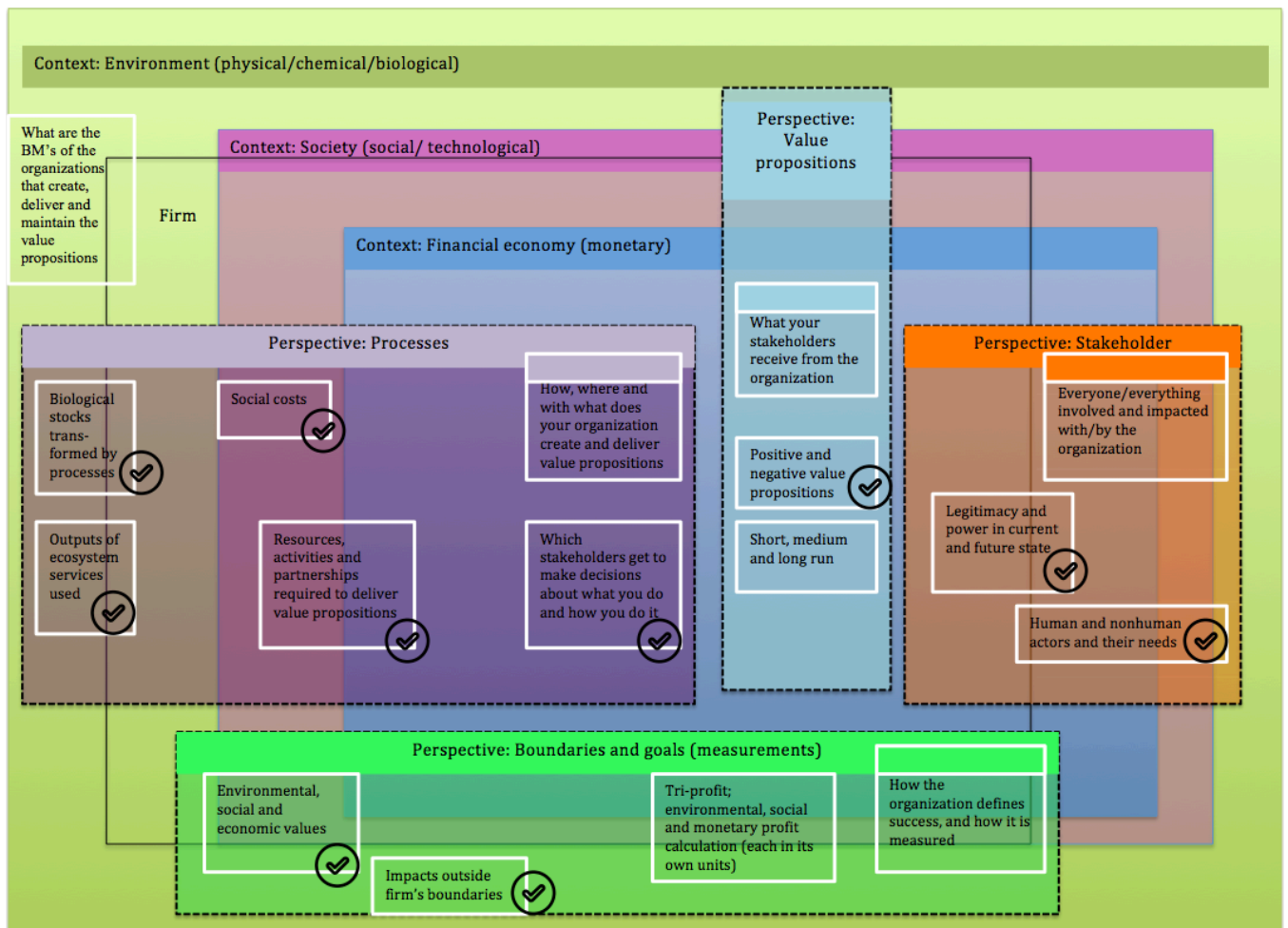


Figure 21 Scores Elements of successful Sustainable Business Model Company 2



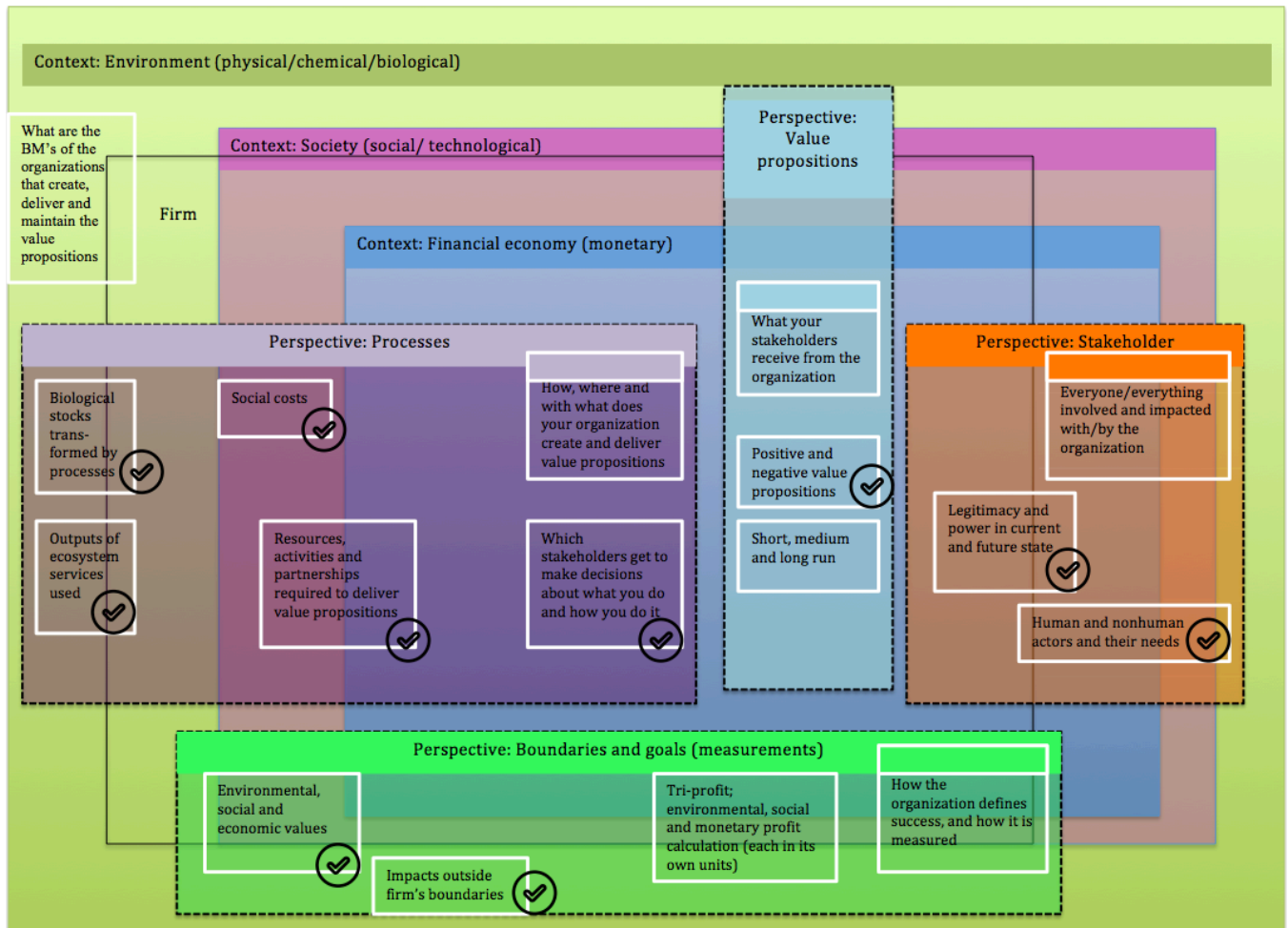


Figure 21 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix C. The results show that company 2 complies with 10 of the 12 elements indicating a successful sustainable business model. Company 2 is not focused on tri-profit measurement however they do believe social and environmental values are important: *“When we decide upon our profit, social values are extremely important. Economic value is necessary in order to achieve this. The same accounts for ecological value. Economic value is a means but not our goal.”* Company 2 is also not focused on medium and long run value proposition: *“Our value proposition is really focused on the here and now, and we did not create a long-term vision”*. Company 2 indicated that they use the Life’s Principles of biomimicry during the creation of their business model, and during business operations. In addition they use a biomimicry design approach on product and system level. However, the figure indicates that they lack the Evolve to Survive life principle, since they focus their value proposition on the here and now. Interview responses revealed that business practices, processes, products, value propositions and mind-sets are built around the social and environmental goals of company 2, and that economic goals are necessary to achieve this. Company 2 proactively engages its stakeholders, including nonhumans, during the different (decision making) processes.

Table 14 shows how sustainability is operationalized in the business model of company 2 based on the Eight Archetype Model.

**Table 14 Scores Eight Archetype Model Company 2**

Model	Constructs	Company 2
Eight Archetypes of a Sustainable Business Model	<b>Efficiency</b>	"I would love to say yes, but it is not always the case. It is not the case that we are constantly trying to minimize material and energy use."
	<b>Waste</b>	"We do focus on creating value from waste. At this moment we are involved in a project with bird watching huts where we use second-hand wood and stone panels. So we do use recycled materials. Our designs have a long timespan and we work with biological materials that can be composted."
	<b>Substitution</b>	"We use sustainable energy ourselves, and we get our own solar panels very soon. The buildings we design are also getting energy from natural/ sustainable resources. I cannot remember the last time we installed a gas boiler."
	<b>Functionality</b>	"We are a designing company and offer a service to our clients. And we educate our clients and society about system thinking."
	<b>Stewardship</b>	"We act a lot based on common sense, but we also conduct life cycle analyses. We are focused on biodiversity but also on more social and cultural problems. Ecological, social and cultural problems are always present during our planning and management activities."
	<b>Sufficiency</b>	"We advise our clients on the use of (raw) materials and try to incorporate sustainability and sufficiency within these advices."
	<b>Repurpose</b>	"Profit is more a resource than a goal. It is way more important to expand our system thinking ideas. We expand these ideas through our design but also by teaching at educational institutes."
	<b>Scale-up</b>	"We have grown from 2 to 6 employees in just a couple of years. We try to spread our ideas and to generate a positive footprint. We are engaged in partnerships to spread ideas and to work together on sustainable projects."

Results indicate company 2 scored 7 out of 8 for the Eight Archetype Model. Company 2 does not operationalize the material and energy efficiency archetype during all different design processes. Operationalization of the archetypes is not only related to the products and projects company 2 design; company 2 also focuses on their processes, education and sustainability awareness creation.

The interviewee of company 2 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models since it creates new perspectives and mind-sets: "*Biomimicry can teach companies the idea of system thinking. When companies apply system thinking within their everyday practices it can make whole industries more sustainable.*" The biomimicry design approach and application of the Life's Principles indirectly influenced the sustainability of the business model of company 2: "*Biomimicry gave us a sustainable reputation. People come to us because we are sustainable and sustainability impacted our business model.*" In addition, company 2 indicated that applying a biomimicry design approach provides guidance and direction, but they did not experience this as restrictive: "*Biomimicry provides direction. We can like a certain material for example, but if we cannot recycle it or it is not biodegradable we cannot choose that material. That is a pity sometimes, however we do not see this as something negative. This is the direction that we deliberately chose and that we support.*" By applying system thinking, which is learned from nature, company 2 tries to make their product and project designs more sustainable. In addition, company 2 is focused on spreading this type of thinking to cause sustainable revolutions in different areas and industries. System thinking and the Life's Principles caused a sustainable approach and created sustainable business model characteristics, which are being operationalized in multiple ways. Table 15 provides a summary of the outcomes from the assessments of company 2.

**Table 15 Summary findings Company 2**

<b>Four Phase Model</b>	Proactive Phase
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model, however value generation is only focused on here and now and there is no focus on tri-profit measurement.
<b>Eight Archetype Model</b>	Operationalizes sustainability in seven ways within their product and project designs, services, awareness creation, collaborations, and education activities. Are unable to constantly focus on the efficiency archetype.
<b>Impact Biomimicry</b>	Biomimicry design approach and its Life's Principles influenced the sustainable mind-set and way of thinking. The business model shows successful sustainable characteristics based on products, processes, awareness creation, education, goals and relations.

### 7.1.3 Company 3

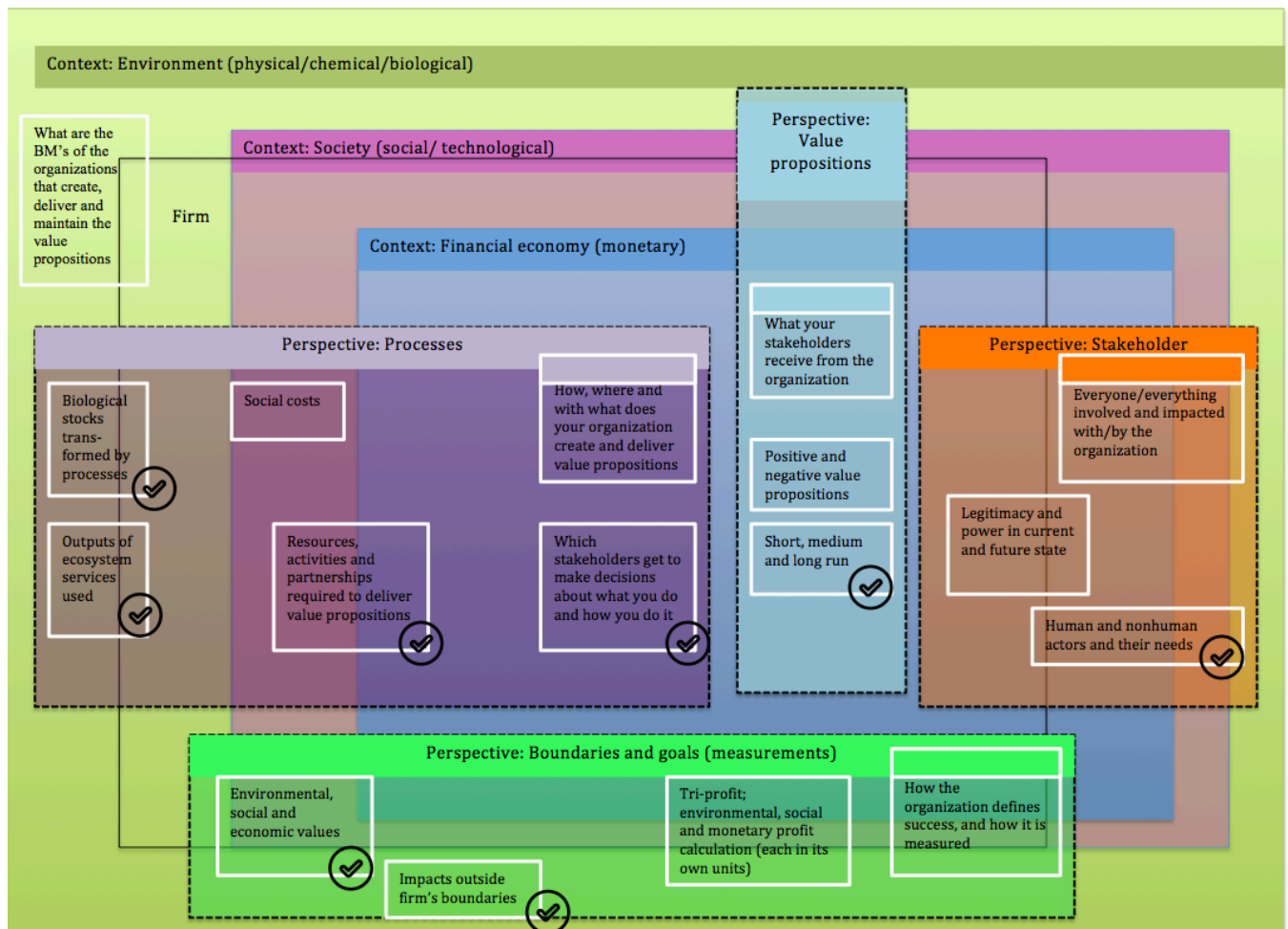
This section describes the results for company 3. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 3 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 3 is discussed. Table 16 provides an overview of the scores of company 3 on the Four Phase Model.

**Table 16 Scores Four Phase Model Company 3**

Model	Constructs	Company 3
4 Phase model	<b>Vision on sustainability</b>	"We consider sustainability in terms of wanting a viable business model. In general we design products and do not produce them. We do have one production company, and it was important for us that that company was b-certified. This means that the company adheres to certain sustainability practices. We cannot really control what our clients do when they licence our designs. The challenge that we have is that our inventions are part of a larger system. We are trying to fit something that is intentionally sustainable into a larger system and it is a challenge. However our main focus is on energy and material reduction to protect the environment."
	<b>Orientation external developments</b>	"The goal of the company is to reduce energy use of companies; that is the entire reason we started the company. We want to show the industrial world that you can save energy and thus save the environment and still have an excellent business model."
	<b>Business case elements</b>	"Sustainability is part of our business model in terms of our main goal: license as much of companies with our designs to save the environment."
	<b>Transparency</b>	"We do not have anything to hide in terms of sustainability. If any of our shareholders wants to know anything we will just tell them. However, we do not proactively provide information regarding our internal sustainability."
	<b>Reporting</b>	"We are not required to have any sustainability reports."

	<b>Stakeholders</b>	“Our role is to be a model of nature’s phenomenal efficiency and inspire other companies to learn from nature instead of exploiting it. Furthermore, we collaborate with other biomimicry partners in order for all partners to be able to create the most successful and sustainable products as possible in order to gain public recognition.”
	<b>Supply chain approach</b>	“Since we are a designing business we do not have a real supply chain. At our own manufacturing firm we use sustainable materials. We use stainless steel for example. However we are not able to insert pressure on our clients to influence their supply chain. So it is a mixed answer, it depends I guess is the best answer.”
	<b>Dominant functional discipline</b>	“There is 100% room for improvement in terms of sustainability. In terms of our internal business we want to continue to improve. In particular we continue to look at reducing our travel/carbon footprint as well as energy use in our office and purchase of equipment and supplies that are as sustainable as possible. And in terms of advising our clients about the use of sustainable materials when manufacturing our designs, we hope that big companies start to see our company as a source of valuable input. In this way we can have more impact on the decisions of our clients.”

Results indicate that company 3 scores 6 out of 8 in the Four Phase Model. They are not required to have any sustainability reports and consider themselves too small to publish any sustainability reports. Since they are a designing firm and license their designs they are unable to make any decision about the suppliers and their sustainability practices. They own a small manufacturing firm themselves where they work together with suppliers to create sustainable products. Most of their designs are licenced by big firms that company 3 does not have any influence on, and therefore they are unable to focus on supply chain approach construct based on co-creation of sustainability. Assessment of the Four Phase Model reveals that company 3 is on its way towards the proactive phase, but that they are currently in the active phase towards sustainability. They are aware of the constructs that define a proactive company, and as they indicated themselves: *“There is 100% room for improvement in terms of sustainability.”* At this moment company 3 does not have the legitimacy and power to influence their supply chain, and to co-create more sustainable businesses, clients and industries. However, due to the sustainable designs the business model of company 3 will reveal some sustainable characteristics.



**Figure 22 Scores Elements of successful Sustainable Business Model Company 3**

The business model in Figure 22 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix D. The results show that company 3 complies with 8 of the 12 elements indicating a successful sustainable business model. Company 3 is not focused on using the tri-profit measurement: “*In terms of profit we do not track any environmental social matrix*”. Company 3 is also not focused on the legitimacy and power of stakeholders in the future state: “*It is kind of a challenge to convince clients to adopt these designs. So, that puts us in a positions of taking the clients we can get*”. In addition, company 3 did not include any social cost elements in their business model. During the interview company 3 mentioned that they use the Life's Principles. However, their application of the Life's Principles differs from other Life's Principles users: “*We do not base our business decision on the Life's Principles. We do base our operational decisions on the Life's Principles.*” This might explain why they do not score positive on all elements of a successful sustainable business model. The fact that company 3 only applies a biomimicry design approach on product level might also explain why they do not score positive on all elements. Interview responses revealed that business practices, processes, products, value propositions and mind-sets are build around the social and environmental goals of company 3, and that economic goals are necessary to achieve this. However, it is kind of a struggle to reach the economic goals, which makes it hard to realize the social and environmental goals. This struggle also causes company 3 to not consider the future legitimacy and power of their stakeholders. Especially, in their own manufacturing firm company 3 values sustainability highly, and takes it into account during decision-making processes regarding processes and materials.

Table 17 shows how sustainability is operationalized in the business model of company 3 based on the Eight Archetype Model.



**Table 17 Scores Eight Archetype Model Company 3**

Model	Constructs	Company 3
Eight Archetypes of a Sustainable Business Model	<b>Efficiency</b>	“That is our whole focus. So if we can use less materials that have the same impact, or we can use less energy that have the same impact that is exactly where our designs are based on.”
	<b>Waste</b>	“We designed a system to clean dirty water for a wastewater treatment company, so that water could be re-used. So in that regard it is one company. But again we do not manufacture the product. But we try to license that design.”
	<b>Substitution</b>	“In California you have the right to elect if you want your electrical power to come from all-renewable. And we do. Furthermore, we use the ten principles of Janine Benyus on how to run your company as a forest and take them into account during internal decisions considering operations.”
	<b>Functionality</b>	“Our clients licence our designs.”
	<b>Stewardship</b>	“We do not have any formal programs for that. It has been such a struggle just to keep the company going that our focus is on our employees to make sure that they have benefits. So, I think that that is where the attention has gone more than going to the next level and doing some deliberate environmental/social or health initiatives.”
	<b>Sufficiency</b>	“Our goal is that our products use less material. We found that some clients use that just to save money and not to save the environment. We absolutely let our clients know that we could advice them about the use of materials. But most of our clients are very large companies. And so they may have their own internal systems. We do take sufficiency into account in our own internal decisions.”
	<b>Repurpose</b>	“I really think that just the fact that our entire focus is on reducing energy use. It is all based on an environmental goal: it is to show the industrial world that you can save energy and save the environment and still have really excellent businesses.”
	<b>Scale-up</b>	“We are planning on crowd funding to get our fan designs directly to the public and not have to have the fan to go through the manufacturers; we want to design the entire fan based on a biomimicry design approach. In terms of open innovation there are only a very few other companies that study fluid dynamics, so it is a challenge for us to bring in ideas from the outside. In general I would say we try to be the provider of innovative ideas to the outside.”

Results denote that company 3 scored 5 out of 8 on the operationalization of the Eight Archetype Model. Company 3 is not focused on creating value from waste: *“We have designed a system to clean dirty water. So in that regard that is one company. We do not directly convert waste, but we are trying to clean polluted water”*. At the moment company 3 is focused on licensing as much as companies as possible to create a change in the industrial energy use, which is challenging for them. This causes that they do not have time to invest in the creation of their aspired stewardship role. The fact that they license their designs to large industrial companies also causes that company 3 is not able to focus on functionality rather than ownership.

The interviewee of company 3 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models since nature provides examples of sustainability: *“Applying biomimicry can contribute to the sustainability of business models because nature is sustainable and humans are not.”* Nature provided a sustainable product solution to company 3, and they license this design to make industrial companies more sustainable. The sustainable business model characteristics of company 3 are directly dependent on the sustainable and by nature inspired product designs they develop. Other sustainable characteristics of company 3 are more related to awareness creation,



education, and collaboration to cause a revolution changing the current linear take-make-waste economies into a more sustainable economy. In addition, company 3 does not feel restricted by the use of a biomimicry design approach since they do not have a fixed focus on only biomimicry: *“Because we are not a pure biomimicry design approach company I do not think it is restricting us. As you heard from my answers we do not say to our clients: we are not going to work with you unless you do cradle-to-cradle for example. I think since we are not strict about those things it does not restrict us.”* Table 18 provides a summary of the outcomes from the assessments of company 3.

**Table 18 Summary findings Company 3**

<b>Four Phase Model</b>	Active Phase
<b>Elements Successful Sustainable Business Model</b>	Semi-Successful sustainable business model; they are struggling to realize their economic goals which makes it challenging to focus and operationalize their social and environmental goals. And they lack power and legitimacy to influence the decisions of their clients.
<b>Eight Archetype Model</b>	Operationalization is done in 5 ways and is mostly related to sustainable product designs they create.
<b>Impact Biomimicry</b>	Biomimicry design approach and Life's Principles provided a sustainable product solution and influences operational business decisions, which created sustainable business model characteristics.

#### 7.1.4 Company 4

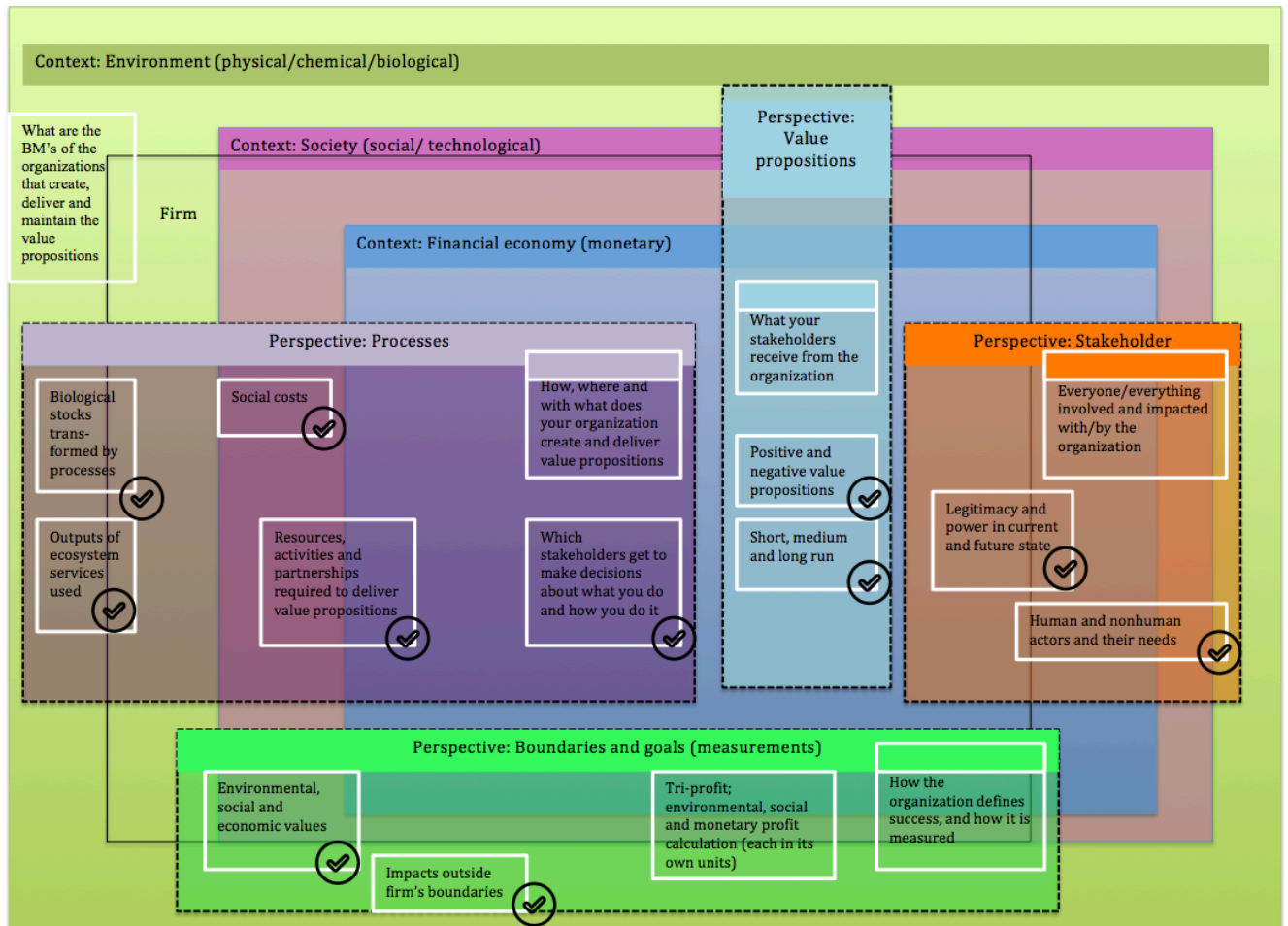
This section describes the results for company 4. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 4 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 4 is discussed. Table 19 provides an overview of the scores of company 4 on the Four Phase Model.

**Table 19 Scores Four Phase Model Company 4**

Model	Constructs	Company 4
4 Phase model	<b>Vision on sustainability</b>	“Our sustainability strategy can be summarized in 7 pillars: 1. No waste, 2. Use of healthy materials, 3. Use of renewable energy, 4. Close cycles, 5. Efficient support (use what is locally available), 6. Create involvement, 7. Have a fitting business model. The first 5 pillars are concretely measureable, however you will never meet these pillars when not everyone within the company, within your chain and in other sectors is involved. Our sustainability strategy needs new and more sustainable ways of cooperation.”
	<b>Orientation external developments</b>	“Right from the start we have tried to counteract the problems in society caused by the linear take-make-waste economy by focusing on closed cycles and our footprint. We have always actively tried to stimulate sustainable developments, even when clients and society were not ready for it. But society is changing and is becoming more and more aware of sustainability issues; therefore we actively share our knowledge and experiences. We provide best practice information to let others benefit from it. We also share information about things we still want to improve and where we are looking for. The cool thing about it is that society can often provide answers to us.”

	<b>Business case elements</b>	“Our whole business and our strategy are built around sustainability and biomimicry principles. We designed a business model fitted for those principles. In order to realize the sustainable development goals our business model has to be social and inclusive and therefor sustainability is integrated in all parts of our business model.”
	<b>Transparency</b>	“Our sustainability report is integrated with all information on our website. All information about the company's position regarding sustainability and the 2020 goals are mentioned on our website. And on product level we offer environmental product declarations, which show all materials and processes used during the production of a product. The website is public.”
	<b>Reporting</b>	“Our sustainability report is integrated on our website.”
	<b>Stakeholders</b>	“Our goal now is to tackle climate change; what is the business case of destroying life on earth? We are life on earth and have to take care of it and make sure that we can continue living on this earth. We want to create a climate fit for all life.”
	<b>Supply chain approach</b>	“We try to incorporate our whole supply chain in the journey of becoming more sustainable. Already in the 90's we trained our suppliers on sustainability and working according to the natural step. We noticed that is possible to ask your suppliers to become more sustainable. And right now our suppliers collaborate with us to create bio-based alternatives and they invest in closed water systems and renewable energy. The supplier's notice that they need to invest at first, but that the investments pay back in the end. Together we need to create a sustainable supply chain.”
	<b>Dominant functional discipline</b>	“Instead of have a restorative impact on society and environment we now also want to tackle climate change. We want to function more within and as an ecosystem and even use Co2 as a building material.”

Results reveal that company 4 scores 8 out of 8 in the Four Phase Model. This outcome implies that company 4 is in the proactive phase of the Four Phase model. This indicates the presence of a sustainable strategy and thus a sustainable business model. Company 4 is one of the two included cases that scores positive of the Sustainability Reporting construct. Sustainability is integrated in all their strategies by creating 7 pillars. These pillars guide the company during strategy creation but also during decision-making. Company 4 is focused on sustainable products, processes, and systems. Company 4 also has the power and legitimacy to influence its supply chain and create sustainable awareness among its stakeholders.



**Figure 23 Scores Elements of successful Sustainable Business Model Company 4**

The business model in Figure 23 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix E. The results show that company 4 complies with 11 of the 12 elements indicating a successful sustainable business model. Company 4 is not familiar with the tri-profit measurement, however during the interview company 4 mentioned: “We want to create ecological and social value. Profit is a necessary resource in order to sustain, a lot of social enterprises are to focused on the social and ecological goals and go bankrupt since they forget about the economic goals”. And: “We have a holistic view regarding all decisions, in this way we make sure that decisions that have a positive impact on one field do not have any negative influence on other fields”. During the interview company 4 mentioned the use of the Life’s Principles during their business model creation, and their everyday practices and decision-making processes. And a biomimicry design approach is applied on product, process, and system level. The business practices, processes and mind-sets are adjusted around their social, environmental and economic sustainability goals. The interviewee noted that it is important that achievement of one goal does not negatively influence any other goal. Stakeholders and the supply chain of company 4 are proactively included in the different parts of the business model and during the business model creation. Company 4 monitors its negative value generation, and tries to reduce this. The creation of closed cycles is one of the pillars of company 4 and incorporated in the Life’s Principles, therefore company 4 scores positive on all elements in the firm’s processes category.

Table 20 shows how sustainability is operationalized in the business model of company 4 based on the Eight Archetype Model.

**Table 20 Scores Eight Archetype Model Company 4**

Model	Constructs	Company 4
Eight Archetypes of a Sustainable Business Model	<b>Efficiency</b>	“We try to lower the footprint of our products by using recycled or bio-based materials, renewable energy and by preventing the creation of waste. This is what we call eco-efficiency. You need efficiency in order to finance sustainability.”
	<b>Waste</b>	“We recycle nylon fishing nets to produce our carpet tiles. But we also use recycled materials coming from a plastic coating interlayer of car windows. In addition we are focused on the circularity of our products; the carpet tiles are being re-used.”
	<b>Substitution</b>	“The building we are in now is build according to the trias ecologica, so the materials, energy processes and its surroundings are analysed. We use renewable energy, have closed water systems and we use biogas during the production. We try to copy natural processes throughout our business.”
	<b>Functionality</b>	“We do not only manufacture carpet tiles, we offer a lot of services like inventory management, installation and maintenance, repair etc.”
	<b>Stewardship</b>	“We started with the environmental product declarations in order to educate everyone what the impacts of our different product are. In addition by acting as an ecosystem we try to contribute to the creation of biodiversity. We focus on integration of biodiversity in our business model; we do not see the protection of creation of biodiversity as a project on the side.”
	<b>Sufficiency</b>	“Sufficiency did not cause the creation of our sustainability strategy, and did not get a lot of attention. However, we are less depending on raw materials due to our sustainability strategy and our focus. Therefor we do not suffer from scarcity and fluctuating prices. We also share information about scarcity with our suppliers; this caused our suppliers to find alternatives for the use of oil.”
	<b>Repurpose</b>	“Our goal is to counteract climate change. Furthermore we focus more and more on social goals that compliment to our ecological goals.”
	<b>Scale-up</b>	“We are not focussed on expansion in physical sense of location. But we do want to expand our modular floor solutions. We truly believe in circularity and something modular can be partly replaced, repaired, cleaned and recycled. In this way not only the environment will benefit from it, it will also create employment. In addition we are engaged in crowdsourcing in order to co-innovate and we are involved in open-innovation projects with a lot of different businesses.”

Results denote that company 4 also scored 8 out of 8 on the operationalization of the Eight Archetype Model. This outcome indicates that company 4 operationalizes sustainability in all 8 ways provided by Bocken et al., (2012). Operationalization is established through the products, processes, systems, buildings, services, collaboration, and awareness creation.

The interviewee of company 4 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models since nature functions as an idea generator for product, process and system designs, and it can deliver new perspectives and mind-sets to companies and its employees: “*Nature provides cool and inspiring ideas.*” and “*Biomimicry provides businesses with another perspective. It changes the way you look at processes, products, services, systems and your organisation. Biomimicry provides you with a holistic perspective. The holistic perspective is necessary because you do not want your practices and solutions to cause harm or problems elsewhere.*” Company 4 mentioned that biomimicry directly influenced the sustainability of their business model: “*Biomimicry and the Life’s Principles guided us during the creation of our sustainable business model and strategy.*” In addition, company 4 indicated that they did not experience biomimicry as restrictive: “*I cannot think of any restrictions caused by applying a*

*biomimicry design approach in the right way. Of course you can use biomimicry to develop weapons, but the ethics, emulate and reconnect part of biomimicry is restricting this. You cannot just only copy nature; you have to do this from a sustainable point of view. You need to apply biomimicry for the right reasons, and in that case it will not be experienced as restricting.”* Overall, the use of a biomimicry design approach on product, process and system level directly influenced the sustainability of the business model of company 4. The Life’s Principles functioned as guidance during the creation of this sustainable business model. Company 4 is not only concerned with their own sustainability; they want to create more sustainable industries in general and are involved in different projects to boost a revolutionary sustainability change in the current economies. Table 21 provides a summary of the outcomes from the assessments of company 4.

**Table 21 Summary findings Company 4**

<b>Four Phase Model</b>	<b>Proactive Phase</b>
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model; they comply with almost all elements. Does not fulfil tri-profit measurements element, however none of the cases does.
<b>Eight Archetype Model</b>	Operationalizes all eight archetypes within their products, processes, projects, services, awareness creation, collaborations, and education activities.
<b>Impact Biomimicry</b>	Biomimicry design approach and the Life’s Principles directly influenced the business strategy and the creation of a sustainable business model. Not only impacted their own business, but also that of their supply chain.

### 7.1.5 Company 5

This section describes the results for company 5. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 5 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 5 is discussed. Table 22 provides an overview of the scores of company 5 on the Four Phase Model.

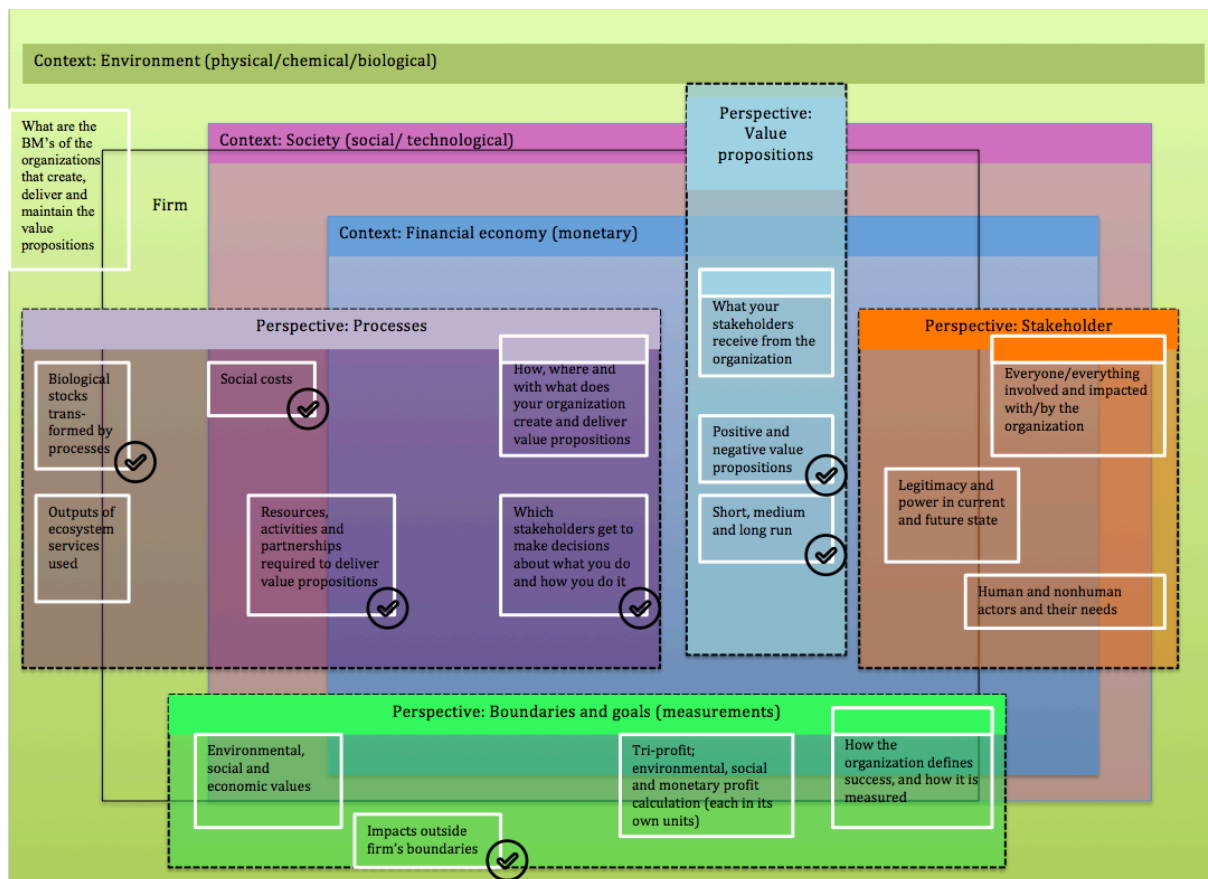
**Table 22 Scores Four Phase Model Company 5**

<b>Model</b>	<b>Constructs</b>	<b>Company 5</b>
4 Phase model	<b>Vision on sustainability</b>	“We believe that sustainability is really important and we are green. We make boats and yachts more energy efficient while at the same time focussing on social sustainability by employing disabled people, and our aspiration to create stabilisers for fishing boats.”
	<b>Orientation external developments</b>	“Our region has lately been in the news for violence against aid workers; we support an organisation that tries to tackle this problem. In addition, we want to provide disabled people with the opportunity to work, therefore we partnered with a producer that employs people with disabilities. We spend one week on a fishing boat and experienced how bad, hard and dangerous the working conditions are there, therefore we decided to expand our business and also focus on the fishing industry.”
	<b>Business case elements</b>	“We cannot only speak about sustainability; we need to show it as well, that is locked in our business model. We are pro-sustainability, which is not only locked in our products and suppliers but also in simple things like separating our waste.” Note: waste separation ≠ part of business model.

	<b>Transparency</b>	"I believe we are very transparent; I am really open and tell you everything. I do agree with you that our website does not directly mention sustainability."
	<b>Reporting</b>	"We do not have a sustainability report. The Marine institute of the Wageningen University did all kind of measurements and published a report about the fuel savings and resistance reduction."
	<b>Stakeholders</b>	"We provide energy savings, resistance reduction and contribute to social sustainability."
	<b>Supply chain approach</b>	"We are really keen on our independence. We do have a large supply chain; in this way we spread the risks. We have a lot of partners to support us with the technical engineering, but also to help us with our patents etc. At the moment we partnered with an organisation that tries to make the fishing industry more sustainable in terms of fuel savings, well being of the fish and ecosystems. We want to help them with the fuel saving part."
	<b>Dominant functional discipline</b>	"We notice that our clients value sustainability more and more, and we want to keep innovating on that side. But before we are able to do this we first need to create a strong core business based on the stabilisers."

Results indicate that company 5 scores 6 out of 8 in the Four Phase Model. Company 5 does not have a sustainability report, but the Marine Institute calculated the fuel savings and resistance reduction caused by their products. In addition, company 5 stated that they are still working on the creation of a strong core business model, and they are not partnered with suppliers to work on co-creation, however they work with their manufacturers (social dimension) and other businesses to co-create sustainability in the Shipbuilding Industry. Before company 5 creates a strategy to offer more sustainable products, they first want to create a strong core business: *"We notice that our clients value sustainability more and more, and we want to keep innovating on that side. But before we are able to do this we first need to create a strong core business based on the stabilisers"*. Assessment of the Four Phase Model reveals that company 5 is currently in the active phase. This indicates that company 5 considers sustainability and that their business model differs from traditional business models; sustainability is seen as market opportunity. A biomimicry design approach provided company 5 with a product design to make the boat industries more sustainable. In addition, sustainability is embedded in the fact that they do want to improve working conditions of fisherman, and provide job opportunities for disabled. This implies that the sustainable characteristics of the business model of company 5 are related to the products they offer, and social sustainability initiatives.





**Figure 24 Scores Elements of successful Sustainable Business Model Company 5**

The business model in Figure 24 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix F. The results show that company 5 complies with 7 of the 12 elements indicating a successful sustainable business model. Company 5 does not consider social and environmental values when deciding upon and measuring profit: *“We are not in this business because we want to become rich, we want to increase the comfort level on yachts, decrease fuel consumption, and improve working conditions on fishing ships. We just want to become a big player in the market, and profit in necessary in order to keep our independency”*. Company 5 does not consider nonhumans as stakeholders and also does not consider the future power and legitimacy of their identified stakeholders. The identified main stakeholders included are themselves, customers, and partners. Company 5 also does not use outputs of ecosystems, however during the interview company 5 stated: *“At the moment we consider energy recovery from water flow when there are no waves”*. Company 5 implemented a biomimicry design approach on product level, which resulted in products that make the boat industry more sustainable. Due to the products and their social sustainability consideration they do fulfil elements of a successful sustainable business model. Company 5 has social and environmental goals but their business practices, processes and their mind-set are not completely focused on it. The first responses during the interview were all related to becoming market leader, and making profit, social and environmental goals followed afterwards. It should be noted that company 5 is aware of the fact that they provide products to an industry that is not sustainable at all (pleasure yacht).

Table 23 shows how sustainability is operationalized in the business model of company 5 based on the Eight Archetype Model.

Table 23 Scores Eight Archetype Model Company 5

Model	Constructs	Company 5
Eight Archetypes of a Sustainable Business Model	Efficiency	"Our product causes boats and yachts to have less resistance, which makes the boats more energy efficient. We also focus on material efficiency; at the beginning we used a lot of material because we wanted to make sure that the stabiliser was unbreakable. We run some test en did experiments and found out that we could have the same functionality with less material. We also did not try to copy all functions of a whale tale. Only the once important to stabilize the boats."
	Waste	"We do separate the waste within our company and we re-use the stabiliser transport boxes."
	Substitution	"We are not able to control the type of energy used in our building and during processes. We hire our building, and our suppliers are big, we simply cannot influence them."
	Functionality	-
	Stewardship	"We are more focused on social impact than on more ecological impact of our company. A company that employs people with disabilities processes our control mechanism. We want those people to be able to work, and want to support this. And we want to expand our business to the fishing industry in order to improve the working conditions on fishing boats. In addition, our region has lately been in the news for violence against aid workers, we support an organisation that tries to tackle this problem."
	Sufficiency	"We do not inform our chain partners about sufficiency, however we do educate them about how to correctly use the product in order to ensure a long lifespan."
	Repurpose	"We try to analyse our processors on their social sustainability, we noticed a lot of unemployment amongst disabled people and wanted to reduce the amount of unemployment by partnering with processing plants that do employee disabled people. In addition, the yacht industry is a good industry for us, however those boat are just designed for pleasure. In order to have a real social impact we really want our products to be used in the fishing industry since it can significantly improve the working conditions in this hard and dangerous industry."
	Scale-up	"We partnered with an organisation that supports sustainability in the fishing industry. We plan on setting up a crowd-funding project in order for our products to be applied in the fishing industry. We do not focus on open-innovation since our competitors have tried to steal our ideas before."

Results show that company 5 scored 5 out of 8 for the Eight Archetypes Model. Company 5 separates their own waste, but they do not create value from waste. In addition, they are also not focused on the substitute with renewables and natural processes archetype. Company 5 indicated that they are not able to influence the type of energy used in their own building and at their suppliers and manufacturers. However, as mentioned before company 5 stated: *"At the moment we consider energy recovery from water flow when there are no waves"*. This indicated that company 5 tries to fulfil the substitution archetype with their product designs. Furthermore, company 5 delivers ownership instead of functionality and therefor they are not focused on the functionality archetype. Results of this assessment also show that company 5 values social sustainability, and consciously select its supply chain on this. More environmental sustainability is embedded within the impact the products have on the boat industry.

The interviewee of company 5 mentioned that applying a biomimicry design approach helped them during the creation of a sustainable image: *"Our business model is build around sustainability. The use of biomimicry helped us creating a sustainable image."* Company 5 considers biomimicry as a

tool to demonstrate their sustainability. Since their strategy is not only focused on biomimicry and they do not use the Life's Principles the use of a biomimicry design approach on product level is not experienced as being restrictive in any sense. Overall, the positive assessment scores of company 5 are based upon the product they offer and their social sustainability concerns. The use of biomimicry supported their general sustainability approach they set for themselves. Company 5 indicated that they first want to create a strong profitable core business before they start making their business model more sustainable. This implies that it will take some time before company 5 will move towards the proactive phase of the Four Phase Model, and that biomimicry will mostly be used as a marketing and idea generation tool. Table 24 provides a summary of the outcomes from the assessments of company 5.

**Table 24 Summary findings Company 5**

<b>Four Phase Model</b>	<b>Active Phase</b>
<b>Elements Successful Sustainable Business Model</b>	Semi-successful sustainable business model; their products have a positive impact on the boat industry, and they consider social sustainability. However they lack the stakeholder elements, tri-profit, social and environmental goals and output of ecosystem used.
<b>Eight Archetype Model</b>	Operationalizes 5 archetypes based on their sustainable products and social concerns. First want to focus on creating strong core business before focusing more on sustainability.
<b>Impact Biomimicry</b>	Biomimicry design approach is considered as a marketing and idea generation tool. Biomimicry only influenced the sustainable strategy on product level, the social sustainability measures do not come forward from a biomimicry design approach.

### 7.1.6 Company 6

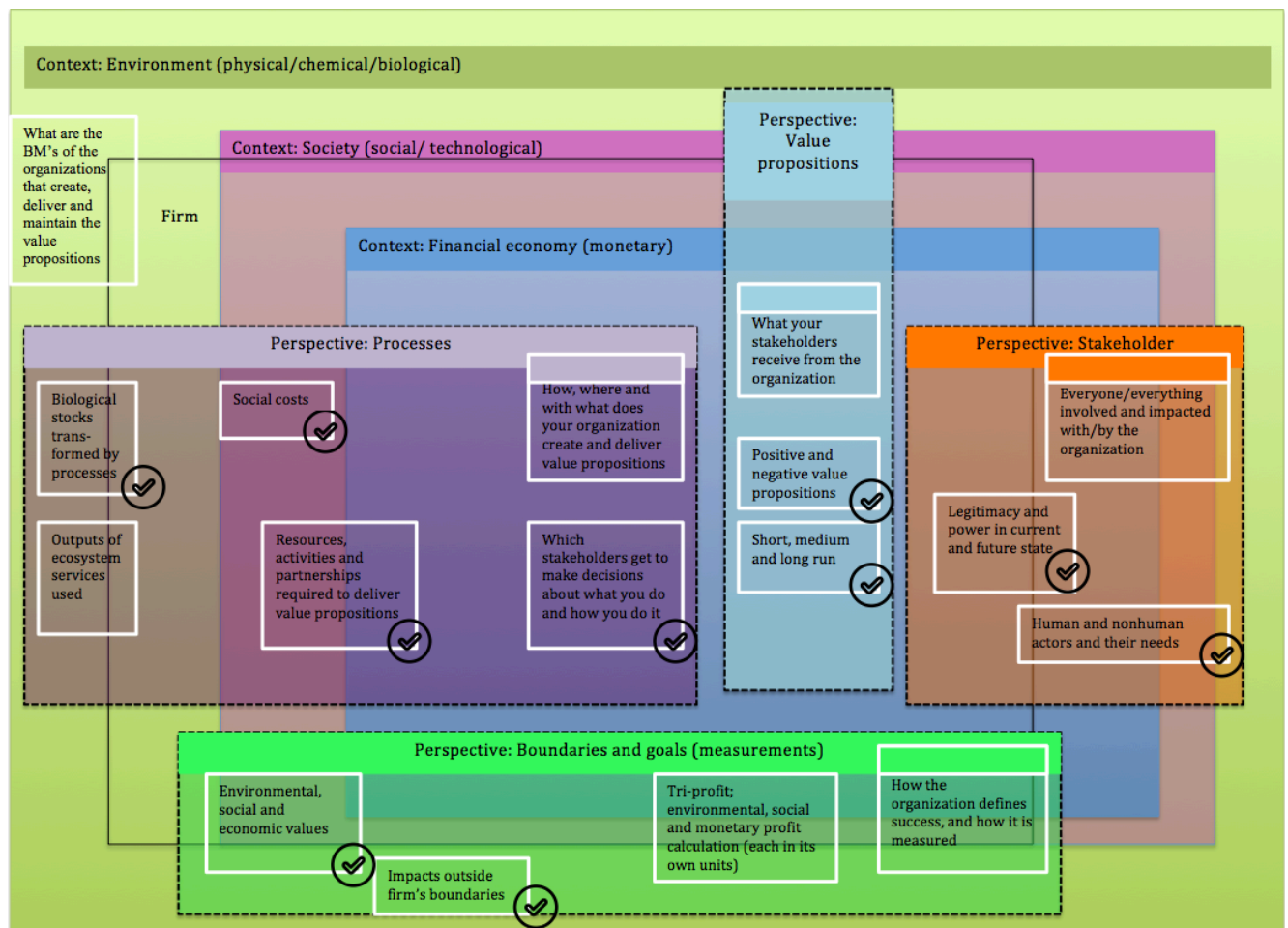
This section describes the results for company 6. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 6 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 6 is discussed. Table 25 provides an overview of the scores of company 6 on the Four Phase Model.

**Table 25 Scores Four Phase Model Company 6**

<b>Model</b>	<b>Constructs</b>	<b>Company 6</b>
4 Phase model	<b>Vision on sustainability</b>	“Sustainability is very important and has been present in this company right from the start. Sustainability is integrated in our business philosophy. It is visible in the way we take care of our people, our environment and the local community, we do not use chemical solvents and focus on material and energy efficiency etc. Our sustainability business philosophy helps us to steer us in the desired direction.”
	<b>Orientation external developments</b>	“We are really responsive towards external developments. A lot is happening at the moment and developments go fast. We want to be able to keep up with all developments. We also keep track on developments regarding artificial intelligence and big data. But also the development of changing technological jobs is something we are responsive towards.”

	<b>Business case elements</b>	“Sustainability can be found in our products, services, the way we handle relationships and we take care of our employees, our building. We really try to have a sustainability image, we even have sustainable coffee, we separate waste, have more sustainable cars etc.”
	<b>Transparency</b>	“Everyone is able to ask us everything, however who wants to know everything? It is true that we do not mention sustainability or biomimicry on our website, we do not want to think in boxes. We do not want to be bounded to one certain method.”
	<b>Reporting</b>	“No, we do not have any shareholders that demand a report. I believe that if we have to, we are able to provide anyone with a report on a short notice.”
	<b>Stakeholders</b>	“We want to make sure that the products consumed by the end consumer are produced with as little as negative impact as possible. The world is depending on mass production in order to feed everyone, but at the same time it has a lot of negative impact on social, ecologic and economic systems. We want to use our knowledge to make the mass production as sustainable as possible to reduce the negative influence for everyone.”
	<b>Supply chain approach</b>	“The impact of our machines is really noticeable at the mass production companies; together with them we need to make production processes more sustainable. However, it is hard for big mass production companies to make the change towards more sustainability. They all want the change but it is hard to put it in practice and we want to support them by offering our more sustainable products to them. This makes it easier for them to start making changes towards more sustainability.”
	<b>Dominant functional discipline</b>	“I believe that our company is ready to take a step to the next level regarding our sustainability strategy. We are trying to find ways to incorporate the Sustainable Development Goals within our practices. We want to make those goals leading during our decision-making processes our practices and strategies.”

Results show that company 6 scored 7 out of 8 for the Eight Archetype Model. Company 6 does not focus on sustainability reporting, however during the interview company 6 stated: “*We are able to provide anyone with a report on a short notice*”. Since company 2 is only lacking the reporting construct of the Four Phase Model company 6 appears to be in the proactive phase towards sustainability, which indicates that sustainability is closely connected to business strategy. According to this assessment the business model of company 6 has sustainable characteristics related to their products, processes, systems, services and relationships. It should be noted however that company 6 does not deliberately market themselves as being sustainable and providing more sustainable solutions.



**Figure 25 Scores Elements of successful Sustainable Business Model Company 6**

The business model in Figure 25 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix G. The results show that company 6 complies with 10 of the 12 elements indicating a successful sustainable business model. Company 6 does not include environmental and social values when measuring profit: *“It is hard to measure profit while including social and ecological value. We measure profit based on economic value.”* However, the boundaries and goals are not only based on economic values: *“We are successful if we can guarantee continuity. From a biomimicry viewpoint you can compare this with nature; something that survives. It is important to make sure that we can provide all our employees with income and to guarantee a future for them”*. Company 6 also does not focus on using outputs of ecosystem services. The social costs are embedded in the fact that they want to offer more sustainable machines and technology with less dropouts and which are easy to clean to mass producers. Company 6 mentioned that they apply a biomimicry design approach on product and process level, and that the Life’s Principles provide guidelines during business model creation, and everyday practices. Business practises, processes and mind-sets of company 6 around based on the social and environmental goals of the company. All stakeholders, including nonhumans, are proactively integrated within the different elements of the business model. Company 6 fulfils a lot of elements indicating that they have a successful sustainable business model; nevertheless they do not market themselves as being a sustainable business.

Table 26 shows how sustainability is operationalized in the business model of company 6 based on the Eight Archetype Model.



Table 26 Scores Eight Archetype Model Company 6

Model	Constructs	Company 6
Eight Archetypes of a Sustainable Business Model	Efficiency	"We are focused on energy and material efficiency. We are discovering the 3D printing techniques to become more material efficient. We do already use less material than before, since our added value is more embedded in technology. We also use topological design, which means that we only use materials where necessary just like trees and bones. We always use the newest available electric motors in the machines; those motors become more efficient every time. But we are also forced to become more efficient. Our machines are transported around the globe, which forces us to make light and easy to disassemble machines."
	Waste	"We refurbish old machines, so our clients can bring in their machine and we place the new technology in the old frames. But the materials we use are decided upon based on their characteristics and not based on the fact that they are recycled."
	Substitution	"We use green energy provided by energy companies at our company. At the moment green energy is so cheap that generation of our own renewable energy is not attractive. However we do consider solar panels."
	Functionality	-
	Stewardship	"We try to make mass production companies as sustainable as we can. In addition we make decisions about who we want as clients, we decided not to produce any machines for weapon industry for example. Life's Principles are also kept in mind when deciding on whom to serve."
	Sufficiency	"We try to make mass production companies as sustainable as we can, and create machines with a long lifespan to reduce the need to produce new machines."
	Repurpose	"We are engaged in a lot of local projects regarding biodiversity. In addition we try to teach at schools in the region, we explain the students what we can learn from nature. We really want to make sure that the current students have the right technical knowledge in order to make a living in the future. We notice that jobs are changing and that other kind of knowledge is required; there are new ways of technology and construction and new ways of producing. The current educational system does not fully adjust to this change. We want to make sure that the students are able to fulfil the future-job positions. We also partnered with other businesses to brainstorm about how we can create packaging from one type of plastic to make it easier to recycle the plastic. And we are looking for other ways to pack baby food for example. Furthermore, we want to guarantee good working conditions."
	Scale-up	"Expansion in our business will include more employees, more outsourcing and more project leading. We do not want to expand the company in physical sense. We are engaged in open innovation however on some of our products and projects are confidential. But we collaborated with the TU Eindhoven for example to create a robotic football team."

Results denote that company 6 scored 7 out of 8 for the Eight Archetypes Model. Company 6 only does not focus on delivering functionality rather than ownership. Clients become owner of the products/technologies/designs, however clients can return for refurbishments. Sustainability is operationalized within their products, technologies, designs, processes, collaborations, and projects.

The interviewee of company 6 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models, since it can deliver new perspectives and mind-sets to companies and its employees: *"A biomimicry design approach contributes to the sustainability of a business model. It provides a certain mind-set. I believe that is the most important contribution of applying biomimicry. It provides guidance during all decision-making processes. Application of the*



*biomimicry principles contributes to the creation of a sustainable strategy.*” According to the interviewee the application of a biomimicry design approach directly influenced their business model: *“Biomimicry contributed to the creation of our strategy. Biomimicry and the Life’s Principles influenced our business operations and determine which clients we want to work with.”* The Life’s Principles function as base for the sustainable business model of company 6. Company 6 never experienced biomimicry as restrictive: *“I do not believe it restricts us, but the Life’s Principles guided us during the creation of our strategy and guides our decisions regarding which clients to serve.”* Company 6 is in the proactive phase, and uses the Life’s Principles as a base for their business model, and business practices. Sustainability is being operationalized in multiple ways and on multiple levels, however company 6 still does not promote themselves as being a sustainable company. Table 27 provides a summary of the outcomes from the assessments of company 6.

**Table 27 Summary findings Company 6**

<b>Four Phase Model</b>	Proactive Phase
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model; focused on all categories. Only does not fulfil the tri-profit measurement and the ecosystem service element.
<b>Eight Archetype Model</b>	Operationalizes 7 archetypes based on their products, technologies, designs, processes, collaborations, and projects. Not focused on delivering functionality.
<b>Impact Biomimicry</b>	Biomimicry design approach and the Life’s Principles function as base on which the business strategy and model are built. However, they do not promote the impact of biomimicry and their sustainability and they do not market themselves as being sustainable.

### 7.1.7 Company 7

This section describes the results for company 7. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 7 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 7 is discussed. Table 28 provides an overview of the scores of company 7 on the Four Phase Model.

**Table 28 Scores Four Phase Model Company 7**

Model	Constructs	Company 7
4 Phase model	<b>Vision on sustainability</b>	“It is the efficiency of our products that makes our business sustainable. But it is not designed to be sustainable. It is designed to be better (more effective with less energy) at the same thing.”
	<b>Orientation external developments</b>	“We noticed that the cooling of buildings and moving air requires a lot of energy. We came up with a solution to make this more energy efficient.”
	<b>Business case elements</b>	“Our whole business is build around the discovery that tubercles can make a lot of products more energy efficient.”
	<b>Transparency</b>	“We are very transparent regarding how the tubercles work. If you look at our website all sciences are laid out there.”
	<b>Reporting</b>	-
	<b>Stakeholders</b>	“We are a geometric innovator that tries to make the global movements of (cooled) air more efficient.”

	<b>Supply chain approach</b>	“We are not in charge of supply chain creation our clients are. We basically introduce a change in shape.”
	<b>Dominant functional discipline</b>	“We are looking for other natural shapes that can make products more energy efficient. So far we did not discovery any shape more efficient than the tubercles.”

Results show that company 7 scored 3 out of 8 for the Four Phase Model. Company 7 did not start this business to be sustainable and does not have a holistic or strategic vision on sustainability. The business model of company 7 is built around the discovery they made, and sustainability is only visible in the efficiency of their designs. Company 7 does not focus on sustainability reporting, however during the interview company 7 stated: “*All sciences behind our product are explained and elaborated on our website, and we are really transparent about that.*” Company 7 did not identify society as a stakeholder, and does not focus on the role they play within society regarding sustainability, company 7 stated: “*Our role and goal is to modify products all over the world based on the tubercles shapes.*” In addition, Company 7 does not focus on co-creation of sustainability with their supply chain: “*We do not really organise a supply chain, we do demonstration models. Our prototypes can be tested, and people are satisfied with the quality of the prototypes and the efficiency, and they can set up a manufacturing and supply chain. But we do not take people who are experts and run their own companies and do that for them. We basically introduce a change in shape, and let our clients do the rest*”. Based on these results it can be assessed that company 7 is in the reactive phase of the four phase model. Company 7 is not completely ignorant towards sustainability, however sustainability is not a part of their current business strategy and model. This outcome reveals that the business model of company 7 is comparable to traditional business models, instead of sustainable business models.

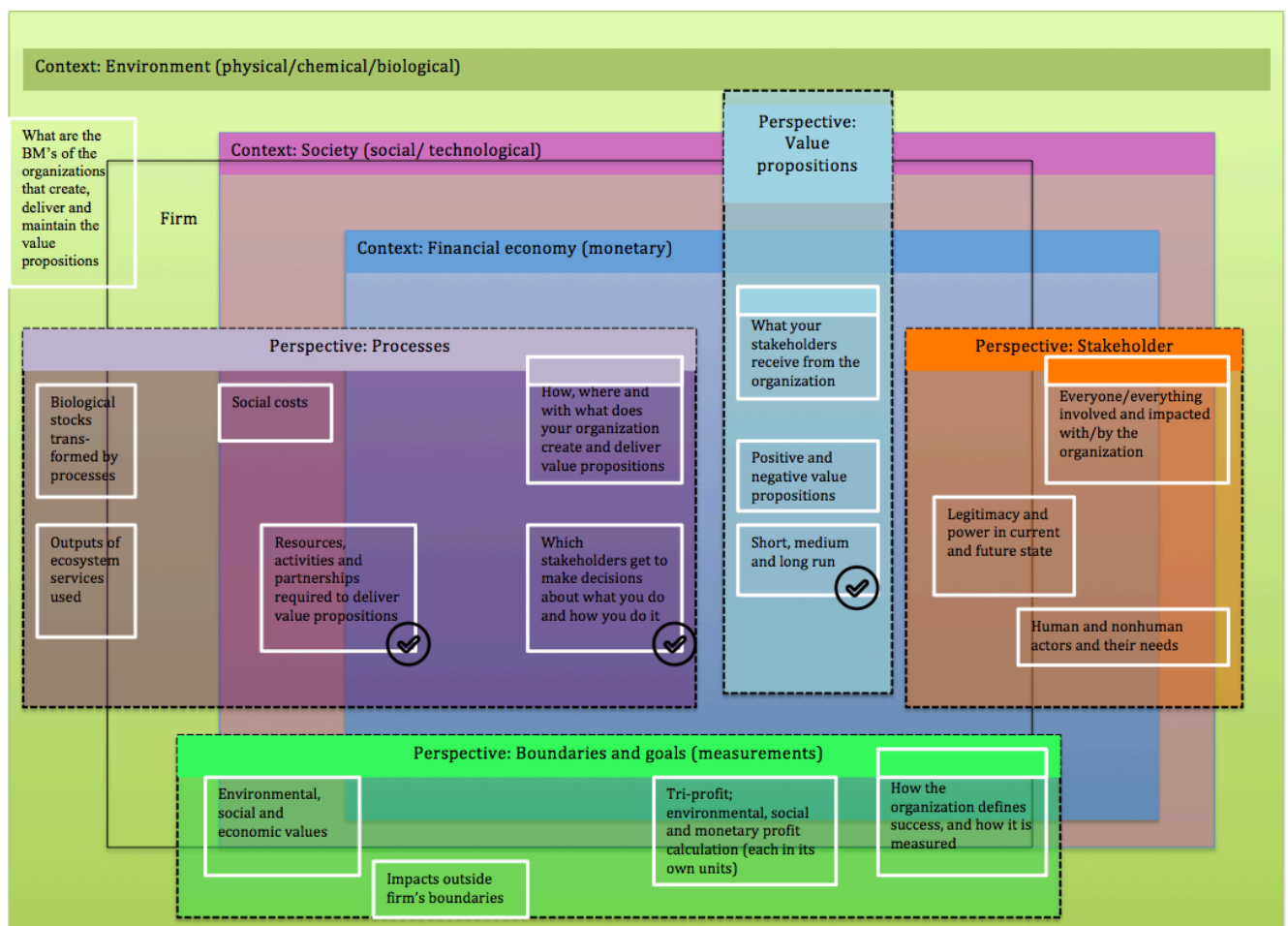


Figure 26 Scores Elements of successful Sustainable Business Model Company 7

The business model in Figure 26 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix H. The results show that company 7 complies with 3 of the 12 elements indicating a successful sustainable business model. Company 7 does not focus on social and environmental values when measuring profit, and goals are only related to impacts on the firm itself: *“We are very successful when products all over the world are modified using tubercles shapes. It is happening more and more, we have products in China, the US, Canada and Europe.”* Furthermore, during the interview company 7 stated: *“I consider the core group of employees as main stakeholders.”* Company 7 does not consider nonhuman stakeholders, and also does not focus on the future power and legitimacy of stakeholders. Company 7 also does not analyse negative value generation: *“With our design change, product become better at doing the same thing.”* However, company 7 does not manufacture and only introduces a design change. These designs do not generate any negative value, and company 7 has little power to influence the negative value generated by products that use their designs. Company 7 does not take sustainability into consideration during processes: *“Our company does not fit into conventional material sourcing and sustainability is not the focus. We do not particularly take environment and ecosystems into consideration during the design processes.”* Some of the products that use their designs do use outputs of ecosystem services like windmills. Company 7 only applied a biomimicry design approach on product level, which makes them score positive on 3 elements. These outcomes are in line with the outcomes from the assessment of the Four Phase Model; company 7 scores low on the elements identifying a successful sustainable business model since their business model should be compared to traditional business models instead of sustainable business models.

Table 29 shows how sustainability is operationalized in the business model of company 7 based on the Eight Archetype Model.

**Table 29 Scores Eight Archetype Model Company 7**

Model	Constructs	Company 7
Eight Archetypes of a Sustainable Business Model	<b>Efficiency</b>	“We designed a 3 dimensional shape that can be applied to a variety of products like fans and turbines. The shape makes the products more efficient. For example one of the fans moved 25% more air while using only 20% of the energy.”
	<b>Waste</b>	“Everything we made so far is still in service and cannot be recycled yet. Our products are much more durable than alternatives since there is less vibration and less noise. We are planning on recycling in the future but it depends on the kind of products.”
	<b>Substitution</b>	-
	<b>Functionality</b>	“We licence our clients to use our shapes, those companies become owners of our shape design.”
	<b>Stewardship</b>	-
	<b>Sufficiency</b>	“We keep sufficiency in mind but it is not our primary concern. The primary concern is shape.”
	<b>Repurpose</b>	“We do not really have social and environmental goals, the very little we can do is that we are progressives in the way we pursue things.”
	<b>Scale-up</b>	“We collaborate with other companies in order to design cooling parts for a large chip manufacturing. Since our innovation is really unusual we are not engaged in that much open-innovation.”

Results indicate that company 7 scored 1 out of 8 for the Eight Archetypes Model. Company 7 discovered that tubercles on whales make them more efficient, and introduced this shape on air moving products to make those products more efficient. Company 7 is not really focused on sustainability, and the other archetypes are not operationalized in their business model. However, company 7 does plan on focusing on the create value from waste archetype in the future. This

assessment indicates that only the product design (copied from nature) is creating a sustainability characteristic for company 7.

The interviewee of company 7 did not respond to the questions related to the impact of biomimicry on the sustainability of their business model, since they do not have a sustainable business model. Table 30 provides a summary of the outcomes from the assessments of company 7.

**Table 30 Summary findings Company 7**

<b>Four Phase Model</b>	<b>Reactive Phase</b>
<b>Elements Successful Sustainable Business Model</b>	Unsuccessful sustainable business model; only fulfils 3 elements. Does not have a sustainable business model and should be assessed on successful elements of traditional business model.
<b>Eight Archetype Model</b>	Only operationalizes the efficiency archetype with their sustainable product design.
<b>Impact Biomimicry</b>	Biomimicry design approach did not influence the sustainability of the business model. It only provided a more efficient design idea.

### 7.1.8 Company 8

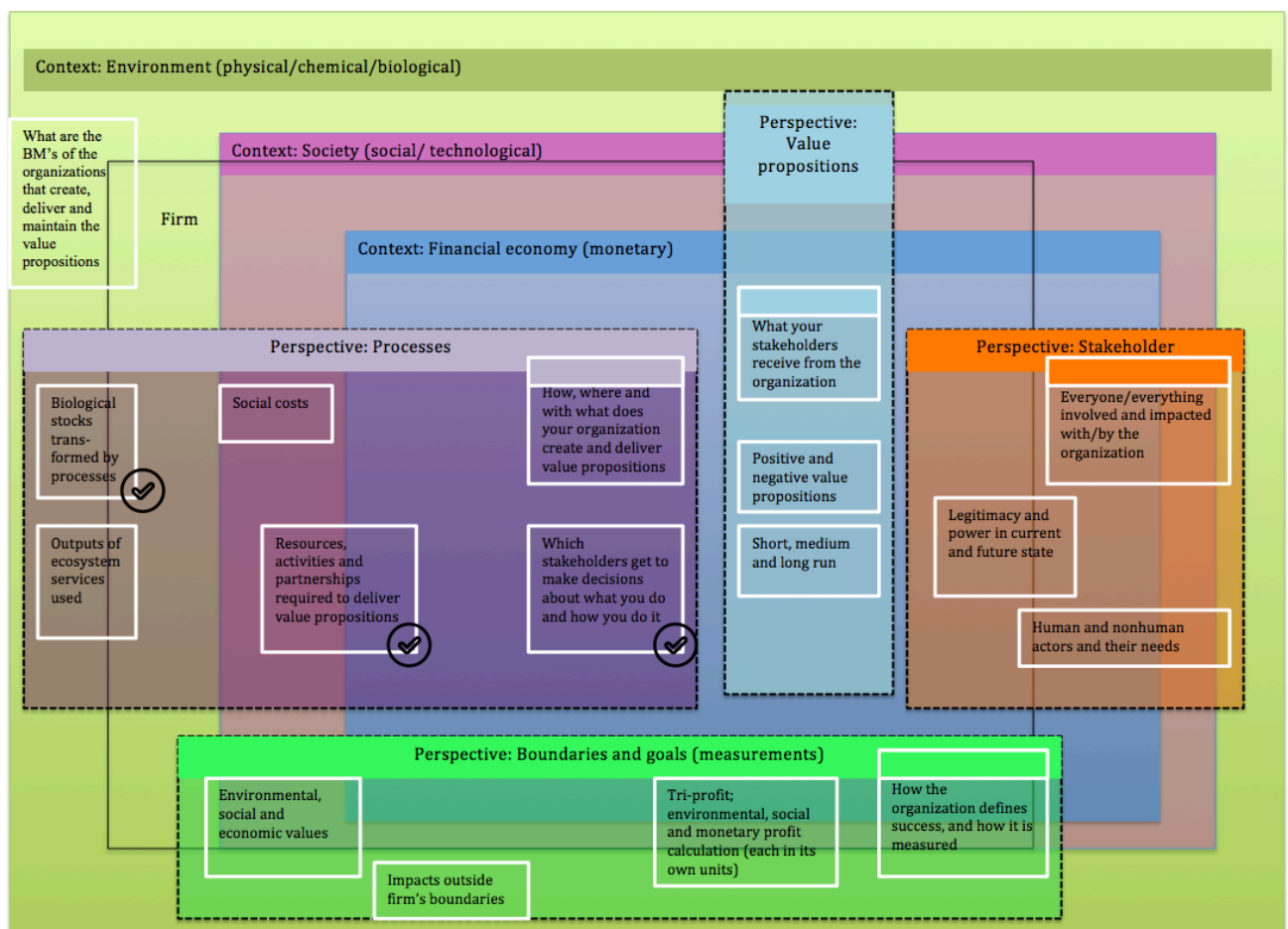
This section describes the results for company 8. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 8 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 8 is discussed. Table 31 provides an overview of the scores of company 8 on the Four Phase Model.

**Table 31 Scores Four Phase Model Company 8**

<b>Model</b>	<b>Constructs</b>	<b>Company 8</b>
4 Phase model	<b>Vision on sustainability</b>	"I wanted to bring an alternative for steel, carbon, aluminium etc. on the market. Basically I created an alternative for oil-based raw materials with the same mechanical characteristics."
	<b>Orientation external developments</b>	"I noticed that the demand for sustainable products is rising; therefor I started to search for sustainable alternatives. I wanted to offer something to the demanding customers."
	<b>Business case elements</b>	"I did not start the business to be sustainable, but sustainability is visible in my business model, it is embedded in the products I offer."
	<b>Transparency</b>	"Transparency and reporting does not have our priority at the moment. Those are things you do when you have a lot of money and a lot of time. Our main priority is to sell our products."
	<b>Reporting</b>	"Transparency and reporting does not have our priority at the moment. Those are things you do when you have a lot of money and a lot of time. Our main priority is to sell our products."
	<b>Stakeholders</b>	"I am the main stakeholder together with the financial partner and we want to pursue our financial goals."
	<b>Supply chain approach</b>	"We work together with universities and other companies in the field of product development. We share knowledge with others if there are mutual interests. At the moment we do not collaborate with NGOs or the like."
	<b>Dominant functional discipline</b>	"The main point is to make good quality products and the rest are all side issues. In the end we do want to profile our business as a sustainable business."



Results show that company 8 scored 3 out of 8 for the Four Phase Model. Company 8 offers a sustainable bio-based alternative for unsustainable materials. However, company 8 does not focus on transparency and reporting. According to the founder of company 8: *“Those are things you do when you have a lot of money and a lot of time. Our main priority is to sell our products”*. As their main focus is selling their products they do not focus on creating sustainability with chain partners, and society is not identified as stakeholder of the company. According to the founder the product they offer is sustainable, but the business model is not based on sustainability. This assessment indicates that company 8 is in the reactive phase of the Four Phase Model. Company 8 is not completely ignorant towards sustainability since they offer a sustainable product, however sustainability is not a part of their current business strategy and model. This outcome reveals that the business model of company 8 is comparable to traditional business models, instead of sustainable business models.



**Figure 27 Scores Elements of successful Sustainable Business Model Company 8**

The business model in Figure 27 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix I. The results show that company 8 complies with 3 of the 12 elements indicating a successful sustainable business model. The boundaries and goals of company 8 are only based on economic value: *“The company is successful if we reach a certain revenue goal each year. In the long run we want to capture a certain part of the market.”* Company 8 only identified human stakeholders and does not focus on their future legitimacy and power. Company 8 produces almost everything in-house and grow their own materials and make decisions about the processes. The materials company 8 uses are non-scarce and they plant new materials after they harvest. Company 8 did not fulfil the social costs and outputs of ecosystem services elements of a successful sustainable business model. Company 8 applied a biomimicry design approach on product level, which resulted in a sustainable product. This assessments reveals that company 8 scores low on the elements identifying a successful sustainable business model, since company 8 does not have a sustainable business model. Comparing





it to elements identifying a successful traditional business model should assess successfulness of company 8.

Table 32 shows how sustainability is operationalized in the business model of company 8 based on the Eight Archetype Model.

**Table 32 Scores Eight Archetype Model Company 8**

Model	Constructs	Company 8
Eight Archetypes of a Sustainable Business Model	Efficiency	“The products I offer are an alternative for oil based raw materials that require a lot of energy during production. In comparison to the oil-based products our products need less transport since a lot of the production is done locally.”
	Waste	“Aside from the resin we do not create value from waste and it is not possible to recycle our products.”
	Substitution	“The company provides an alternative and more sustainable solution. And in the future we might want to run our processes on renewable energy, but not at this moment.”
	Functionality	-
	Stewardship	“We are not involved in things like customer and biodiversity protection.”
	Sufficiency	“The materials we use to produce the products are not scarce, and we cultivate a lot of those materials, like bamboo, ourselves.”
	Repurpose	“Besides our financial goals we do not pursue any social or ecological goals.”
	Scale-up	“We want to expand in terms of production and location.”

Results indicate that company 8 scored 2 out of 8 for the Eight Archetypes Model. Company 8 operationalizes material and energy efficiency in its business model and focuses on sufficiency by showing society that there are non-scarce locally produced alternative raw materials. Aside from efficiency and sufficiency company 8 does not focus on the other archetypes: “*Our main priority is selling our products.*” This assessment indicates that only the products produced by company 8 provide the company with a sustainable characteristic. The company does not consider other sustainable characteristics and other ways to operationalize sustainability. Table 33 provides a summary of the outcomes from the assessments of company 8.

**Table 33 Summary findings Company 8**

<b>Four Phase Model</b>	Reactive Phase
<b>Elements Successful Sustainable Business Model</b>	Unsuccessful sustainable business model; only fulfils 3 elements. Does not have a sustainable business model and should be assessed on successful elements of traditional business model.
<b>Eight Archetype Model</b>	Only operationalizes the efficiency and sufficiency archetype with their sustainable product design.
<b>Impact Biomimicry</b>	Biomimicry design approach did not influence the sustainability of the business model. It only provided a sustainable product idea.

### 7.1.9 Company 9

This section describes the results for company 9. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 9 operationalized sustainability in the business model based on the Eight Archetype Model. In addition,

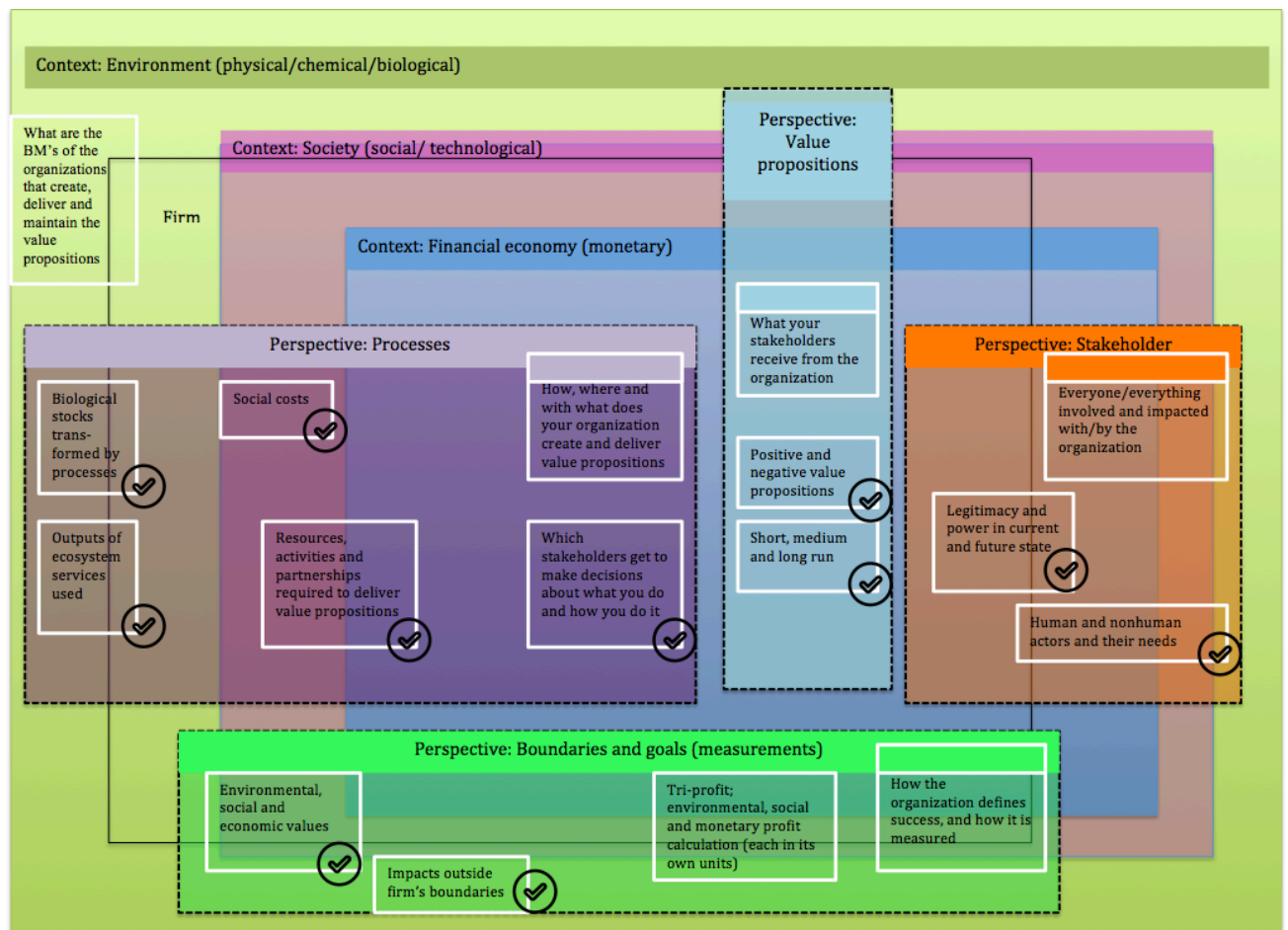


the impact of biomimicry on the business model of company 9 is discussed. Table 34 provides an overview of the scores of company 9 on the Four Phase Model.

**Table 34 Scores Four Phase Model Company 9**

Model	Constructs	Company 9
4 Phase model	<b>Vision on sustainability</b>	"We notice that the term sustainability becomes more and more important at our company. A lot of different programs are developed by the head quarter related to sustainability. Our clients also become more aware of sustainability and start demanding sustainable packages for example. Together with our clients we both try to become more sustainable."
	<b>Orientation external developments</b>	"I believe we are responsive from different levels within the organisation; the board, the family; the different countries. We want to be future-proof and that is why we are responsive towards developments in the market at our clients and at our surroundings and environment. The packaging industry for example changes to different type of packaging materials, and we need to adjust our products to this trend."
	<b>Business case elements</b>	"I think we can say that sustainability is not yet embedded in our business model, but it is gaining in awareness and attention."
	<b>Transparency</b>	"We are very transparent. We share our knowledge and information and open our doors for others. And information regarding our sustainability performance is embedded in the annual report."
	<b>Reporting</b>	"There is a sustainability section in our annual report."
	<b>Stakeholders</b>	"We do not have a leading role regarding sustainability within society."
	<b>Supply chain approach</b>	"Together with our suppliers and clients we try to become more sustainable. We proactively make our clients aware of how they can make their processes more energy efficient. We for example expose leakages and explain the efficiency of new products to them. Since four months we organise the efficiency tour, we go to machine builders and other clients and show them possibilities to reduce their co2 emission. And we partner with our suppliers in order to see what the possibilities are regarding efficiency."
	<b>Dominant functional discipline</b>	"Our company created sustainability departments and sustainability will become more and more embedded within the organisation in the coming years. Sustainability goals are formulated for the short medium and long term and the goals are mentioned in the annual report."

Results show that company 9 scored 6 out of 8 for the Eight Archetype Model. Company 9 is transitioning towards more sustainability, however according to the interviewees sustainability is not yet visible in the business model: *"I think we can say that sustainability is not yet embedded in our business model, but it is gaining in awareness and attention."* In addition, company 9 indicated that they do not focus that much on having an impact on sustainability within society. These outcomes indicate that company 9 is moving towards the proactive phase of the Four Phase Model. Currently however they are in the active phase of the Four Phase Model. Outcomes reveal that company 9 does have a clear vision on sustainability and its opportunities, and takes sustainability measures. This indicates that the business model of company 9 will show some sustainable characteristics, however they mentioned themselves that this will most likely not be embedded in the entire business model.



**Figure 28 Scores Elements of successful Sustainable Business Model Company 9**

The business model in Figure 28 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix J. The results show that company 9 complies with 11 of the 12 elements indicating a successful sustainable business model. Company 9 only does not focus on tri-profit measurement and profit is measured based on economic values: *"We are a commercial organisation, so we are successful when we achieve our commercial goals. Profit is one of the things necessary in order to guarantee future-proofness, however social and ecological values are becoming more and more important."* Company 9 applies a biomimicry design approach on product and process level, and positive scores relate to their products, processes, projects, collaborations, and services. However, since company 9 explained that they are currently transitioning towards more sustainable practices and processes their mind-sets are not focused on sustainability yet. The economic goals are still of great importance, and define success of the company. Nevertheless, social and environmental goals have been formulated and gain more and more importance. Stakeholders, including nonhumans, are important to company 9 and they are engaged in focal processes of the company. Furthermore, company 9 tries to reduce its negative value generation and actively studies its negative (social) impact. The sustainability of the firms' processes gained a lot of attention the past years, which led to sustainable buildings and manufacturing processes. These scores reveal that company 9 fulfils almost all elements identifying a successful sustainable business model, which is contradicting to the findings coming from the Four Phase Model assessment. The interviewees of company 9 indicated that sustainability is not yet embedded in the business model, yet these results show that they actually fulfil the elements identifying a successful sustainable business model.

Table 35 shows how sustainability is operationalized in the business model of company 9 based on the Eight Archetype Model.

Table 35 Scores Eight Archetype Model Company 9

Model	Constructs	Company 9
Eight Archetypes of a Sustainable Business Model	Efficiency	"We focus on efficiency on production and product level. During the production we have closed water systems, but we also try to re-use heat. And our products are designed to be more energy efficient than previous products and alternatives. We review product designs even on molecule level to see if we can change the composition of our materials in order to make the product more efficient. We also try to encourage energy efficiency at our clients with our energy efficiency tour."
	Waste	"We recycle materials in some cases, but it is not our main focus. However, we want to start using more 3D printing technology and waste can be a great source of material for the 3D printers. But this is still work in progress."
	Substitution	"In this building in the Netherlands we use partly renewable energy from solar panels. A project group at our facility is proactively involved in making this building more energy efficient and use renewable energy sources."
	Functionality	"Our clients get ownership of the products; we are not involved in any leasing activities yet. However, we do offer a lot of education programs on different kinds of education institutes and in-house and create efficiency awareness at businesses."
	Stewardship	"We try to protect society and the environment. In our policy is stated that we need to guarantee safety for our employees and residents. The policy also mentioned that we cannot directly produce for the weapon industry. In addition we try to protect society by pursuing future-proofness. And with our energy efficiency solutions and our tour we try to protect the environment. We try to create awareness amongst society about the impact of the use of energy and provide them with solution to reduce their energy use. In addition, we try to play an important role during education activities."
	Sufficiency	"We share knowledge regarding the lifespan of our products and how to use them optimally. And we educate businesses about energy efficiency."
	Repurpose	"We want to include local communities within our business, and try to educate them and show them what we do. We have partnered with multiple businesses with the goal to increase the quality of life around our industrial area. We organize science days for interested people. And we educate at educational institutes to make children interested in technology. We also provide trainings and courses for businesses and individuals regarding technology, we even provide courses to become a windmill service engineer even though we do not even produce windmills; we just believe it is important to train them. The products we created in our bionic network are also not created in order to generate money. We try to copy nature as good as possible and recreate nature in technological products. After we created the products we search for applications. We do this together with our clients. Sometimes we can find great applications for the products, and sometimes we do not."
	Scale-up	"We are engaged in open-innovation projects, especially with our clients to find applications for our products. I cannot share information regarding crowd funding and our scale-up solutions with you."

Results from the assessment of the Eight Archetype Model show that company 9 operationalizes 7 out of 8 archetypes within its business model. Company 9 did not yet operationalize the creating value from waste archetype in their businesses model. Company 9 is currently in the exploration phase regarding the use of waste stream during 3D printing processes: *"We are currently exploring future possibilities for 3D printing techniques. In order to print we need materials, and those materials can come from waste streams. Students provide us with great ideas about how and which waste stream to use for 3D printing. We believe we can create a successful business model based on 3D printing with*

waste streams; right now we are figuring out how to do this.” For company 9 it should be mentioned that the substitution with renewables and natural processes is especially operationalized in their facilities and processes, but not in the products of company 9. The positive outcomes of this assessment are again contradicting to the outcomes of the assessment of the Four Phase Model. Company 9 operationalizes sustainability within their businesses model in various ways, and on various levels, while they indicated that sustainability is not yet embedded in their business model.

The interviewees of company 9 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models, since nature functions as optimal example of sustainability: *“Ecosystems and nature are self-sustaining and self-supporting; we can only learn from that. So I believe that biomimicry can definitely contribute to the creation of a sustainable business model.”* According to the interviewees the application of a biomimicry design approach indirectly influenced the sustainability of their business model: *“Applying biomimicry created a sense of sustainability; we became more aware of the environment. And that sense of sustainability influenced our business model.”* Company 9 never experienced the application of a biomimicry design approach as being restrictive since they are not only focussing on biomimicry: *“Since we are not only focussing on biomimicry we are not restricted by it.”* These statements are in line with the outcomes of the sustainable business model and the archetypes assessments, however they are contradicting to their statement that sustainability is not a part of their business model. Based on the outcomes of the assessments it seems that biomimicry and sustainability did influence the business model and that the business model has sustainable characteristics, but that the interviewees are not yet aware of this. Table 36 provides a summary of the outcomes from the assessments of company 9.

**Table 36 Summary findings Company 9**

<b>Four Phase Model</b>	Active Phase
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model; they comply with almost all elements. Does not fulfil tri-profit measurements element, however none of the cases does. This is contradicting to the assessment of Four Phase Model.
<b>Eight Archetype Model</b>	Operationalizes 7 archetypes within their products, processes, projects, services, awareness creation, and education activities. Plans on operationalizing Waste Archetype in near future. This is contradicting to the assessment of Four Phase Model.
<b>Impact Biomimicry</b>	Biomimicry design approach did influence the general vision on sustainability. This created vision on sustainability caused a change in their traditional business model. However, company does not yet recognize that they switched to a sustainable business model.

#### **7.1.10 Company 10**

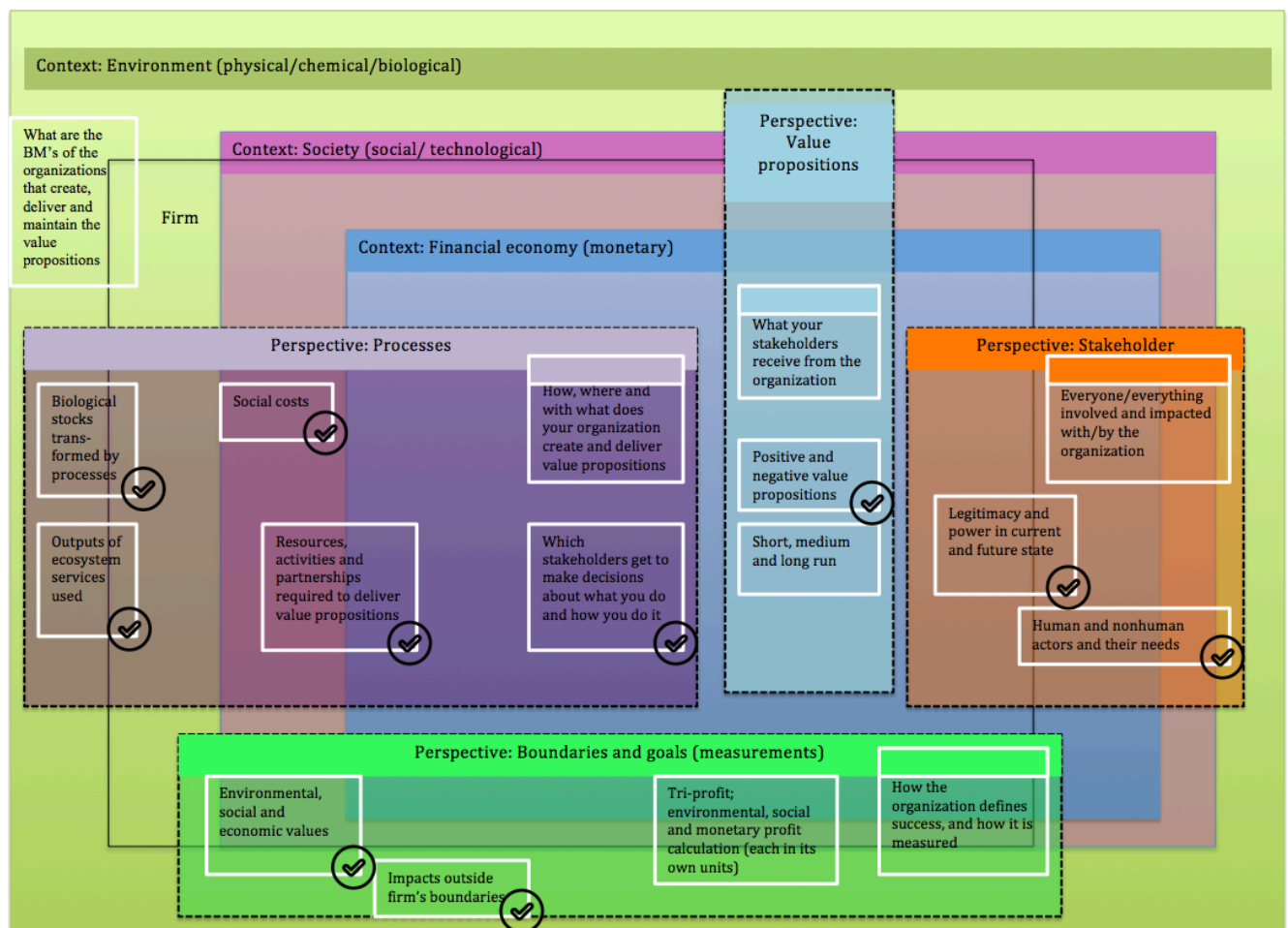
This section describes the results for company 10. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 10 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 10 is discussed. Table 37 provides an overview of the scores of company 10 on the Four Phase Model.

Table 37 Scores Four Phase Model Company 10

Model	Constructs	Company 10
4 Phase model	<b>Vision on sustainability</b>	"I strongly believe in biomimicry and its purpose. I do not only apply biomimicry during my work, but it is really a lifestyle. You can compare it with a belief."
	<b>Orientation external developments</b>	"I am responsive towards developments in society. The way of living together is changing; people want to live more sustainably, or want to share facilities. I try to keep up with these kinds of developments and create innovative products and projects that support these developments. But I also keep an eye on technological developments and robotics to see if you can use it in a sustainable way while at the same time increasing comfort. And I notice an increasing awareness regarding sustainability and try to support this by providing courses and workshops. I also keep economic changes in mind, the amount of one-person households is increasing, and I adjust my designs to this."
	<b>Business case elements</b>	"Sustainability is embedded in the business model and beyond. It is my way of thinking, and is present during all decisions, activities, processes, relations, projects etc. Everything I do is based on the life's principles."
	<b>Transparency</b>	"I do not believe I can be any more transparent. It is not that I am always talking about our sustainability performance but it is my lifestyle. And I try to promote this lifestyle and way of thinking."
	<b>Reporting</b>	"I do not have a real sustainability report, but regulation demands reports regarding energy performance and flora and fauna reports. We deliberately chose to use ecological performance standards to indicate that the standards in an area are at least the same after we build something in a particular area."
	<b>Stakeholders</b>	"My role and the role of my company is to show society a way to incorporate sustainability by using biomimicry. I hope that I can function as best practice to help society to become more sustainable."
	<b>Supply chain approach</b>	"My supply chain knows that I am a sustainable architect and together we try to create sustainable projects."
	<b>Dominant functional discipline</b>	"My vision is that everything that will be created in the future fits in all systems, and I want to contribute to this. I want society to become in balance with ecosystems."

Results indicate that company 10 scored 7 out of 8 for the Eight Archetype Model. Company 10 is obligated by law and regulations to make certain measurements and report, however they do not produce an official sustainability report. These outcomes indicate that company 10 is in the proactive phase of the Four Phase Model, which implies the presence of a sustainable strategy and a sustainable business model. The interviewee took the proactive phase towards sustainability beyond the business boundaries and indicated that this proactive attitude is embedded in her lifestyle. The positive scores relate to designs, projects, services, processes, education, and collaborations.





**Figure 29 Scores Elements of successful Sustainable Business Model Company 10**

The business model in Figure 29 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix K. The results show that company 10 complies with 10 of the 12 elements indicating a successful sustainable business model. Company 10 does not use the tri-profit measurement: *"Intuitively I take social and ecological values in consideration during profit calculations but I am not familiar with tri-profit."* And furthermore, the value proposition element is not focused on the medium and long term: *"I did not establish any long term vision, just as I do not set up any profit goals upfront."* Company 10 applies a biomimicry design approach on product, process and system level, and uses the Life's Principles within everyday practices, decision-making etc. However, the Life's Principles did not help the company to develop any long-term value propositions. Company 10 has clear social and environmental goals and the whole business model is focused on these goals. Stakeholders, including nonhumans, are of high importance to the company since they determine the sustainability of the designs and projects. Company 10 empathized on the fact that the construction industry is unsustainable, and therefore a transition towards more sustainable businesses and projects is necessary. Since the construction industry is unsustainable the sustainability of the firms' processes is of high importance to the company. Company 10 sees its business model as a best practice example for other businesses within the industry.

Table 38 shows how sustainability is operationalized in the business model of company 10 based on the Eight Archetype Model.



**Table 38 Scores Eight Archetype Model Company 10**

Model	Constructs	Company 10
Eight Archetypes of a Sustainable Business Model	<b>Efficiency</b>	"During the design I focus a lot on efficiency. For material efficiency I analyse the structure in order to be able to use as little as materials as possible. I try to design in such a way that the buildings can make use of natural elements like suns, water and wind. I try to get energy from the sun without installing solar panels for example. Building can become more efficient when you use the natural elements around those buildings."
	<b>Waste</b>	"I am always looking for recycled materials to use in my designs. If it would be possible my designs would consist completely out of recycled materials."
	<b>Substitution</b>	"I focus on the creation of natural energy processes."
	<b>Functionality</b>	"The commissioners become owner of the building, but that does not account for all products I design. We focus for example on sharing energy facilities. I am currently working on a project where a big server that is present on that business park heats all buildings of different companies without one of the projects being the owner of this server. In addition I provide trainings and workshops."
	<b>Stewardship</b>	"Biophilia is the belief that being in contact with nature is good and healthy for body and mind. I always incorporate this in my projects in order to create a relationship between human and nature. Biodiversity is always high on my priority list too."
	<b>Sufficiency</b>	"My whole supply chain knows that I am a sustainable architect and they know that I take scarcity etc. into account, so they try to come up with sustainable products that I can use in my designs."
	<b>Repurpose</b>	"My goal is to create a better and balanced world by implementing biomimicry design approaches in all my projects."
	<b>Scale-up</b>	"I am really actively engaged in open-innovation projects with suppliers, clients and other interested. We for example try to solve sustainability problems in the construction industry. But I also teach at educational institutes about biomimicry, biophilia, and sustainability. At the moment I do not think that I will scale up my business in terms of employees. But I do want to stay engaged in all types of open-innovation projects."

Results from the assessment of the Eight Archetype Model show that company 10 operationalizes 8 out of 8 archetypes within its business model. Sustainability is operationalized in the designs, projects, processes, collaborations, training and workshops of company 10.

The interviewee of company 10 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models, since nature functions as optimal example of sustainability and biomimicry creates new perspectives and mind-sets: *"Nature is a sustainable business model, so applying biomimicry can definitely generate sustainable business models."* And: *"Businesses will only become more sustainable if they apply biomimicry on all levels and focus on all Life's Principles. Biomimicry should create a different mind-set in order to make business models more sustainable."* The interviewee emphasized on the fact that applying biomimicry will only help to develop sustainable business models if it is applied on all levels and based on the Life's Principles. Therefore, company 10 indicated that the application of biomimicry directly influenced the sustainability of its business model: *"I go all the way and apply all essential biomimicry principles in my business model."* Company 10 indicated that the Life's Principles and biomimicry design approaches guided the direction and decisions of the company, but never felt restricted by it: *"Biomimicry formed my life style and created my ethical moral. I do not want any clients that work with me in order to green wash for example. But I do not see this as an obstruction."* Biomimicry and the Life's Principles did not only impacted the sustainability of the business model of company 10, it also impacted the lifestyle of the interviewee. Company 10 aspires to be a real life example of how biomimicry and biophilia can

support businesses during the transition towards more sustainable business practices. Table 39 provides a summary of the outcomes from the assessments of company 10.

**Table 39 Summary findings Company 10**

<b>Four Phase Model</b>	Proactive Phase
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model; they comply with almost all elements. Does not fulfil tri-profit measurements element, however none of the cases does.
<b>Eight Archetype Model</b>	Operationalizes all archetypes within their processes, projects, services, awareness creation, and education activities.
<b>Impact Biomimicry</b>	Biomimicry design approach and its Life's Principles did influence the sustainability of business model and functions as base for entire business strategy. Wants to share these impacts with other to co-create more sustainable businesses. And includes biophilia thinking.

#### 7.1.11 Company 11

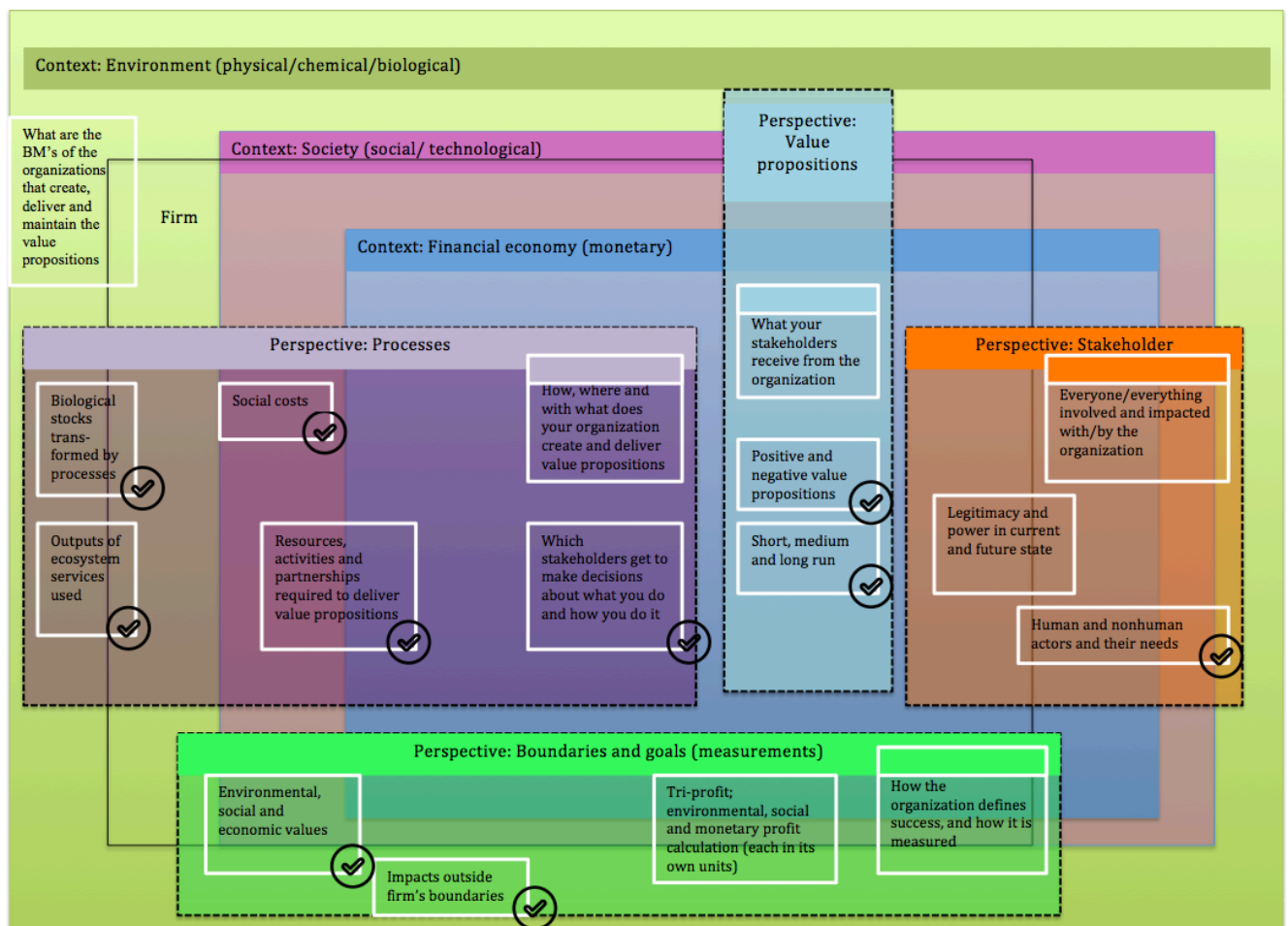
This section describes the results for company 11. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 11 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 11 is discussed. Table 40 provides an overview of the scores of company 11 on the Four Phase Model.

**Table 40 Scores Four Phase Model Company 11**

Model	Constructs	Company 11
4 Phase model	<b>Vision on sustainability</b>	"Sustainability is of high importance for everyone. The agricultural sector is not taking responsibility for their mass use of water. Water scarcity causes a lot of problems for the environment and society. Therefore, I wanted to tackle this by finding an innovative solution to grow plants and trees with 90% less water."
	<b>Orientation external developments</b>	"We try to solve problems that society deals with. We want to solve food scarcity issues, water scarcity, erosion, unemployment, immigration, desertification, and lower ground water levels."
	<b>Business case elements</b>	"The whole business is established in order to make the agricultural sector more sustainable. In addition, we try to incorporate sustainability in our material usages for example."
	<b>Transparency</b>	"We do not have any secrets, we even try to share our ideas with others because we want water to be used way more efficient globally. We hope that we can help society and nature with our ideas and therefore we share them with everyone. The information we provide is very transparent, our website is even available in 16 languages."
	<b>Reporting</b>	"We do not have a sustainability report."
	<b>Stakeholders</b>	"Saving humanity is the reason I started this business."
	<b>Supply chain approach</b>	"If you share information with others you will always get something back and you can both benefit from it. And that is what we do with all people involved in our supply chain."
	<b>Dominant functional discipline</b>	"There is no choice; everyone needs to become more sustainable. In the future we want our product to have a sufficient and positive impact on the problems we try to tackle, and we need to grow in order to achieve that."



Results denote that company 11 scored 7 out of 8 on the constructs identifying a proactive phase of the Four Phase Model. Company 11 does not focus on reporting: *“We do not have a sustainability report.”* The company did not provide a reason of why they do not have a sustainability report. The outcomes indicate that company 11 is in the proactive phase, since only two of the included cases have a sustainability report and company 11 scores positive on all other constructs. Company 11 aspires to have a pivotal role in transitioning the agricultural industry towards more sustainable practices. This does not imply that the whole industry should use the products of company 11; they want to create awareness in order to induce change.



**Figure 30 Scores Elements of successful Sustainable Business Model Company 11**

The business model in Figure 30 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix L. The results show that company 11 complies with 10 of the 12 elements indicating a successful sustainable business model. Corresponding to all previous mentioned companies company 12 does not use tri-profit measurements: *“We do not use any measurements tool to calculate our social and ecological value.”* However, the interviewee of company 11 stated that: *“The company is successful when we caused a revolution in water using industries and reduce the global water usage and the problems caused by it. Our motivation is 100% ecological; solving the water problems is our number one priority and profit is a resource to achieve our goals.”* In addition, company 11 is really focused on changing the ways we use water; but they are not focused on the future legitimacy and power of their stakeholders. Company 11 applies a biomimicry on product and process level, and did not mention the use of the Life’s Principles during the creation of their business strategy and model and their business practices. The business model of company 11 is based on their social and environmental goals, which have the highest priority. The entire business is focused on achieving those goals, and economic values are seen as necessary resource to reach those goals. Inclusion of stakeholders,

including nonhumans, is of high importance to company 11 since support from stakeholders is necessary to cause a revolution. Sustainability is also important during the firms' processes, however company 11 indicated that they are unable to influence some of the manufacturing processes.

Table 41 shows how sustainability is operationalized in the business model of company 11 based on the Eight Archetype Model.

**Table 41 Scores Eight Archetype Model Company 11**

Model	Constructs	Company 11
Eight Archetypes of a Sustainable Business Model	Efficiency	"Our products make the growing processes of trees and plants more efficient, since less water is needed and the survival rate is higher. We also focus on material efficiency by looking at the design of our product and making adjustments to the materials and shapes used."
	Waste	"We use old paper pulp to produce our biodegradable products. The plastic granules used to produce the plastic products cannot come from recycled plastic. However, those products have a lifespan of 15 years, and after those 15 years our distributors are obligated to take the products back and make sure it gets recycled."
	Substitution	"We do not have any influence on the energy used during processes."
	Functionality	"The buyers of our product become owners. But we try to create a revolution in water usage by educating people about water usage, and creating awareness. And we provide videos showing how to grow plants and trees for free."
	Stewardship	"With our products we want to contribute to ecosystem restoration and we want to do it in an efficient and cheap way. I even advice our clients to put native trees and plants at unprofitable parts of the fields like corners, entrances, steep slopes etc. In this way the clients create spaces for birds and wildlife and contribute to biodiversity protection. Our motivation is 100% ecological; solving the water problems is our number one priority."
	Sufficiency	"We try to create global awareness regarding water usage and scarcity. We are very active on social media last month our YouTube page had around 3900 visitors per day, and I write a lot of columns. I guess that the water scarcity in South Africa will also cause more awareness."
	Repurpose	"Our main goal is not to make profit; we want to tackle the problems that are caused by water scarcity. And we want that small and poor farmers are able to buy our products, and benefit from it. We also make video clips that show how to grow tomatoes and we want people to learn from it. We hope that the world will produce more food with fewer resources."
	Scale-up	"In order to be able to help small and poor farmers we need to be big and have scale advantages. This will bring the cost price down and make our products affordable for them. We are also engaged in open-innovation projects, we have created a network of around 10 businesses that are equally motivated as we are. And in order to scale-up we have developed our own kind of crowd funding idea. People can support our company, and if it becomes a big success they will earn part of their investments back."

Results from the assessment of the Eight Archetype Model show that company 11 operationalizes 7 out of 8 archetypes within its business model. Company 11 only does not focused on substitution with renewables and natural processes, according to the interviewee they are not able to influence the processes at their manufacturers. Company 11 operationalizes sustainability within their products, projects, education programs, and awareness creation activities. Besides the aspiration to start a revolution in the use of water, company 11 is also concerned with the social welfare of small farmers.

The interviewee of company 11 mentioned that applying a biomimicry design approach cannot contribute to the sustainability of business models but that it functions as an idea generator: *“I do not believe that having biomimicry as goal will lead to sustainable business models. However, I believe that it is always good to analyse how nature solves certain problems. And a lot of companies should do this.”* Furthermore, the interviewee indicated that biomimicry did not influence the sustainability of their business model, their sustainability approach did: *“Biomimicry did not influence my business model. My sustainability approach did.”* Company 11 did not experience biomimicry as creating restrictions for the company since applying biomimicry is not one of their goals: *“I do not believe that biomimicry can negatively influence a business in any way. But you should not constrain your business to just look at nature. If you are an innovative company you should be curious to what is new and be open to everything. It is not only about nature, or only about this or only that. You just need to be open towards all kinds of solutions that come your way; even if you did not expect to find any solutions from that direction.”* The sustainable characteristics of the business model of company 11 come forward from a general sustainability approach and the aspiration to start a revolution to change the water usage in the agricultural industry. Table 42 provides a summary of the outcomes from the assessments of company 11.

**Table 42 Summary findings Company 11**

<b>Four Phase Model</b>	<b>Proactive Phase</b>
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model; they comply with almost all elements. Does not fulfil tri-profit measurements element, however none of the cases does. And does not consider future power and legitimacy of stakeholders.
<b>Eight Archetype Model</b>	Operationalizes 7 archetypes within their processes, projects, services, awareness creation, and education activities. Is unable to influence energy usage during manufacturing.
<b>Impact Biomimicry</b>	Biomimicry design approach did not influence the sustainability of business model and strategy. Biomimicry only provided ideas for their products and the processes within these products. Their sustainable business model comes forward from their vision on sustainability and sustainable aspirations.

### 7.1.12 Company 12

This section describes the results for company 12. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 12 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 12 is discussed. Table 43 provides an overview of the scores of company 12 on the Four Phase Model.

**Table 43 Scores Four Phase Model Company 12**

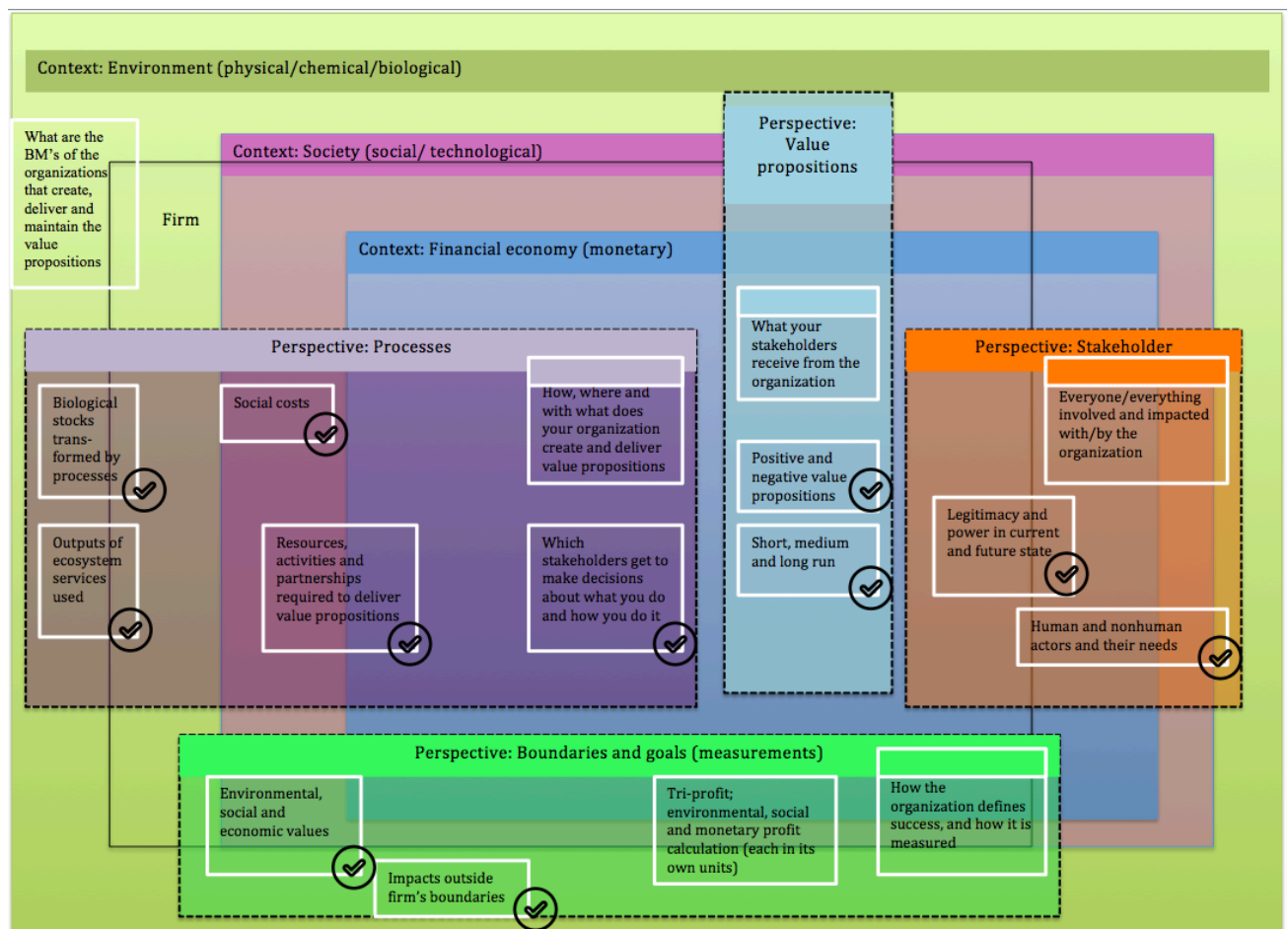
<b>Model</b>	<b>Constructs</b>	<b>Company 12</b>
4 Phase model	<b>Vision on sustainability</b>	“We do not like people to guess what sustainability is; we show it to them by being efficient and animal and environmental friendly. Sustainability is not one element; you have to focus on a lot of interlinked elements.”
	<b>Orientation external developments</b>	“We can be very reactive, and are able to switch and adapt quickly. We are changing the way we work almost every week. If something turns out to scare the animals we would dump that project. That is why we collaborate with the university, because we want to include research in our business.”



<b>Business case elements</b>	“Sustainability is incorporated in our business model because we want it, and it is beneficial during funding applications. You need to be able to show others how sustainability is operationalized in your business before they understand it. We make sure we use non-toxic materials, are efficient, work with local suppliers, collaborate with students and the university, minimizing wasted time, energy and recourses, and travel as less as possible.”
<b>Transparency</b>	“We are a bit secretive about what we are doing. We are really transparent towards the people we want to work with. But we do not want to spend a lot of time and money on applying for patents and therefore we are secretive about what we are doing.”
<b>Reporting</b>	“Currently we do not have any kind of report; we are still at the early phases. I do think once we getting up and working more with stakeholders, clients, customers, that will be something that we will be actively promoting an pushing out there making sure internally and externally as well. And if we want to be b-corp certified we need to have a report.”
<b>Stakeholders</b>	“We are aware that the racing industry is a luxury thing; in reality you should not be racing horses. But it is something that is out there so we are looking at how can we be as responsive to minimize the stress to these high performance animals that cost lots of money. So we are trying to come up with ways to minimize the stress for those animals. So our role is to contribute to animal welfare.”
<b>Supply chain approach</b>	“Together with local suppliers we try to make our products as sustainable as possible. In the future we want to focus more on the impact and sustainability of our supply chain.”
<b>Dominant functional discipline</b>	“In the future we would like to be able to have that continuous feedback from the students and the university and the clients. And we are looking at making sure that we minimize the use of materials and interlink all products and materials to minimize the use of energy and materials for each product. And we want to become self-sufficient and self-supporting and not rely on funding.”

Results indicate that company 12 scored 5 out of 8 on the constructs identifying a proactive phase. Company 12 is not transparent and does not focus on reporting: “*We are a bit secretive about what we are doing.*” In the future they might want to be b-corporation certified, and that is the moment they want to start with focusing on transparency and reporting. In addition, company 12 does not indicate society as a stakeholder. They are operating in the race horsing industry, which is a “*luxury industry*” according to them. Right now, the business is focusing on making this luxury industry a bit more sustainable. Based on these outcomes it can be indicated that company 12 aspires to move towards the proactive phase of the Four Phase Model, however they currently are in the active phase. This indicates that company 12 most likely implemented sustainability measures within its business model and that the business model will show some sustainable characteristics.





**Figure 31 Scores Elements of successful Sustainable Business Model Company 12**

The business model in Figure 31 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix M. The results show that company 12 complies with 11 of the 12 elements indicating a successful sustainable business model. Company 12 also does not focus on tri-profit measurement: “*At the moment we do not measure our social and environmental values. We want to collaborate with different people and provide opportunities for them, and we want to contribute to animal welfare.*” Company 12 applies a biomimicry design approach on product level, and mentioned that they use the Life’s Principles during the creation of their business model and their strategy. In addition, the Life’s Principles provide guidance during everyday business practices and decision-making. In comparison to the outcomes of the assessment of the Four Phase Model, company 12 scores high on almost all elements of a successful sustainable business model. The business practices and processes are built around the social and environmental goals, and stakeholders are of high importance for company 12. Stakeholders are included in all focal processes since they co-create sustainability and the company values their feedback. The Life’s Principles functioned as a blue print during the development of the firm’s processes and caused the company to fulfil those elements of success.

Table 44 shows how sustainability is operationalized in the business model of company 12 based on the Eight Archetype Model.

**Table 44 Scores Eight Archetype Model Company 12**

Model	Constructs	Company 12
Eight Archetypes of a Sustainable Business Model	<b>Efficiency</b>	"We do not want to use materials where we do not need them. And we also try to reduce the use of materials that require a lot of energy in usage and manufacturing."
	<b>Waste</b>	"We are currently looking into a business opportunity to sell horse poo. And during the development of the prototypes we use waste materials from previous prototypes. But we also recycle business plans when applying for funding for example. We are making sure that our products can be taken apart easily. Since we are working with animals certain parts of the product may break, and when this happens we do not want to replace the whole product but just the part that broke. It also allows us to recycle or even upcycle certain parts."
	<b>Substitution</b>	"We try to make our technologies run on solar energy. This is not only beneficial for the environment, but a lot of stables also do not always have energy."
	<b>Functionality</b>	"After we delivered a product we want to keep working with our clients. We want to continue with providing our service, in this way we are able to receive feedback and can we keep improving our products. We are never going to have a finished product. We want feedback about what works and does not work and how the animals react to it."
	<b>Stewardship</b>	"We want to contribute to society by providing an opportunity for students; in this way we can give something back to society. And we want to contribute to animal welfare."
	<b>Sufficiency</b>	"One of the things we are doing is educating people to make sure that they do not waste materials, or different parts of it. We also instruct the students about this, you do not want people just wasting stuff by buying more products than they need and having those products just laying around. We also inform or clients about this, we do not want to put too much technology in the stables because that might scare the horses."
	<b>Repurpose</b>	"Besides our economic goals we want to teach the students about product development, collaboration, engineering, the horse industry etc. And we want to help reducing stress of racehorses."
	<b>Scale-up</b>	"We are looking to scale-up by setting up a joint venture with another company. Furthermore, we hope that students come up with new innovative ideas that make it possible for us to scale-up. Everybody is creative when given the right opportunity. Over time we might go mass market, but we first want to make sure our products really work. When we go mass market we want to license manufacturers."

Results from the assessment of the Eight Archetype Model show that company 12 operationalizes 8 out of 8 archetypes within its business model. Operationalization is embedded within the firm's products, processes, designs, services, collaborations, and social opportunities they provide.

The interviewee of company 12 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models, since nature provides examples of sustainability and it creates new perspectives and mind-sets: *"You can use nature as an idea generator."* And: *"Biomimicry does make you think differently about how you frame your questions and how things work. It provides a shift in mind-set."* In addition, the interviewee stated that application of the biomimicry design approach directly influenced their business model: *"Biomimicry and its Life's Principles made us look at using as much as natural resources as possible and making sure that we get feedback from everything."* Furthermore, the interviewee wants to warn other businesses for having a too fixed focus on implementing just biomimicry as an approach to become more sustainable: *"Applying biomimicry can be restrictive if you just focus on looking at the natural world and replicate this. That is why I use nature as an idea generator, and sometimes some of it coming out will not be replicating something"*

from the natural world but will give ideas to look at it as a metaphor or something like that. I know for some whom do focus much on biomimicry it can be restricting, but if you start of from this point but realize that it is to expensive to manufacture, or you can get the materials or you are going down a dead end of finding solutions in the natural world cause some spend 6 months just analysing it. So that is why I kind of consider the bigger picture. So it can be restrictive if you just focus on biomimicry. But if you consider that as a starting block to look into how do you use nature-based solutions and look into other areas.” The business model of company 12 shows sustainable characteristics, and biomimicry and the Life’s Principles directly influences these characteristics, this is contradicting to the outcomes of the assessment of the Four Phase Model. However, company 12 is a start-up company and time will indicate whether or not they transit towards the proactive phase. Table 45 provides a summary of the outcomes from the assessments of company 12.

**Table 45 Summary findings Company 12**

<b>Four Phase Model</b>	<b>Active Phase</b>
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model; they comply with almost all elements. Does not fulfil tri-profit measurements element, however none of the cases does.
<b>Eight Archetype Model</b>	Operationalizes 8 archetypes within their products, designs, processes, projects, services, and opportunities.
<b>Impact Biomimicry</b>	Biomimicry design approach functioned as idea generator and the Life’s Principles directly influenced the sustainability of the business model. The strategy is based on Life’s Principles, however they are willing to step aside from the Life’s Principles if execution becomes unrealistic.

### 7.1.13 Company 13

As mentioned in the method section, company 13 is not (yet) a company and the interview only provided results regarding the relationships between biomimicry and sustainability.

The interviewee indicated that nature provides examples of sustainability and can be used as idea generator: *“Everything in nature is resilient and sustainable. And all problems are already solved by nature. Applying biomimicry will make businesses more resilient, make them organically grow, and make them more adoptable and respectful. However, I do want to mention that the current definition of sustainable businesses is wrong. The current definition is all about humans and only focused on the next generation. In nature this is totally different. Currently being sustainable is doing something good for humans, and not for nature. Applying biomimicry and the Life’s Principles can make companies really sustainable.”* The interviewee emphasized that a revolution in current business strategies is necessary in order to create real sustainable businesses: *“In order for businesses to become more sustainable we need a shift in mind-set and applying biomimicry can contribute to this. The current mind-sets are only focused on being productive, and are only beneficial for a few people.”* The interviewee identified biomimicry as one promising approach to start this revolution, and to change the current business practice mind-sets.

### 7.1.14 Company 14

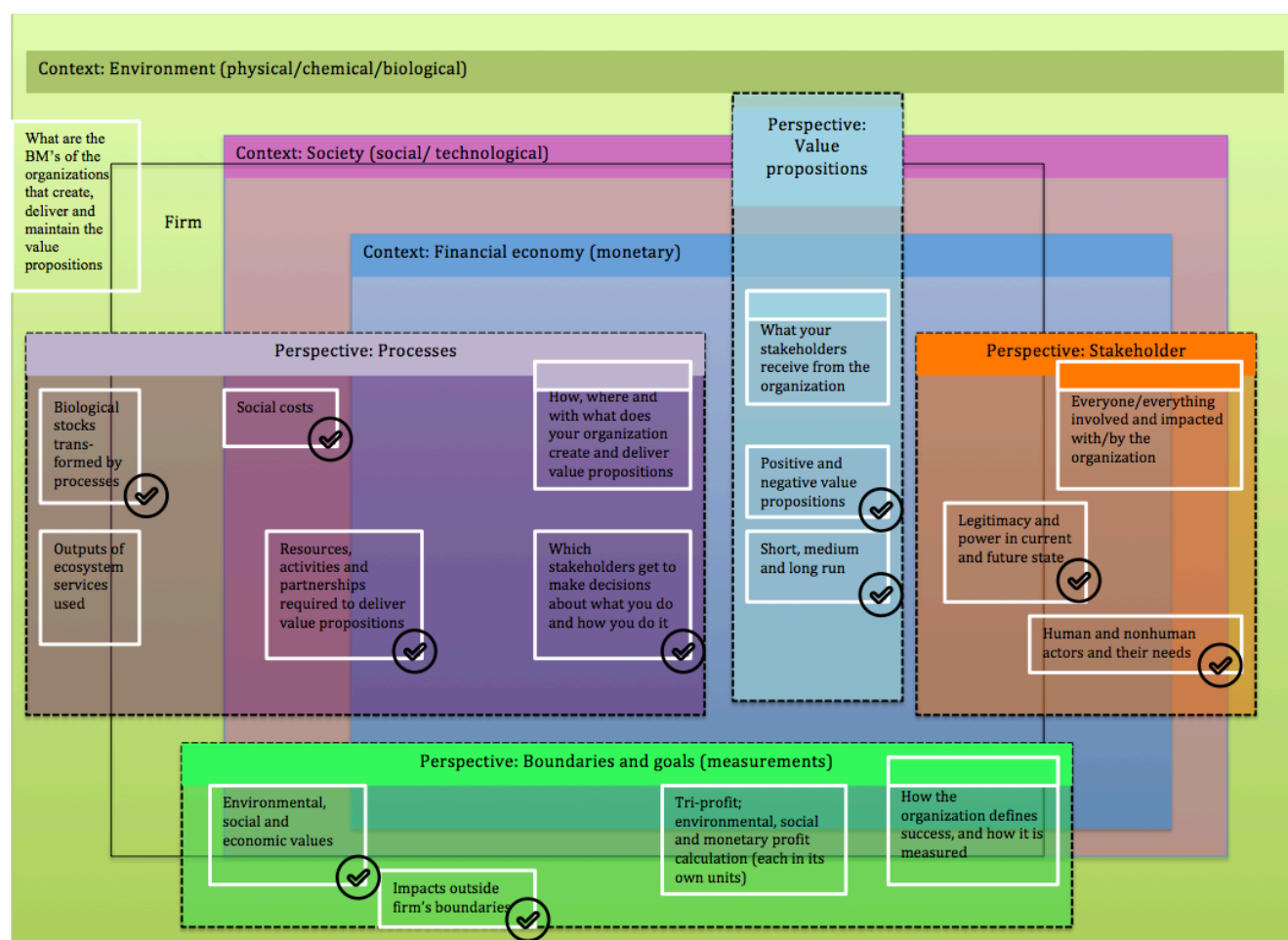
This section describes the results for company 14. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 14 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 14 is discussed. Table 46 provides an overview of the scores of company 14 on the Four Phase Model.

Table 46 Scores Four Phase Model Company 14

Model	Constructs	Company 14
4 Phase model	<b>Vision on sustainability</b>	"Sustainability is our main focus. Together with our community we strive to deliver sustainable, scalable and community-based farming systems to let anybody, anywhere access healthy food. We provide a regenerative solution to decentralize food production, enhance its supply chain and increase food quality within cities."
	<b>Orientation external developments</b>	"We started this company to tackle some challenges of the fresh food supply chain, the current fresh food supply chain is not sufficient and sustainable. Current available vertical farming alternatives have high capital requirements, and are labour intensive. We believe that these alternatives do not have a real impact on the food supply chain, and that the products produced in these farms are really expensive. Therefor we propose a decentralized urban farming model. In addition, there is a big trend in ordering food, and food express companies pop up. We are actually trying to get this trend in our favour, because if we produce food locally it also has to be distributed so in the future we can use and partner up with one of these distribution suppliers to distribute the products of our urban farmers."
	<b>Business case elements</b>	"We applied nature's patterns in our business model with the help of the Life's Principles. Since sustainability is our main focus it is integrated in our whole business model."
	<b>Transparency</b>	"We put most of our effort in explaining how we are doing things. But since we have not really begun to commercialize we did not really focus on transparency yet."
	<b>Reporting</b>	"We are trying to make life cycle assessments, but as right now we are just beginning the production and understanding how the system is going to be manufactured and so on, we have not been able to assess this. But it is definitely in the road map. We want to develop life cycle analysis because we want to get the b-corp certification."
	<b>Stakeholders</b>	"Our role is to create a decentralized fresh urban food network to tackle challenges of the current food supply chain. We want to offer a sustainable solution and make it easy for urban citizens and businesses to grow a variety of healthy fresh food without effort."
	<b>Supply chain approach</b>	"Our supply chain defines the sustainability of our products so collaborating with them is very important. For example with our 3-d printing suppliers we are also trying to reduce the volume of the product so that we use less materials. Our suppliers help us in the development and of course also keeping our sustainability approach."
	<b>Dominant functional discipline</b>	"We want to create a net positive product; we aspire to have a positive footprint. In addition, we want to create a decentralized urban food processing network and a decentralized manufacturing network. In the future we want to make or systems mostly by using 3-d printing techniques so businesses and citizens all over the world can use the systems. And we want to do life cycle assessments. With the help of one of our partners we try to improve our circularity. And with the help of another partner we are looking for substitutes for certain materials."

Results denote that company 14 scored 6 out of 8 on the constructs identifying a proactive phase. Company 14 indicated that they do not yet focus on transparency and sustainability reporting: *"We are just beginning the production and understanding how the system is going to be manufactured and so on, we have not been able to assess this. But it is definitely in the road map."* Once company 14 starts to commercialize, these two constructs will gain focus as well. Based on these outcomes it can be indicated that company 14 aspires to move towards the proactive phase of the Four Phase Model, however they currently are in the active phase. Based on the provided answers it could be argued that company 14 actually has a proactive strategy and attitude towards sustainability, but since they are a start-up company they are unable to score positive on all constructs yet and therefore they are still in

the active phase. Positive scores on the constructs do not only relate to the product they offer, but also to their services, network, processes, collaborations, and awareness creation activities.



**Figure 32 Scores Elements of successful Sustainable Business Model Company 14**

The business model in Figure 32 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix N. The results show that company 14 complies with 10 of the 12 elements indicating a successful sustainable business model. Company 14 does not yet focus of the use tri-profit measurement, however during the interview company 14 stated: *“Our success is measured by the social, economic and environmental impact of our business model. Since we are still in the developing phase it is hard to measure this all and take it into account during calculations. One advantage of our product is that it is digitalised, so we can measure and calculate things precisely in the future.”* Company 14 already indicated how social and environmental impacts will be measured in the future, but since they are still in the developing phase these types of measurements are not done yet. In addition, company 14 does not focus on outputs of ecosystem used: *“we cannot influence the water and energy resources of our users.”* Company 14 applies a biomimicry design approach on product, process and system level and indicated that they use the Life’s Principles during business model creation, everyday practices and decision-making processes. The business model of company 14 is built around their social and environmental goals and stakeholders, including nonhumans, are engaged in focal processes of the company. The Life’s Principles also influenced the sustainability of the firms’ processes.

Table 47 shows how sustainability is operationalized in the business model of company 14 based on the Eight Archetype Model.



Table 47 Scores Eight Archetype Model Company 14

Model	Constructs	Company 14
Eight Archetypes of a Sustainable Business Model	<b>Efficiency</b>	“We use led light for horticulture, which allows us to use low quantities of energy. Sensors on our products detect sunlight; if there is sunlight the led lights will go out. Our products are based on soilless food production, which needs 90% less water than regular food production. Our products also have information systems to read the different environmental conditions and adopt the irrigation frequencies; this makes the use off water more efficient. And the use of 3-d printer techniques makes our products more material efficient. The design of our product is also very efficient and uses the space optimal. Also the fact that the product can expand easily is a form of efficiency.”
	<b>Waste</b>	“We use 3-d printing to avoid waste, but we also recycle waste from other industries.”
	<b>Substitution</b>	“Our systems are able to run on renewable energy resources, but we cannot influence the energy resources of our clients. We are also not able to influence the energy resources during the manufacturing processes.”
	<b>Functionality</b>	“We offer our systems as a service; we install the system and also offer service for maintenance and resource supply that our customers need, so they do not have to do anything. In the future we want to do crowd sourcing in order to provide our services all over the world.”
	<b>Stewardship</b>	“We have a strong focus on creating environmental and social economic values. We are doing education activities for children, we talk with organisations, give lectures, and try to promote our vision whenever we can. We also try to promote our particular technical vision on urban farming and try to create awareness. In addition, biophilia is really important to us; if we bring nature into our houses we bring nature into houses and this has several social benefits.”
	<b>Sufficiency</b>	“The system has a user manual and we give some instructions. We also provide remote assistance via Wi-Fi connection. And we try to educate consumers that imported food is less sustainable.”
	<b>Repurpose</b>	“Our social goal is that people can access fresh healthy local food that is like our slogan: anybody anywhere can access healthy food. We are not going to forget about farmers, we also want to empower them and increase their productivity and make them part of our network. If we are able to create this network we will allow people to access fresh produced, lower price, locally. While giving the people the possibility to profit of course, that is important as well. For example elderly, unemployed people, disabled people are able to do urban farming, so we can also empower for those parts of society to grow food. Our system can create: students, healthy people, an economy and it can grow a more sustainable society. Besides biomimicry we are also focused on biophilia. Biophilia justifies why we have to do urban farming in urban spaces and not in vertical factories; if we bring farming into our houses, we bring nature into our houses. This has several benefits for humans. Environmental goals are decentralized food production of course, so reducing the need to import products from other countries, reducing transportation, and preservation of food, distribution, reducing pesticide use and reducing water waste.”
	<b>Scale-up</b>	“We already did a crowd funding campaign to make us able to sell our first piloting systems. And we plan on creating a crowd-sourcing model. When cities all over the world use our systems we will not be able to install and maintain those systems ourselves, so we will give people the opportunity to do this service for us, and they will be paid. We also want people to share information within the community. Different plants need different parameters; the growers can upload their used parameters so others can obtain information about which parameters to use to successfully grow a certain plant. This is like an open-innovation base. In the future we also want to involve more students by creating



		contests. And by using 3-d printing techniques we want to share our designs in such a way that businesses and citizens all over the world can use the systems.”
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Results from the assessment of the Eight Archetype Model show that company 14 operationalizes 7 out of 8 archetypes within its business model. Company 14 is not able to operationalize the substitute with renewables and natural processes archetype: *“Our systems are able to run on renewable energy resources, but we cannot influence the energy resources of our clients.”* Operationalization is embedded in the products, processes, network, collaborations, services, and education activities of company 14.

The interviewee of company 14 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models, since nature provides examples of sustainability and it provides ideas: *“Applying biomimicry can contribute to the sustainability of a business model since nature teaches you about sustainability.”* And: *“Nature is also about finding new solutions. Nature is the best designer.”* The interviewee indicated that biomimicry and the Life’s Principles caused them to start the company: *“Biomimicry really empowered us to start our business and create our business model. The Life’s Principles guided the creation of our business model.”* Without biomimicry company 14 was unable to develop their sustainable product and the Life’s Principles helped them to embed sustainability throughout their business model. Besides their focus on biomimicry and its Life’s Principles they also focus on biophilia to create a sustainable and healthy connection between people and their environment. Table 48 provides a summary of the outcomes from the assessments of company 14.

**Table 48 Summary findings Company 14**

<b>Four Phase Model</b>	Active Phase
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model; they comply with almost all elements. Does not fulfil tri-profit measurements element, however none of the cases does. And unable to fulfil ecosystem service element.
<b>Eight Archetype Model</b>	Operationalizes 7 archetypes within their products, designs, processes, network, services, collaborations, and education activities. Unable to fulfil substitution archetype.
<b>Impact Biomimicry</b>	Biomimicry design and the Life’s Principles founded the company and created a sustainable business model. Besides biomimicry they include biophilia thinking within their business practices and decisions.

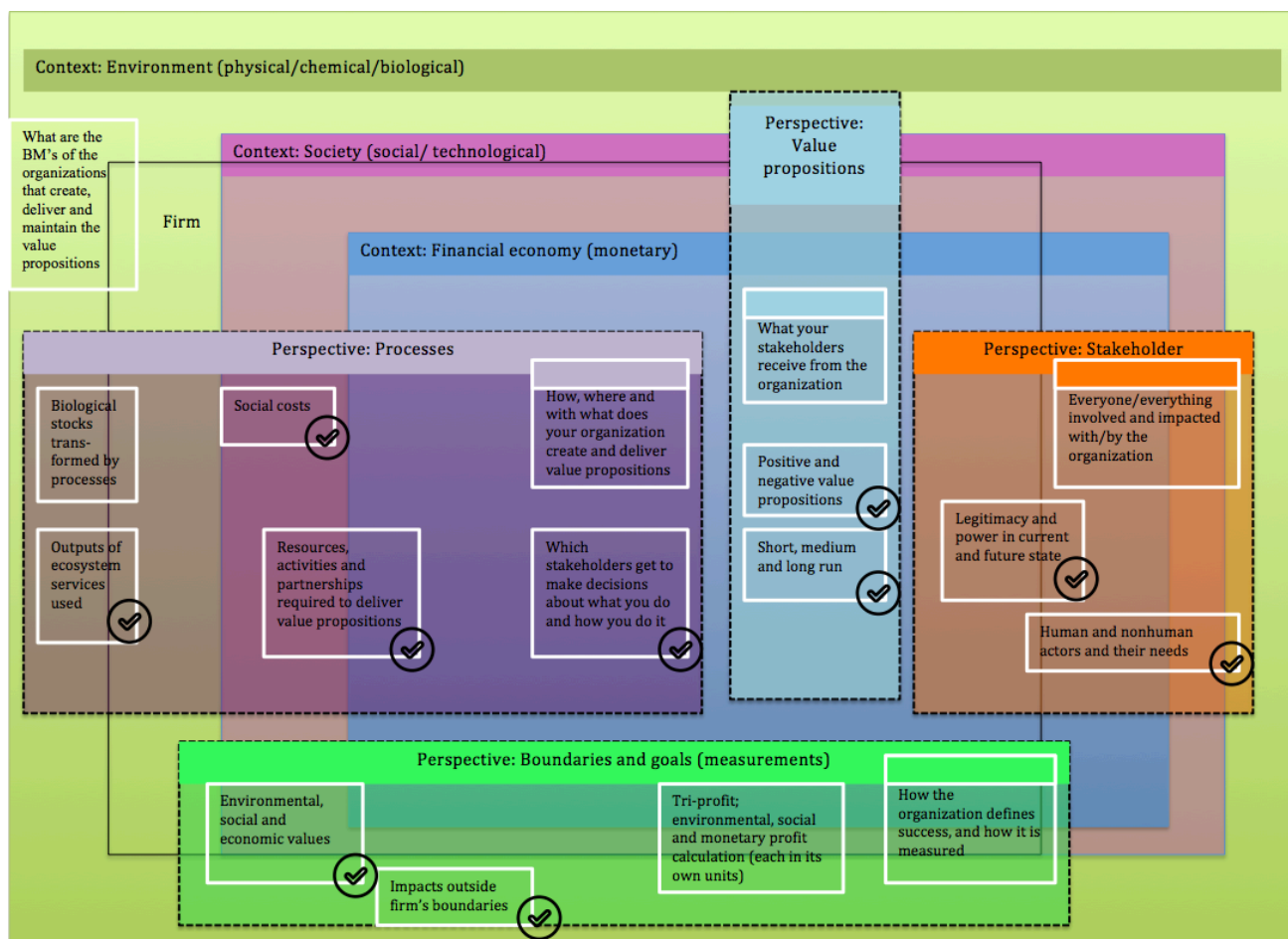
### 7.1.15 Company 15

This section describes the results for company 15. First of all, it elaborates upon the Four Phase Model and the assessment of the proactive phase. Secondly, the business model is assessed upon the elements identifying a Successful Sustainable Business Model. And this section describes how company 15 operationalized sustainability in the business model based on the Eight Archetype Model. In addition, the impact of biomimicry on the business model of company 15 is discussed. Table 49 provides an overview of the scores of company 15 on the Four Phase Model.

Table 49 Scores Four Phase Model Company 15

Model	Constructs	Company 15
4 Phase model	<b>Vision on sustainability</b>	"We are trying to address the UN sustainability goals with our knowledge ecosystems. We want to empower perspectives and connect solutions to the global challenges."
	<b>Orientation external developments</b>	"We are adapting ourselves to opportunities. We are opportunity driven like nature. Our opportunities come from imbalances between humans or between humans and nature. We want to tackle those imbalances by connecting information and knowledge."
	<b>Business case elements</b>	"Sustainability formed the beginning of our business. The use of the Life's Principles caused sustainability to be embedded in every part of the business model."
	<b>Transparency</b>	"We are willing to share our information with everyone; and we have an open-source platform. However, it is hard to evaluate the software industry and make life cycle analysis. I guess we will get there at some point, but it is hard."
	<b>Reporting</b>	"We are focusing on making it work so far; the evaluation part will come later. We are conscious that we do not have it, but I think it is only a matter of time and location."
	<b>Stakeholders</b>	"We want to give our stakeholders, and society the right tool to be able to put all knowledge information and solutions together to connect solutions and power perspectives. We want that everything, including nonhumans, becomes part of the conversation table and connect solutions around it. We live on the same planet all together, and it is important to note that nonhumans are not only animals and plants but also minerals for example."
	<b>Supply chain approach</b>	"Especially the users of our tool are really important to create sustainability. They are the ones that share their information, knowledge, experiences and solutions. Without the users we would not have an impact."
	<b>Dominant functional discipline</b>	"By using the Life's Principles it gives us full potential of evolving in the future, just like nature. Right now we look more like a seed but we already envision ourselves as a tree. We need to integrate, adapt, evolve and develop in order to get there. But we cannot grow too fast, if a tree grows too fast it will lose its strength. We want to have a positive net impact and bring content for the future generations. And we want to find balance between humans and nature. Whenever we see an opportunity we will move."

Results denote that company 15 scored 7 out of 8 on the constructs identifying a proactive phase. Company 15 indicated that they do not have any sustainability reports at the moment: *"We are focusing on making it work so far; the evaluation part will come later. We are conscious that we do not have it, but I think it is only a matter of time and location."* These results reveal that company 15 is in the proactive phase towards sustainability, which indicates that they have a sustainable strategy and business model. The influence of the Life's Principles is already noticeable in the results of this assessment; they make comparisons between the constructs and nature.



**Figure 33 Scores Elements of successful Sustainable Business Model Company 15**

The business model in Figure 33 is corresponding to the Successful Sustainable Business Model as indicated in Figure 18. Corresponding quotes that support the check marks can be found in Appendix O. The results show that company 15 complies with 10 of the 12 elements indicating a successful sustainable business model. Company 15 is not focused on tri-profit measurement: *"We know that our sustainable impact is getting better and better and is organically developing, but we do not measure it at the moment. Economic indicators are crucial right now because we are looking for investors. We believe that once our economic value is doing well we will be able to create more social and environmental impact. When financial key indicators are stable we start measuring the other values."* Company 15 bases decisions regarding products and processes based on the Life's Principles, and since they develop a software tool they do not need lots of resources, yet they are unable to influence the decisions of their supply partners regarding scarcity. The fact that they developed a software tool also caused them to be unable to comply with the Use Life-Friendly Chemistry life principle. Company 15 applies a biomimicry design approach on product, process and system level. In addition, the Life's Principles functions as blue print during the creation of their business model, which caused the sustainable characteristics of their business model. The business model is focused on achieving social and environmental goals and stakeholders are engaged in focal processes of the company.

Table 50 shows how sustainability is operationalized in the business model of company 15 based on the Eight Archetype Model.

**Table 50 Scores Eight Archetype Model Company 15**

Model	Constructs	Company 15
Eight Archetypes of a Sustainable Business Model	<b>Efficiency</b>	“Our tool is focused on optimizing, and that is a form of efficiency. It is not material or energy efficiency but content optimization.”
	<b>Waste</b>	“One of the current problems is internet obesity; there are lots and lots of things on the internet. We connect things on the internet; we build muscles with that information. So we are using whatever is already there and bring it to different kind of connections. By looking at those connections you will find many solutions. We realized that solutions are there; it is just a matter of connecting.”
	<b>Substitution</b>	“For us this is embedded in the Life’s Principles. Since the goal of biomimicry is to create conditions fit for life we believe it is embedded throughout our business. We need new generation companies. We try to move companies to become sustainable, but that is like trying a horse to behave as a bear. We try to be a living example of a new generation company by substituting old business practices with new practices based on the Life’s Principles and biomimicry.”
	<b>Functionality</b>	“One of our goals is to be a community enabler and business enhancer for anybody. We are trying to develop opportunities for others instead of trying to be the primary value for everyone.”
	<b>Stewardship</b>	“This is embedded in the Life’s Principles. We try to enhance biodiversity with this tool and to solve global challenges by providing a tool that connects solutions to problems.”
	<b>Sufficiency</b>	“By looking at nature we realized that by competing you are losing your energy. The best exchange between parties is collaboration. So society is able to have the biggest impact when we bring collaboration to the surface. And that is what we are trying to do with our open-source platform.”
	<b>Repurpose</b>	“Business theory needs more biology and we use biomimicry to share this with the world. Our main goal is to become pollinators of solutions to global challenges. Even though it might not be the part that is economically beneficial for us, it is something that is in our vision and we really want to achieve this.”
	<b>Scale-up</b>	“We are involved in open-innovation; our platform is an open source platform where people can share and transfer knowledge and collaboratively can find solutions. We also collaborate with other companies, for example in a hackathon for HIV resistance in Africa. And we are planning on giving innovation workshops. The next developments of the platform are all focused on collaborative elements.”

Results from the assessment of the Eight Archetype Model show that company 14 operationalizes 7 out of 8 archetypes within its business model. Company 15 is unable to focus on the material and energy efficiency archetype since they create software. However, they created a new type of efficiency with the software: content optimization. By gathering all available information on one-place searches become more efficient. One could argue that this optimization indirectly causes efficiency: because using the tool saves time and thus energy. And in addition, it is easier to recycle content and less storage space is needed. Their way of creating value from waste is also unconventional in comparison to the other included companies; information surplus on the Internet is seen as waste since it is not optimally used. Operationalization is embedded in the tool, platform, network, services, and collaborations of company 15.

The interviewees of company 15 mentioned that applying a biomimicry design approach can contribute to the sustainability of business models, since nature provides examples of sustainability and it provides new perspectives and mind-sets: *“The Life’s Principles are the patterns of nature, and if we behave more like something that is already sustainable then we have more probability to succeed in making sustainability global.”* And: *“The Life’s Principles teach companies that they need to create conditions fit for life. Applying the Life’s Principles in business models will create sustainable*



*mind-sets.*” Furthermore, the interviewees of company 15 indicated that biomimicry and its Life’s Principles directly impacted the sustainability of their business model: *“We incorporated the Life’s Principles, and we are more resilient to change, we are flexible and able to adapt. Without our biomimicry perspective we would not have been able to dig into biology to bring science on the top of this visualization. We could have developed a nice visualization but biomimicry gave us different insides.”* Biomimicry and its Life’s Principles provided company 15 with guidance and steered them into a certain direction, however they did not experience the restrictions as something negative: *“On the one hand applying biomimicry restricts you. It provides guidelines; you cannot just maximize for example. You need to be able to keep adapting and you cannot have a fixed structure. However, these guidelines liberated us. It gives us guidelines that we support and it inspires us in certain ways. You cannot do business as usual. We have to dig really deep in order to fulfil the Life’s Principles. But by fulfilling you know that you are pursuing sustainability. So, in that sense it is liberating because that is exactly our intention and our core thing.”* Biomimicry and the Life’s Principles supported company 15 to embed sustainability throughout their business model. Table 51 provides a summary of the outcomes from the assessments of company 15.

**Table 51 Summary findings Company 15**

<b>Four Phase Model</b>	Proactive Phase
<b>Elements Successful Sustainable Business Model</b>	Successful sustainable business model; they comply with almost all elements. Does not fulfil tri-profit measurements element, however none of the cases does. Unable to fulfil biological stock element.
<b>Eight Archetype Model</b>	Operationalizes 7 archetypes within their tool, platform, network, services, and collaborations. Unable to fulfil efficiency archetype
<b>Impact Biomimicry</b>	Biomimicry design approach and the Life’s Principles directly influenced the business strategy and the creation of a sustainable business model.

## 7.2 Cross Case Analysis

This section provides a cross case analysis of the case results presented in section 7.1. Cross case analysis is of high importance to identify differences and similarities, discover patterns, and to draw conclusions. Section 7.2.1 provides a detailed cross case analysis of the Four Phase Model assessments. In section 7.2.2 a detailed cross case analysis of the elements of Successful Sustainable Business Model assessments is given. And section 7.2.3 provides a detailed cross case analysis of the Eight Archetype Model assessments. Section 7.2.4 presents a cross case analysis of the impact of biomimicry on the sustainability of business models. And finally, section 7.2.5 provides a combined analysis of all conducted cross case analyses.

Table 52 provides a summary of the above presented results regarding the type of company, whether or not they use the Life's Principles, and the level on which they applied a biomimicry design approach. This information is crucial when cross analyses are made, and the table functions as reminder for the reader.

**Table 52 Summarization company type, use of Life's Principles and the level of biomimicry design approach**

Company	Company type	Life's Principles	Level
1	Start-up	×	Product
2	Established	✓	Product, and System
3	Established	✓	Product
4	Established	✓	Product, Process and System
5	Start-up	×	Product
6	Established	✓	Product and Process
7	Established	×	Product
8	Start-up	×	Product
9	Established	×	Product and Process
10	Start-up	✓	Product, Process and System
11	Start-up	×	Product and Process
12	Start-up	✓	Product level
13	No company		
14	Start-up	✓	Product, Process and System
15	Start-up	✓	Product, Process and System

The interviews data indicated that 8 out of the 14 companies embedded the Life's Principles from nature within their business decisions, strategies and business models. 4 out of these 8 companies are start-up companies, and the other 4 companies are already established companies. This indicates that both start-ups and established companies are able to implement the Life's Principles. The remaining 6 companies did not use the Life's Principles. Another indicator kept in mind during the analysis is the level of biomimicry practiced by the companies as can be seen in

Table 52. 6 companies apply biomimicry on product level (1,3,5,7,8,12) of which company 3 and 13 use the Life's Principles. 3 companies apply biomimicry on product and process level (6,9,11) of which company 6 uses the Life's Principles. Company 2 applied biomimicry on product and system level and uses the Life's Principles. And finally 4 companies apply biomimicry on product, process and system level (4,10,14,15), these 4 companies all use the Life's Principles. Based on the data in table 52 three different groups can be identified; businesses that use Life's Principles on all levels, businesses that use Life's Principles on product and or process level, and businesses that do not use the Life's Principles.

### 7.2.1 Four Phase Model

This section analyses the overall assessments of the Four Phase Model of Sustainable Entrepreneurship. This model has eight variables that each will be described briefly in this section. In general, the difference in scores of start-up and established companies on the Four Phase Model is small. On average start-up companies score positive on 5,8 out of the 8 constructs of the proactive phase, and established companies scored positive on 6,2 out of 8 constructs. The difference in scores between businesses that use the Life's Principles and businesses that do not use Life's Principles is bigger. On average companies that use the Life's Principles score positive on 6,6 out of the 8 constructs of the proactive phase, and companies that do not use the Life's Principles score positive on 5,2 out of the 8 constructs. When the levels on which biomimicry is applied are taken into account there is a difference in average scores between businesses that apply biomimicry just on product level (4,8 out of 8), on product and process level (6,67/8), on product and system level (7/8), and on product, process & system level (7/8). This analysis indicates that businesses that apply a biomimicry design approach on multiple levels score positive on more constructs than businesses that only apply biomimicry on product level. And businesses that use the Life's Principles score positive on more constructs than businesses that do not use the Life's Principles. The radar graph of the Four Phase Model is presented in Figure 34.

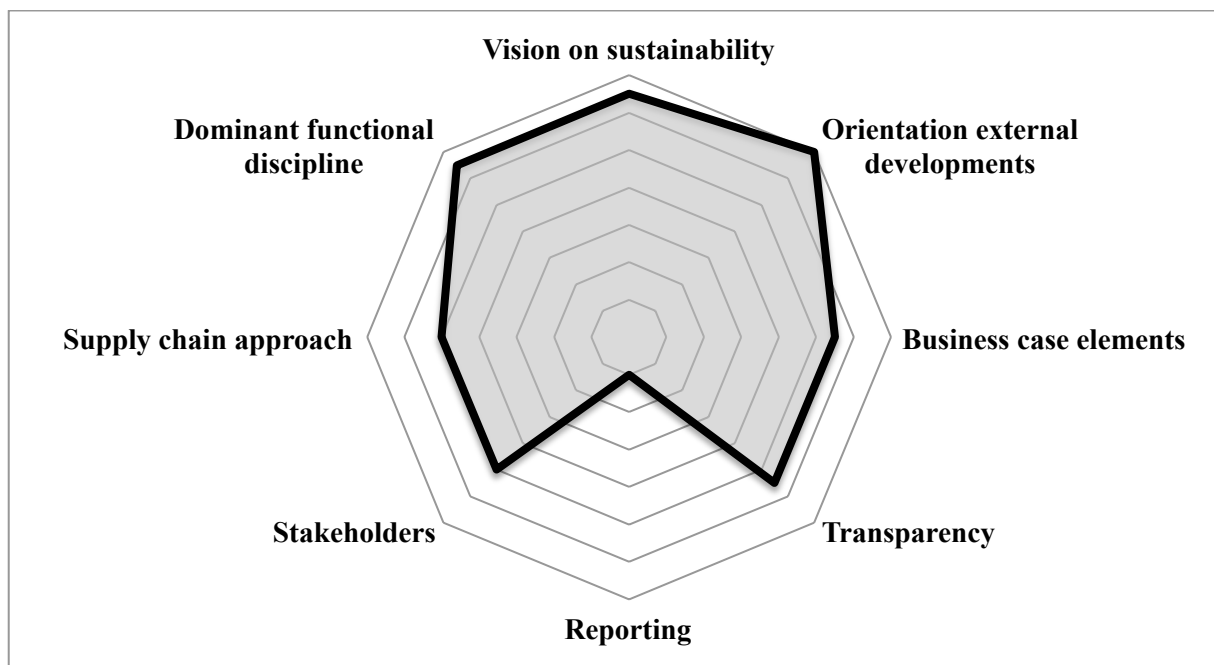


Figure 34 Radar Graph of Four Phase Model constructs

Comparisons of the data from the included cases exposed that the businesses can be classified in three groups based on the scores on the Four Phase Model. Company 2, 4, 6, 10, 11, and 15 have a proactive approach towards sustainability. These companies all score positive on 7 or 8 of the eight constructs. The companies that score 7 out of 8 only lack a positive score on the reporting construct. Overall, companies scored low on this construct as can be seen in the radar graph of the Four Phase Model in

Figure 34. Only company 4 and 9 scored positive on this construct. The other companies do not see the use of a sustainability report; some claim that it is too costly and that it takes too much time, others claim that they are not obligated to have any since they are too small. Out of the companies in the proactive phase only company 11 does not use the Life's Principles. All companies in the proactive phase apply biomimicry on more than one level.

Furthermore, it could be indicated that company 1,3,5,9,12 and 14 are on their way towards the proactive phase but that they are currently more in an active phase towards sustainability. Out of these 6 companies only company 9 and 14 applied a biomimicry design approach on more than just product level and company 3, 12 and 14 use the Life's Principles. Out of the companies in the active phase only company 9 scored positive on the reporting construct. In addition, the companies lack the supply chain approach construct (1,3), the dominant functional discipline construct (5), the business case element construct (9), the stakeholder construct (9, 12), and the transparency construct (12,14). It should be noted that 5 out of the 6 companies in the active phase are start-up companies, and van Tilburg et al., (2012) indicated that businesses need to grow and develop over time in order to get in the proactive phase. Time will reveal whether or not these companies will eventually be classified in the proactive phase.

Company 7 and 8 score positive on the least constructs of the proactive phase. Both companies only scored on 3 constructs. The companies both stated that sustainability is not a part of their current business model. This might provide the explanation for why they score lower than the other companies. The results of company 9 also showed that sustainability is not a part of their current business model, however they score on more constructs of the proactive phase as well as the elements of a successful sustainable business model and the Eight Archetypes in comparison to company 7 and 8. One explanation for this outcome could be that sustainability is actually unconsciously part of the business model of company 9. These data indicate that company 7 and 8 are not in the active or proactive phase of the Four Phase Model. Company 7 and 8 can be classified in the reactive phase of the Four Phase Model of Sustainable Entrepreneurship since they do include sustainability within their product designs and products. In the inactive phase of the Four Phase Model businesses do not try to integrate sustainability whatsoever.

Next brief cross case analysis for all eight constructs of the Four Phase Model are given and findings are supported by examples provided during the interviews. Summarizing tables for each construct are provided to present and categorize the different responses that resulted in positive scores.

### Vision on Sustainability

All businesses noticed growing sustainability awareness among society, and have a holistic and strategic view on sustainability except from company 7. All start-ups indicated that they founded the companies based on their vision on sustainability. They wanted to offer more sustainable solutions and contribute to solving global challenges: *"Sustainability is of high importance for everyone. The agricultural sector is not taking responsibility for their mass use of water. Water scarcity causes a lot of problems for the environment and society. Therefore, I wanted to tackle this by finding an innovative solution to grow plants and trees with 90% less water."* And analysis revealed that the included established companies grew or intensified their vision on sustainability over time: *"We notice that sustainability becomes more and more important at our company. A lot of different programs are developed by the head quarter related to sustainability. Our clients become also more aware of sustainability and start demanding sustainable packages for example. Together with our clients we both try to become more sustainable."* Table 53 provides a summary of the cross case analysis of the vision on sustainability construct.

**Table 53 Summary of the cross case analysis of the vision on sustainability construct**

Total positive scores	N=13
Start-ups	Have vision on sustainability from the start
Established companies	Grew or intensified their vision on sustainability



	over time
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### Orientation External Developments

The case results showed that all companies are responsive towards events and developments in society. Some companies are responsive towards external developments since they noticed that current practices are unsustainable (1,2,3,4,5,7,8,11,14,15): *“Right from the start we have tried to counteract the problems in society caused by the linear take-make-waste economy by focusing on closed cycles and our footprint.”* Other companies are responsive towards events and developments in society because they want to secure their future-proofness (2,4,6,9,10,12,14,15). These companies want to keep up with new developments, information, practices, techniques etc. that guides them during decision making processes: *“We are really responsive towards external developments. A lot is happening at the moment and developments go fast. We want to be able to keep up with all developments. We also keep track on developments regarding artificial intelligence and big data. But also the development of changing technological jobs is something we are responsive towards.”* The companies that indicated that they are responsive in both ways (2,4,14,15) all use the Life’s Principles. Table 54 provides a summary of the cross case analysis of the External Developments construct.

**Table 54 Summary of the cross case analysis of the External Developments construct**

Total positive scores	N=14
Notice that current practices are unsustainable	N=10
Secure future-proofness	N=8
Responsive in both ways	N=4 (all use Life’s Principles)





### Business Case Elements

As results in section 7.1 revealed, only company 7,8 and 9 did not score positive on this construct. However, based on the other scores of company 9 it could be argued that sustainability did become part of their business model, but that not everyone within the company is aware of it. The businesses that use the Life's Principles indicated that the principles provided guidelines to create their business case elements: *"We applied nature's patterns in our business model with the help of the Life's Principles. Since sustainability is our main focus it is integrated in our whole business model."* In all included businesses sustainability is embedded in the product part of their business case, however for businesses to score positive on this construct sustainability must be incorporated in more than just the products offered. Table 55 provides a summary of the cross case analysis of the Business Case construct.

**Table 55 Summary of the cross case analysis of the Business Case construct**

Total positive scores	N=11
Life's Principles guided sustainable business case creation	N=8

### Transparency

It could be argued that all included companies are transparent in some way; as they all shared their information with the author of this research. Some companies indicated that they are not proactively sharing information regarding their sustainability, but that they are willing to share this information with everyone who asks (1,2,3,5,6): *"We are totally transparent. Everyone who wants to know what is in our product will get answers."* Other companies proactively share information regarding their sustainability on their websites (4,7,9,10,11,15): *"We do not have any secrets, we even try to share our ideas with other because we want water to be used way more efficient globally. We hope that we can help society and nature with our ideas and therefore we share them with everyone. The information we provide is very transparent, our website is even available in 16 languages."* Company 8 and 14 want to have a successful running business before they start focusing on the transparency construct: *"Transparency and reporting does not have our priority at the moment. Those are things you do when you have a lot of money and a lot of time. Our main priority is to sell our products."* Company 12 deliberately decided not to be transparent in order to prevent having to spend money on patents: *"We do not want to spend a lot of time and money on applying for patents and therefore we are secretive about what we are doing."* Table 56 provides a summary of the cross case analysis of the Transparency construct.

**Table 56 Summary of the cross case analysis of the Transparency construct**

Total positive scores	N=11
Proactively sharing information on website	N=6
Not proactively sharing information, but willing to provide when someone asks	N=5
Deliberately not transparent	N=1
Want to focus on transparency in the future	N=2

### Reporting

As assessments in section 7.1 showed, only 2 companies score positive on this construct (4,9). These companies are both multinational established companies. Three start-up companies indicated that they aspire to apply for b-corporation certification in the future, and that they want to focus on this construct in the future (12,14,15): *"We are trying to make life cycle assessments, but as right now we are just beginning the production and understanding how the system is going to be manufactured and so on, we have not been able to assess this. But it is definitely in the road map. We want to develop life cycle analysis because we want to get the b-corp certification."* The other companies do not aspire to create a sustainability report in the future. Table 57 provides a summary of the cross case analysis of the Reporting construct.



**Table 57 Summary of the cross case analysis of the Reporting construct**

Total positive scores	N=2
Want to focus on reporting in the future	N=3
Do not aspire to focus on reporting in future	N=9

### Stakeholders

Most of the included companies have a higher goal, which is beneficial for society and not just for the companies themselves. Some companies use their products as a way to reach these higher goals (1,4,5,6,11,14): *“We provide energy savings, resistance reduction and contribute to social sustainability.”* Other companies are more focused on sharing knowledge and ideas to create awareness in order to let society benefit (2,3,4,10,15): *“We want to give our stakeholders, and society the right tool to be able to put all knowledge information and solutions together to connect solutions and power perspectives. We want that everything including nonhumans become part of the conversation table and connect solutions around it.”* Table 58 provides a summary of the cross case analysis of the Stakeholder construct.

**Table 58 Summary of the cross case analysis of the Stakeholder construct**

Total positive scores	N=10
Use products to create benefits for society	N=6
Sharing knowledge and ideas to create awareness in order to let society benefit	N=5
Create benefits for society in both ways	N=1

### Supply Chain Approach

Some of the included companies collaborate with their suppliers in order to find sustainable materials to use in their products (1,2,12,14): *“Our supply chain defines the sustainability of our products so collaborating with them is very important. For example with our 3-d printing suppliers we are also trying to reduce the volume of the product so that we use less materials. Our suppliers help us in the development and of course also keeping our sustainability approach.”* Company 4 and 9 try to make their supply chain more sustainable by letting their suppliers think about their own sustainability: *“We try to incorporate our whole supply chain in the journey of becoming more sustainable. We noticed that is possible to ask your suppliers to become more sustainable. And right now our suppliers collaborate with us to create bio-based alternatives and they invest in closed water systems and renewable energy. The supplier’s notice that they need to invest at first, but that the investments pay back in the end. Together we need to create a sustainable supply chain.”* Other companies focus more on creating sustainable projects with their supply chain (2,10,11): *“My supply chain knows that I am a sustainable architect and together we try to create sustainable projects.”* And other companies try to make their clients more sustainable with the help of their entire supply chain (5,6,9,11,15): *“The impact of our machines is really noticeable at the mass production companies; together with them we need to make production processes more sustainable. However, it is hard for big mass production companies to make the change towards more sustainability. They all want the change but it is hard to put it in practice and we want to support them by offering our more sustainable products to them. This makes it easier for them to start making changes towards more sustainability.”* Table 59 provides a summary of the cross case analysis of the Supply Chain Approach construct.

**Table 59 Summary of the cross case analysis of the Supply Chain Approach construct**

Total positive scores	N=10
Make clients mode sustainable with help of entire supply chain	N=5
Collaboration to find sustainable materials	N=4
Creating sustainable projects with supply chain	N=3
Let suppliers think about their own sustainability	N=2



### Dominant Functional Discipline

All companies recognize that they can improve their businesses and become more sustainable in the future. Most companies created strategies or visions related to future sustainability, except from company 5. All visions and strategies of company 5 are focused on creating a strong core business based on stabilisers: *“We notice that our clients value sustainability more and more, and we want to keep innovating on that side. But before we are able to do this we first need to create a strong core business based on the stabilisers.”* Some companies focus their visions and strategies on making their products more sustainable (1,2,4,7,11,12,14): *“There is always room for improvement. We continuously want to improve and become more sustainable. All our designs are more sustainable than the previous ones. We are not really focused on growth and profit; we are more content driven. Spreading system thinking is our goal.”* Other companies focus their vision and strategies more on making their future business operations more sustainable (3,6,9,12,14,15): *“I believe that our company is ready to take a step to the next level. We are trying to find ways to incorporate the Sustainable Development Goals within our practices. We want to make those goals leading during our decision-making processes and our practices.”* Some companies go even further and aspire to create sustainable systems in the future in which society comes in balance with ecosystems (2,4,10,15): *“We want to find balance between humans and nature. “Whenever we see an opportunity we will move.”* The companies with this aspiration all use the Life’s Principles. Table 60 provides a summary of the cross case analysis of the Dominant Functional Discipline construct.

**Table 60 Summary of the cross case analysis of the Dominant Functional Discipline construct**

Total positive scores	N=13
Make their products more sustainable	N=7
Make business operations more sustainable	N=6
Create sustainable systems to balance society and ecosystems	N=4 (all use Life’s Principles)

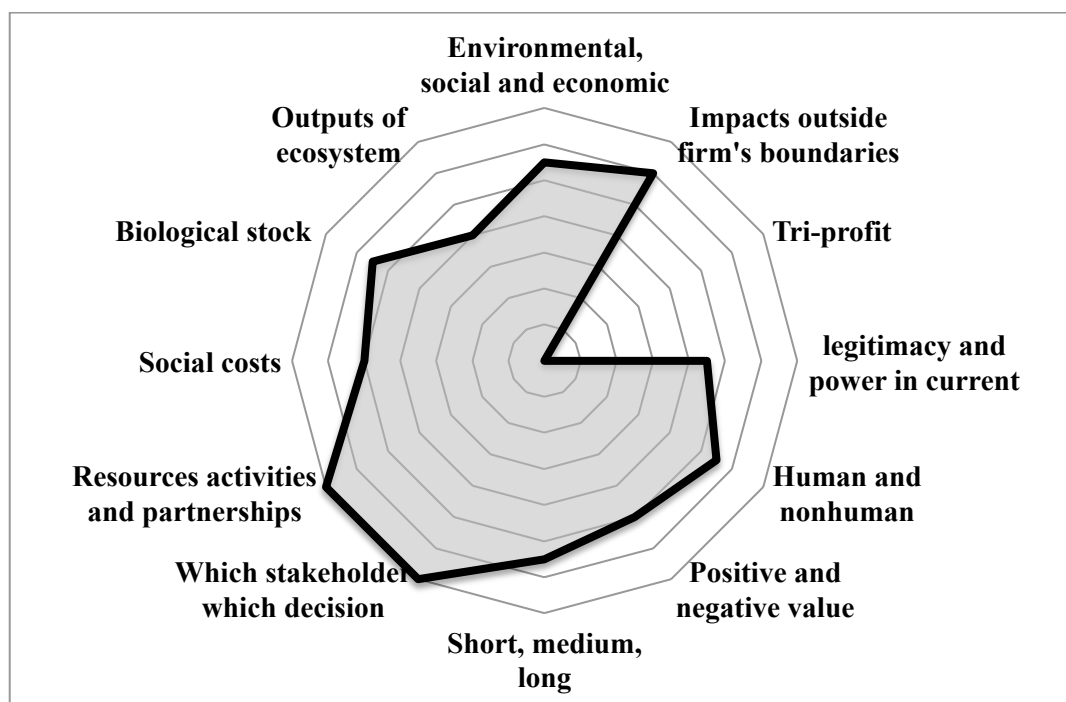
Based on this cross case analysis some patterns can be identified. The more businesses focus on sustainability and implement sustainable practices, the more proactive they are. And proactivity causes businesses to embed sustainability in their business models, and thus supports the creation of sustainable business models. Businesses that use the Life’s Principles have a higher chance to be in the proactive phase and the same applies to businesses that apply a biomimicry design approach on more than one level.

### 7.2.2 Elements of Successful Sustainable Business Models

This section analyses the overall assessments of the fulfilment of the elements that define a Successful Sustainable Business Model. This model has 12 variables divided in 4 categories that each will be described briefly. In general, the difference in positive scores of start-up and established companies on the different elements is small. On average start-up companies score positive on 8,5 out of the 12 elements that identify a successful sustainable business model, and established companies score on average positive on 8,8 out of 12 elements. The difference in scores between businesses that use the Life’s Principles and businesses that do not use Life’s Principles is bigger. On average companies that use the Life’s Principles score on 9,9 out of the 12 elements that identify a successful sustainable business model companies that do not use the Life’s Principles score on average on 7 out of the 12 elements. When the levels on which biomimicry is applied are taken into account (without distinguishing between Life’s Principles and no Life’s Principles) there is a difference in average scores between businesses that apply biomimicry just on product level (6,5/12), on product and process level (10,33/12), on product and system level (10/12), and on product, process & system level (10,25/12). This analysis reveals that businesses that apply a biomimicry design approach on multiple levels score positive on more elements than businesses that only apply biomimicry on product level. And businesses that use the Life’s Principles score positive on more elements than businesses that do not use the Life’s Principles. The radar graph of the Elements of Successful Sustainable Business



Models as presented in Figure 35 provides an overview of how the participating companies scored on the twelve different elements.



**Figure 35 Radar Graph of elements of Successful Sustainable Business Model**

Comparisons of the data from the included cases exposed that the businesses can be classified in three groups based on the fulfilments of the elements identifying a Successful Sustainable Business Model. The first group exists of companies that fulfil almost all elements of a successful sustainable business model (2,4,6,9,10,11,12,14,15). All these companies lack the fulfilment of the tri-profit measurement element and some of them lack one other element. None of the companies mentioned that they measure social value. And only company 4 measured the ecological values and impacts of their products and display this in product declarations. The companies indicated that it simply is too hard and complicated to measure social and ecological values and that they lack the required data. The business models of all these companies show successful sustainability characteristics. In this group company 9,12, and 14 are in the active phase of the Four Phase Model, while the other companies are in the proactive phase. Company 9 and 11 are the only companies in this group that do not use the Life's Principles.

Companies that have semi-successful sustainable business model characteristics form the second group. Company 1,3, and 5 are all in the active phase of the Four Phase model and all fulfil eight elements of a successful sustainable business model. Since they are not in a proactive phase yet, the other elements might be fulfilled once the businesses move to the next phase.

And finally company 7 and 8 form the third group. Both companies only fulfilled 3 elements of a successful sustainable business model; which indicates that they have an unsuccessful sustainable business model. The assessments of the Four Phase model revealed that these companies have traditional business models instead of sustainable business models; therefor comparing the business models to the elements of successful traditional business models should indicate the successfulness of this group.

Next brief cross case analysis for all four categories and its elements are given and findings are supported by examples provided during the interviews.

### Boundaries and Goals Category

The first insights coming from the cross case analyses is that none of the businesses focused on the tri-profit elements included in this category. Overall, businesses see their economic goals as necessary resource in order to achieve and create social and environmental values: *“Profit is a necessary resource in order to sustain, and a lot of social enterprises are too focused on the social and ecological goals and go bankrupt since they forget about the economic goals.”* And: *“Money is a tool necessary in order to achieve our higher sustainable goals.”* It should be noted that the start-up companies indicated that they should have stable economic values before their business models can have any social and/or environmental impact. Most start-ups blamed the current economy for this, without those economic values they are not able to survive in the current linear take-make-waste economies. Out of all the start-up companies only company 14 created clear plans of how to measure their social and economic values in the future. Aside from company 7 and 8 all companies wanted to generate social, environmental and economic impacts outside the firms boundaries. Examples of impact that companies have or desire to achieve mentioned during the interviews are: decrease fuel consumption, increase working conditions, tackle climate change, implement system thinking, stimulate life long learning, be an example to others, cause a revolution in current industries, provide learning and development opportunities, increase animal welfare, create a network/community, enable people to make profit, create awareness, co-development etc. Company 6 compared the boundaries and goal category with nature: *“We are successful if we can guarantee continuity. From a biomimicry viewpoint you can compare this with nature; something that survives.”* Nature creates social, environmental, and economic values and impacts other systems. Based on the provided answers related to this category the companies can be divided in three groups again.

Some companies defined their social, environmental and economic goals in detail and build their business practises, processes and mind-sets around the social and environmental goals and impacts (2,3,4,6,10,11,12,14,15). All these companies started their responses during the interviews with social and environmental goals and impacts before they mentioned more economic goals. It should be noted that all these companies use the Life’s Principles except from company 11. The second group that can be characterized exists of companies that do have social and environmental goals and impacts but their business practises, processes and their mind-sets are not completely focused on them (1,5,9). For these companies their first responses towards the question when their businesses would be successful were all related to making profit and becoming a big market player, their social and environmental goals came later: *“I would say that the business is successful once we have 5% market share.”* And *“We want to become a big market leader in the field of stabilisers.”* And *“We are a commercial organisation, so we are successful when we achieve our commercial goals”*. The third group consists out of company 7 and 8, their goals and impacts are only related towards economic values: *“We are very successful when products all over the world are modified by using tubercles shapes. It is happening more and more, we have products in China, the US, Canada and Europe. We already have a big market.”* And *“The company is successful if we reach a certain revenue goal each year. In the long run we want to capture a certain part of the market”*.

### Stakeholders Category

The included companies identified the following main stakeholders: Consumers, Legislators, Government, Environment, Clients, Nature, Systems, Shareholders, Everyone, Everything, Supply chain, Manufacturers, Owner and Co-owner, Suppliers, Bank, Market, Employees, Local Community, Commissioners, Humanity, Horses, Supporting Organisations, and Experts. The mentioned stakeholders are human as well as nonhuman. All companies except from company 5,7 and 8 identified nonhumans, like nature and ecosystems, as their main stakeholders. These 3 companies mainly see themselves and their customers as main stakeholders: *“I am the main stakeholder of this business. In addition my financial partner is also a stakeholder. We try to understand the demands of the customers and base our prices on the willingness of the customers. I do not include ecosystems or the like.”* Especially company 2,4,6,9,10,11,12,14 and 15 proactively engage their stakeholders, including nonhumans, in focal processes of the organization. In order to be successful businesses should consider the current as well as the future legitimacy and power of their stakeholders. Only 9 out of 14 businesses are currently doing this. Company 14 explained why is important to also consider





the future power and legitimacy of stakeholders: *“Our stakeholders can empower us, and therefore it is important to take their future power into account.”* Company 15 added: *“We consider the future legitimacy and power of our stakeholders, because they are important in our growth process.”* All companies that use the Life’s Principles score positive on both elements of this category, except company 3 they do not consider the legitimacy and power of their stakeholders in the future. In addition, company 1,9 and 11 score positive on both elements as well. And again, it can be concluded that company 7 and 8 do not fulfil the Elements of a Successful Sustainable Business Model for this category.

The included companies can be divided into three groups based on their answers related to these elements. The first group include company 2,4,6,9,10,12,14,15. These businesses fulfil both elements of success in this category, and proactively include their stakeholders in focal processes. The second group that can be identified consists out of company 1,3, and 11. These companies all score on 1 or 2 of the elements but are not on the same level as the first group of companies. Company 1 does not proactively engage its stakeholders; and company 3 and 11 do not consider the future state of their stakeholders. Company 5,7 and 8 form the last group, they all do not fulfil the Elements of a Successful Sustainable Business Model for this category.

### **Value Proposition Category**

From the analysis in the Boundaries and Goals category could be derived that most of the companies, except from companies 7 and 8, focus on social and environmental values but that they do not measure the impact. These social and environmental values can also be found in the, by the included companies provided, value propositions. 10 out of the 14 included cases indicated that they are aware that they also generate negative value. Almost all these 10 companies mentioned that they try to reduce their negative value generation, however they justify their negative value generation by mentioning that they already generate less negative value than other businesses in their industries: *“I think that as little footprint that we will be generating by producing our products will be redeemed with environmental services that we are offering.”* Only company 4 and 9 put values on their negative value generation. Company 4 creates product declarations, describing all positive and negative value generated during the production and use of the different products. And company 9 studies what the social impact of moving a factory has on the local community and decision about relocation depends on outcomes of these studies. Company 5,6,10 and 12 emphasised on the fact that they are aware that the industries and markets they work in and serve are not sustainable and generate a lot of negative value. However, they still want to serve these industries and markets, just to show how it can be done in a more sustainable way. Especially, company 5 and 12 understand that in a sustainable world there should not be such things as pleasure yachts and race horses, however since they do exist the companies mentioned that they will try and make those unsustainable industries more sustainable: *“Yachts will never be sustainable, since they are used for pleasure, we try to make them a bit more sustainable by increasing the energy efficiency. And to be honest whole economies rely on the pleasure yacht industry, losing the pleasure yacht will also cause a lot of social damage.”* In general, the included businesses could fulfil the positive and negative value generation element in more detail. All businesses are able to give their positive value generations easily, however when asked about negative value generation the businesses became less detailed in their answers and the interviewees had to dig deep. In addition, it is important that businesses consider short, medium and the long run in their value propositions. Company 2,8 and 10 indicated that they only focus their value proposition on the here and now, and that they did not create any strategy for the future. This does not indicate that all other companies focus their desired future value proposition on sustainability. The long-term sustainability visions and strategies are elaborated upon in the Dominant Functional Discipline construct of the Four Phase Model of Sustainable Entrepreneurship. The long run considerations of company 1,3,4,6,7,9,11,12,14 and 15 are in varying degrees focused on sustainability; where company 11 is talking about creating a whole revolution in the agricultural sector company 12 talks about investigating whether their products could also be used in other industries and sectors.



### Firms' Processes Category

All included cases have a clear overview of which stakeholders get to make which decisions and the influence of certain stakeholders on the processes. Company 2 for example stated: *"Eventually the client, and the budget of our clients determines the sustainability of the materials."* In addition, all included companies indicated that all resources, activities and partnerships related to their processes are focused towards achieving their value propositions. Company 3 for example mentioned: *"We try not to make an easy decision for the company; if we have to buy some equipment you know we try to not make an easy decisions but make a decisions which is environmentally aware as possible. We try to promote energy efficiency so we have to also put our money where our mouth is."* However, not all decisions regarding resources, activities, and partnerships are related to sustainability. Company 1,2,3,4,10,11,12,14 and 15 indicated that sustainability is always a weighing factor in deciding upon which materials to use. Besides sustainability, functionality, efficiency, mechanical properties and esthetical properties are mentioned as weighing factors. Company 4, 10 and 12 test the sustainability of the materials; company 4 and 10 make life cycle analysis, and company 12 created a red list of unsustainable materials they do not want to use in their products. Company 5,6 and 9 explained that their decisions regarding the use of materials are sometimes based upon sustainability, however functionality had the main priority. Company 8 produces most of their used materials themselves, which are sustainable and non-scarce. However, the materials that they do not source themselves are not analysed on sustainability. Company 7 also does not focus on sustainability when deciding upon materials. Company 1,2,4,5,6,9,10,11,14 and 15 focus their activities related to product design and (manufacturing) processes on sustainability. These companies for example create closed-water systems, have circular products and processes, use 3-d printing, are focused on the Sustainable Development Goals, measure impact on other systems etc. In regard to partnerships, company 1,4,5,10,12,14 and 15 elaborated upon the fact that a lot of their partnerships are based on sustainability factors like: locality, social sustainability, decentralization, and located in the European Union. However, it should be noticed that included companies often experienced that they are unable to influence the sustainability of their partners, and that there are no sustainable partners available: *"It is hard to influence the decisions of our technical manufacturers, they provide us with standard technical materials and we cannot influence their sustainability."* And *"In the paper pulp industry there is less innovation and less sustainability. We cannot really influence this."*

Social costs of processes are taken into account in multiple ways. The included companies gave the following examples: create safer and better working conditions, refuse the use of materials that cause social trouble, design products and processes that contribute to the Sustainable Development Goals, focus on employee engagement, design processes in such a way that products become affordable to everyone, focusing on decentralization, create job/study opportunities etc.

The worlds biological stock is not infinite therefore it is important that companies take scarcity into account during their processes. At this moment company 2,3,4,5,6,8,9,10,11,12, and 14 consider scarcity. Company 5 and 11 specifically mentioned that scarcity is translated into price, so that they consider it since scarcity has an economic impact: *"Scarcity can be translated into price, and since we want our cost price to be as low as possible we definitely take scarcity into account."* On the other hand company 6 indicated that alternatives for scarce resources, like 3-d printing, are still very expensive which makes it hard to substitute for the scarce resources. And company 2 indicated that non-scarce alternatives are not always available: *"Sometimes there is no sustainable substitute for building materials."*

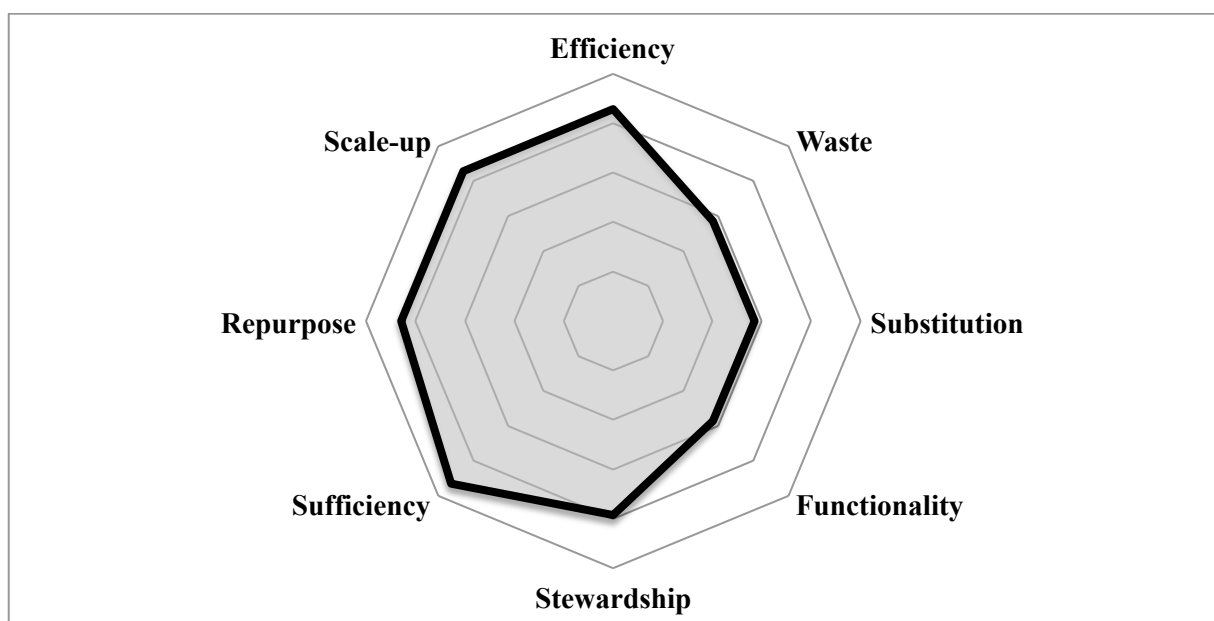
Only 8 included companies incorporate the use of ecosystem services, like sunlight, wind, and water streams, within their core business model. These businesses try to use ecosystem services in a sustainable way and these services contribute to the achievement of the economic, social and economic goals of the companies. The use of ecosystem services is a sustainable alternative to for example the use of oil or gas, use of ecosystem services does not mean depletion of those services. Of course oil is also an ecosystem service; however the way it is being used right now is not sustainable. Company 2 and 10 for example try to include ecosystem services into their building designs. In this way the buildings can benefit from the water, wind and light systems in the environment. And other



products re-use rain and condensation water, use biomaterials, use renewable energy etc. Company 5 considers fulfilling this element in the future, by recovering energy from water streams. However, it should be noted that the included cases in general should consider this element in more detail in order to be successful. Fulfilling this element, by making use of/re-using ecosystem services and systems will make their business models more sustainable.

### 7.2.3 Eight Archetype Model

This section analyses the overall assessments of the Eight Archetype Model. This model has eight constructs that each will be described briefly in this section. In general, the difference in positive scores of start-up and established companies on the Eight Archetypes is small. On average start-up companies score positive on 6,1 out of the 8 archetypes, and established companies on average score positive on 5,8 out of 8. The difference between companies that use and do not use Life's Principles is bigger. On average companies that use the Life's Principles score positive on 7,1 out of the 8 archetypes, and companies that do not use the Life's Principles score positive on 4,5 out of the 8 archetypes. If the levels on which biomimicry is applied are taken into account there is a difference in average scores between businesses that apply biomimicry just on product level (4,3/8), on product and process level (7/8), on product and system level (7/8), and on product, process & system level (7,5/8). This analysis indicated that businesses that apply a biomimicry design approach on multiple levels score positive on more archetypes than businesses that only apply biomimicry only on product level. And businesses that use the Life's Principles score positive on more archetypes than businesses that do not use the Life's Principles. The radar graph of the Eight Archetypes results as presented in Figure 36 Provides an overview of how the participating companies scored on the eight different archetypes.



**Figure 36 Radar Graph of Eight Archetypes Model**

Comparisons of the data from the included cases exposed that the businesses can be classified in three groups based on the positive scores on the Eight Archetype Model. Based on their high positive scores company 2,4,6,9,10,11,12,14 and 15 are grouped together. These companies operationalize sustainability in 7 or even 8 different ways within their business models. Of these companies company 9 and 11 are the only companies that do not use the Life's Principles. And company 9,12, and 14 are the only companies in the active phase of the Four Phase Model.

Company 1,3 and 5 all operationalize sustainability in 5 ways, therefore these companies together form the second group. Company 3 is the only company out of these three that used the Life's Principles. And all three companies are in the active phase of the Four Phase Model.

Again, company 7 and 8 have the least positive scores, therefore they are grouped together. Both companies focus on efficiency, and company 8 is also focused on sufficiency. It should be noted that these three group classifications consist out of the exact same companies as the groupings made for the elements identifying a successful sustainable business model.

Next brief cross case analysis for all eight archetypes are given and findings are supported by examples provided during the interviews. Summarizing tables for each archetype are provided to present and categorize the different responses that resulted in positive scores. It should be noted that some companies operationalize one archetype in more than one way.

### Maximizing Material and Energy Efficiency

Company 11 is focused on material efficiency. In addition, company 1,7, and 8 are focused on energy efficiency. And the cross case analysis indicated that most companies operationalize material as well as energy efficiency: (3,4,5,6,9,10,12,14): *“That is our whole focus. So if we can use less materials that have the same impact, or we can use less energy that have the same impact that is exactly where our designs are based on.”* It should be noted that company 2 and 15 both do not focus on the efficiency archetype, while they do use the Life’s Principles. All other companies that use the Life’s Principles focus on material as well as energy efficiency. Adding to this multiple companies indicated that they learned the efficiency from nature (3,5,6,7,10,11,14): *“We also use topological design, which means that we only use materials where necessary just like trees and bones.”* The included companies differ in what they make more efficient: some companies create more efficient products (1,3,5,7), company 8 focused on more efficient processes, while other companies focus on both (4,6,9,10,11,12,14). Table 61 provides a summary of the cross case analysis of the Efficiency archetype.

**Table 61 Summary of the cross case analysis of the Efficiency archetype**

Total positive scores	N=12
Material and Energy efficiency	N=8
Energy efficiency	N=3
Material efficiency	N=1
More efficient products and processes	N=7
More efficient products	N=4
More efficient processes	N=1

### Creating value from Waste

At this moment 6 companies do not focus on this archetype, however company 1,7 and 9 indicated that they are planning to operationalize this archetype in the near future: *“Not at this moment. But we plan on doing so in the future. We want to recycle the wraps and use recycled materials during the production process.”* The results indicated that some companies create value from waste by using recycled materials to produce their products (2,10,14,15): *“I am always looking for recycled materials to use in my designs. If it would be possible my designs would consist completely out of recycled materials.”* Company 6 creates value from waste by recycling their own products: *“We refurbish old machines, so our clients can bring in their machine and we place the new technology in the old frames.”* And results showed that other companies use recycled materials and recycle their own products (4,11,12): *“We recycle nylon fishing nets to produce our carpet tiles. But we also use recycled materials coming from a plastic coating interlayer of car windows. In addition, we are focused on the circularity of our products; the carpet tiles are being re-used.”* It should be noted that 2 companies mentioned that they create value from ‘non material waste’. Company 12 recycles their business plans when applying for funding, pitching their ideas, and speaking at events. Company 15 recycles information.



Table 62 provides a summary of the cross case analysis of the Waste archetype.

**Table 62 Summary of the cross case analysis of the Efficiency archetype**

Total positive scores	N=8
Use recycled materials during production	N=4
Use recycles materials and recycle own products	N=3
Create value from 'non material' waste	N=2
Recycle own products	N=1

### **Substitution with Renewables and Natural Processes**

This archetype can be divided into two ways of operationalization. The first way is operationalization of substitution in the products companies design/ manufacture (2,3,10,12,15): *"We try to make our technologies run on solar energy. This is not only beneficial for the environment, but a lot of stables also do not always have energy."* The second way is operationalizing substitution in the buildings and processing plants of the company (2,4,6,9): *"In this building in the Netherlands we use partly renewable energy from solar panels. A project group at our facility is proactively involved in making this building more energy efficient and use renewable energy sources."* Table 63 provides a summary of the cross case analysis of the Substitution archetype.

**Table 63 Summary of the cross case analysis of the Substitution archetype**

Total positive scores	N=8
Substitution in the products	N=4
Substitution in the buildings and manufacturing processes	N=3
Substitution in products and buildings and manufacturing processes	N=1

### **Deliver Functionality rather than Ownership**

Most companies that scored positive on this archetype operationalize this archetype by educating society. By providing education these companies hope to initiate a sustainability revolution at individuals, other companies and society. The businesses themselves are not seeking to financially benefit from it; they want to develop and create opportunities for others instead of being the primary value for everyone (2,9,10,11,15): *"We try to create a revolution in water usage by educating people about water usage, and creating awareness. And we provide videos showing how to grow plants and trees for free."* Other companies operationalize this archetype by providing their products as a service in order to have continuous feedback loops, and for maintenance purposes (4,12,14): *"We offer our systems as a service; we install the system and also offer service for maintenance and resource supply that our customers need, so they do not have to do anything. In the future we want to do crowd sourcing in order to provide our services all over the world."* In all other cases the buyers of the products become owner of the products and focus is on ownership. Table 64 provides a summary of the cross case analysis of the Functionality archetype.

**Table 64 Summary of the cross case analysis of the Functionality archetype**

Total positive scores	N=8
Providing education to initiate sustainability revolution	N=5
Providing product as a service	N=3

### **Adopt a Stewardship Role**

The assessments showed that businesses take responsibility for their actions processes and materials by focussing on biodiversity protection, biophilia, employing disabled people, creating opportunities, improving working conditions, making other industries and businesses more sustainable, and by focusing on the future-proofness of their businesses. Before conducting the interviews the author of this research was not familiar with biophilia. Company 10 and company 14 both did not only apply a

biomimicry design approach, they also applied biophilia: *“Biophilia is the belief that being in contact with nature is good and healthy for body and mind. I always incorporate this in my projects in order to create a relationship between human and nature.”* Company 1 adopts a stewardship role just by the product that they offer; the other companies operationalized this archetype in multiple ways and not just by their products. Three companies do not focus on adopting a stewardship role (3,7,8). Company 7 and 8 indicated that they are not interested in such a role, while company 3 indicated that they are unable to focus on it since it has been a struggle to just keep the company going. Table 65 provides a summary of the cross case analysis of the Stewardship archetype.

**Table 65 Summary of the cross case analysis of the Stewardship archetype**

Total positive scores	N=11
Operationalized by:	
<ul style="list-style-type: none"> <li>- Biodiversity protection</li> <li>- Incorporating biophilia</li> <li>- Employing disabled people</li> <li>- Creating opportunities</li> <li>- Improving working conditions</li> <li>- Making other industries and businesses more sustainable</li> <li>- Ensuring future-proofness</li> </ul>	

### Encouraging Sufficiency

The assessments revealed that multiple companies take sufficiency into account when deciding upon the used (raw) materials (2,3,4,8,10): *“The materials we use to produce the products are not scarce, and we cultivate a lot of those materials, like bamboo, ourselves.”* Other companies educate their customers about the lifespan of their products and how to use the products to expand the lifespan (1,5,6,9,14): *“We try to make mass production companies as sustainable as we can, and create machines with a long lifespan to reduce the need to produce new machines.”* Companies also operationalized this archetype by educating their supply chain about sufficiency (2,3,4,9,10,11,12,14): *“One of the things we are doing is educating people to make sure that they do not waste materials, or different parts of it. We also instruct the students about this, you do not want people just wasting stuff by buying more products than they need and having those products just laying around. We also inform or clients about this, we do not want to put too much technology in the stables because that might scare the horses.”* It should be mentioned that company 15 operationalizes sufficiency in a different way; they want to spend their energy sufficient. Energy is limited and by focussing all your energy on competing you are losing this energy. The best energy exchange between parties is through collaboration, so they mention you can use your energy sufficiently by focussing on collaboration. With the help of their tool they try to educate this towards the users. Adding to this, company 15 is the only company that indicated they learned sufficiency from nature. Table 66 provides a summary of the cross case analysis of the Sufficiency archetype.

**Table 66 Summary of the cross case analysis of the Sufficiency archetype**

Total positive scores	N=13
Educating supply chain about sufficiency	N=8
Educate customers about lifespan of products and how to expand lifespan	N=5
Take sufficiency into account when deciding upon (raw materials)	N=5

### Repurpose for society/Environment

Except from company 7 and 8 all included cases have more social and environmental goals besides making profit. Most of these companies indicated that profit is a necessary resource in order to pursue the social and environmental goals. Some companies have environmental goals (1,3): *“I really think that just the fact that our entire focus is on reducing energy use. It is all based on an environmental*





goal: it is to show the industrial world that you can save energy and save the environment and still have really excellent businesses.” Company 5 is more focused on social goals: “We noticed a lot of unemployment amongst disabled people and wanted to reduce the amount of unemployment by partnering with processing plants that do employee disabled people. In addition, the yacht industry is a good industry for us, however those boat are just designed for pleasure. In order to have a real social impact we really want our products to be used in the fishing industry since it can significantly improve the working conditions in this hard and dangerous industry.” Other companies pursue social and environmental goals (2,4,6,9,10,11,12,14,15): “Our goal is to counteract climate change. Furthermore we focus more and more on social goals that complement to our ecological goals.” Company 1 and 3 indicated that they pursue their non-economic goals just by the products they offer, the other companies pursue their social and environmental goals with the help of: their products, knowledge sharing, processes, collaborations, projects, education activities, approaches/thinking, and networks. Table 67 provides a summary of the cross case analysis of the Repurpose archetype.

**Table 67 Summary of the cross case analysis of the Repurpose archetype**

Total positive scores	N=12
Social and environmental goals	N=9
Environmental goals	N=2
Social goals	N=1
Pursue environmental and social goals with help of: their products, knowledge sharing, processes, collaborations, projects, education activities, approaches/thinking, and networks.	N=10
Pursue environmental goals with product	N=2

### Developing Scale-up Solutions

Assessments indicated that most of the included companies operationalize this archetype by crowd funding (1,3,5,11,14), collaboration (1,2,4,5,12,15) and open-innovation (4,6,9,10,11,14,15). In addition, company 4 and 14 use crowd sourcing as a way to operationalize this archetype: “We plan on creating a crowd-sourcing model. When cities all over the world use our systems we will not be able to install and maintain those systems ourselves, so we will give people the opportunity to do this service for us, and they will be paid.” Crowdsourcing was not one of the scale-up examples provided by Bocken et al., (2014), however the author decided to include this as an example of scale-up solutions as well. Table 68 provides a summary of the cross case analysis of the Scale-up archetype.

**Table 68 Summary of the cross case analysis of the Scale-up archetype**

Total positive scores	N=12
Open-innovation	N=7
Collaboration	N=6
Crowd funding	N=5
Crowd sourcing	N=2

### 7.2.4 Biomimicry Design Approach

This section analyses the overall assessments of the impact of a biomimicry design approach on the sustainability of business models. According to the included companies application of a biomimicry design approach can impact a business model since nature is sustainable (1,3,9,10,13,14,15), nature can be used as an idea generator (4,11,12,13,14), and nature can change the perspectives and mind-sets within businesses (2,4,6,10,12,13,15). Almost all companies that use the Life’s Principles, except from company 14 indicated that the application of a biomimicry design approach can create a certain type of sustainability mind-set and provide sustainability perspectives throughout the entire company which will be beneficial for the sustainability performance of a company. In addition, all companies that use the Life’s Principles indicated that the application of a biomimicry design approach directly influenced

the sustainability of their business model (4,6,10,12,14,15). While other companies indicated that using biomimicry indirectly or did not impacted the sustainability of their business model (1,2,5,9,11). None of the included companies felt restricted by the application of a biomimicry design approach. Some companies mentioned that they liked the guidance and direction the biomimicry design approach provided them (2,4,6,10,13,15). Other companies did not feel restricted since they do not have a fixed focus on just applying biomimicry as a design approach (1,3,9,11,12). This cross case analysis indicates that there is no reason for other companies to be hesitant towards applying a biomimicry design approach; since it only has been experienced as something positive.

### 7.2.5 Combined analysis

This section provides a final analysis of all conducted cross case analyses. Taken all assessments together resulted in the table as provided in Table 69. Table 69 summarizes the total scores of the included companies on the different models. For each model the two highest scores and the lowest scores are marked (highest are market yellow, lowest red).

**Table 69 Summary of all assessments**

Theme	Four Phase Model	Elements Successful Business Models	Eight Archetype Model	Company Type	Life's Principles
Company 1	6/8 Active	8/12 Semi-successful	5/8	Start-up	×
Company 2	7/8 Proactive	10/12 Successful	7/8	Established	✓
Company 3	6/8 Active	8/12 Semi-successful	5/8	Established	✓
Company 4	8/8 Proactive	11/12 Successful	8/8	Established	✓
Company 5	6/8 Active	8/12 Semi-successful	5/8	Start-up	×
Company 6	7/8 Proactive	10/12 Successful	7/8	Established	✓
Company 7	3/8 Reactive	3/12 Unsuccessful	1/8	Established	×
Company 8	3/8 Reactive	3/12 Unsuccessful	2/8	Start-up	×
Company 9	6/8 Active	11/12 Successful	7/8	Established	×
Company 10	7/8 Proactive	10/12 Successful	8/8	Start-up	✓
Company 11	7/8 Proactive	10/12 Successful	7/8	Start-up	×
Company 12	5/8 Active	11/12 Successful	8/8	Start-up	✓
Company 13	-	-	-	No company	
Company 14	6/8 Active	10/12 Successful	7/8	Start-up	✓
Company 15	7/8 Proactive	10/12 Successful	7/8	Start-up	✓



Just as for the cross case analyses made above, the companies can again be grouped in three groups based on the total scores. The first group includes company 2,4,6,10,11 and 15. These companies have the highest scores on all three assessed models. This group is in the proactive phase of the Four Phase Model, has successful sustainable business model characteristics and operationalizes sustainability in multiple ways. Company 10,11, and 15 are start-ups and company 2,4 and 6 are already established companies. Out of this group, company 11 is the only case that does not deliberately mention the use of the Life's Principles. In addition, company 11 is the only company in this group who does not experience biomimicry to have a direct impact on the sustainability of their business model; their sustainable business model characteristics arise from a sustainability approach in general. However, it might be possible that this general approach unconsciously includes the Life's Principles. All businesses in this group hope to create a revolution to change the current linear take-make-waste economies and industries. This group suggests that a new type of business generation is necessary in order to solve global challenges. According to this group, businesses and their solutions should not only be focused on being able to meet the needs of the next generation; focus should be on multiple more generations to come. Considering the use of Life's Principles it might be expected that company 3,12 and 14 should also be part of this group. However, although using the Life's Principles company 3 never scored highest on one of the models. Company 3 provided the underlying cause of this result during the interview: *"We do not base our business decision on the Life's Principles. We do base our operational decisions on the Life's Principles."* Company 12 and 14 both score highest on the Elements that identify a Successful Sustainable Business Model and the Eight Archetype Model and are start-up companies. Company 12 and 14 are still in the developing phase; this might explain why they are not in the proactive phase yet. Getting into the proactive phase is a gradual process, and company 12 and 14 might need more time to develop and grow before they are able to score high on the elements identifying the proactive phase towards sustainability.

Company 1,3,5,9,12 and 14 are classified as the second group. These companies do have visions and strategies towards sustainability, but do not score high on all three assessed models. Company 1,5,12 and 14 are start-up companies and company 3 and 9 are established companies. These companies are all in the active phase of the Four Phase Model. In addition, company 1,3, and 5 show semi-successful sustainable business model characteristics, while company 9,12, and 14 show successful sustainable business model characteristics. And company 1,3, and 5 operationalize 5 archetypes while company 9,12, and 14 operationalize 7 or 8 archetypes. Yet these companies are grouped together since moving towards the proactive phase will strengthen, and be beneficial for the sustainability of their business models. As mentioned company 3,12 and 14 use the Life's Principles, and the reasons why they are not included in the first group are provided above. All companies in this group are focused on applying biomimicry on product level, company 9 also applies it on process level and company 14 applies it also on process and system level. Results regarding the impact of biomimicry on the sustainability of their business model varied. Biomimicry directly influenced the sustainability of the products of company 1,3,5 and 9 and created an overall sustainability approach that impacted the rest of their business model, while biomimicry and the Life's Principles directly impacted the sustainability of the business models of company 12 and 14.

The third identified group consists out of company 7 and 8, which both scored lowest on all 3 models. This group does not have a vision on sustainability, and does not focus on having sustainable business models. Their application of a biomimicry design approach did not result in having a sustainable business model whatsoever. The business models of this group are identified as traditional business models. Both companies applied biomimicry just on product level, which resulted in products with sustainable characteristics. Besides having products with sustainable characteristics, biomimicry or a general sustainability approach did not have any influence on the business models of company 7 and 8. During the interviews company 7 explained that they do not focus on having any sustainability goals; their goal is creating efficient products. By looking at nature they achieved efficiency, and thus sustainability, but sustainability was not a goal in itself. And after thoroughly analysing the results from the interview with company 8, the low scores might be caused by the fact that company 8 applies a bio-based design approach instead of a biomimicry design approach.

## 8. Discussion

This section describes the discussion of this conducted research and of the results. This section consists of two parts. The first part will discuss the importance of the main findings of this research and elaborates upon the importance and provides an answer to the main research question. The second part will elaborate upon and discuss the limitations of this research.

### 8.1 Importance of main findings

The results of this research are an important first step in combining both biomimicry and sustainable business model theories. Literature and other types of research already proved that nature is well adapted to the operational conditions of this planet and can therefore be considered as sustainable, and that businesses can learn from nature. In addition, research regarding what businesses can learn from nature and how it can contribute to solving global challenges is also very extensive. However, research related to the commercialization of these ideas is currently underrepresented. It is valuable to know that businesses can learn sustainability from nature, however research regarding the effects of a biomimicry design approach on the (sustainability of) business models is also of high importance. This high importance is caused by the current vision on biomimicry; it is seen as a promising approach to create more sustainable businesses. Research will reveal whether commercializing biomimicry practices can actually fulfil these promises. Application of a biomimicry design approach should be beneficial for the sustainability of companies in order for them to start commercializing innovative product, process and, system level ideas provided by nature. The interviews conducted during this research function as best practice information and provide successful and unsuccessful examples of biomimicry application and its impact on sustainability characteristics. Potential biomimicry practitioners can take these examples into consideration when deciding about the sustainability outcomes they want to achieve. These results function as roadmap and show which activities, perspectives, decisions and operationalizations lead to which sustainability outcomes. Potential biomimicry practitioners will generate more sustainable business models if they decide to apply a biomimicry design approach on multiple levels, and if they use the Life's Principles as guidance during strategy creation, business practices, and decision-making processes. However, results also show that businesses are able to survive and earn profits by only coping/imitating nature on product level; this will most likely not result in a strong sustainable business model.

Prior to the interviews, the researcher hypothesised that the results would differ between start-up companies and already established companies since mainstream established businesses need to integrate sustainability within their business model and therefore they have to (gradually) transform their original business model. Start-up companies, on the other hand, can pursue a sustainable business model from the outset (Bocken et al., 2014). However, the cross case analysis did not show a big difference in the amount of positive scores towards any of the included models between start-ups and established companies. This might be caused by the facts that the amount of start-ups and the amount of established companies that use the Life's Principles are both  $n=4$ . It should be noted that the differences between the businesses that qualify as established and that qualify as start-ups during this research could change over time. Start-ups mature, and businesses can move towards a different phase of the Four Phase Model, which will influence their business model. Despite the fact that there are no differences found between start-ups and established companies, the assessments revealed differences in scores related to the use of Life's Principles and the level on which biomimicry is applied.

Findings resulting from the Eight Archetype Model assessments are in line with the theory of the Four Phase Model; the more proactive the more sustainability is operationalized in the business strategy and business model (van Tilburg et al., 2012). Cases furthest from having a proactive phase, especially cases in the reactive phase, operationalized sustainability mainly within their products and product designs. The closer businesses move towards having a proactive approach, the more businesses focus on other ways of operationalization and the more sustainability becomes embedded within the companies. Incorporating sustainability in the business strategy and business model does not

immediately imply that a company is successfully sustainable. Therefore the comparisons with the elements identifying a successful sustainable business model are valuable.

None of the included cases successfully fulfilled the tri-profit measurement element, while all other elements were at least focused on by eight cases. Respondents declared that these kinds of measurements are hard and complicated, and therefore they do not focus on it. Based on this analysis it could be debated whether or not the tri-profit measurement element was a worthy indicator of successful sustainability incorporation in a business model. On the one hand this element should be left out of consideration since none of the cases focused on it, on the other hand it should be considered by cases and other companies aspiring to become strongly sustainable since measurements will provide quantitative proof of the sustainability performances of companies. Leaving the tri-profit measurement included in the assessments will highlight its importance and might stimulate companies to start focus on it. Upward & Jones (2016) emphasized upon the importance of the tri-profit measurement by explaining that the measurement supports the inclusion of society and the environment in the value capturing processes; which is key in a successful sustainable business model.

Another remarkable finding when combining results from interviews and literature is that Bocken et al., (2014) identified biomimicry as one example to operationalize the Substitute with Renewables and Natural Processes Archetype. Outcomes revealed that although all businesses applied a biomimicry design approach not all businesses scored positive on this archetype. Applying biomimicry did not always resulted in substitution with renewables and natural processes. This might be explained by the degree of biomimicry applied; companies that scored positive on this archetype are classified in the high or medium degree category. In addition, businesses with a biomimicry design approach do operationalize the other indicated archetypes of Bocken et al., 2014. Substitution is one of the things businesses can learn from nature, but not all businesses focus on this archetype. And nature offers a lot of other innovative solutions to businesses. The researcher opinion therefore is that the conclusion of Bocken et al., (2014) that biomimicry is always an example of operationalization of this archetype is too simplistic and misleading. Based on the interview results biomimicry could actually directly or indirectly be an example for all the identified archetypes by Bocken et al., (2014). One of the Life's Principles for example explains that nature can teach companies to be resource efficient; and thus supports businesses to operationalize the Efficiency archetype. Depending on the degree on which biomimicry is applied biomimicry could actually cause businesses to operationalize all eight archetypes. It could be argued that all archetypes are actually somehow embedded within nature's Life's Principles; nature provides the ultimate examples of sustainability operationalization.

The literature review revealed that businesses often face sustainability as a complicated and expensive hurdle that restricts them during their everyday business practices (Schaltegger et al., 2016). However, the results from this research indicated otherwise; all included businesses experienced the use of a biomimicry design approach as something positive and did not negatively felt restricted in any way. Some companies did not feel restricted since their goal is not to have a fixed focus on just applying biomimicry; they are not only bounded to the rules and guidelines of the Life's Principles. The other companies did not feel restricted since they thought the rules and guidelines are beneficial to the company and they preferred to be stirred into this sustainable direction. Overall, interview outcomes showed that a biomimicry design approach can influence the sustainability of a business model in three ways: nature can function as an sustainable idea generation tool, nature can provide examples of how to operationalize sustainability since nature is sustainable, and a biomimicry approach can provide businesses and its employees with new sustainable perspectives and mind-sets. The cases that deliberately used the Life's Principles as guidance during business model creation, decision-making and everyday practices indicated that biomimicry directly influenced the sustainability of their business model. Nature provided them with rules and guidelines that function as a normative framework of sustainability. Considering this normative framework directly influenced the business model characteristics of these companies. Other cases noted that biomimicry indirectly impacted the sustainability of their business model. These companies indicated that applying biomimicry resulted in a growing awareness towards sustainability, and helped creating a general sustainability approach.



This general sustainability approach directly influenced the business models. Some of these companies also consider biomimicry as a tool to market their sustainability to their customers.

One remarkable finding is that all results from the models included in this research could be categorized in three groups as presented in section 7.2. An overall assessment of all results resulted in an overall categorization of companies based on the role of biomimicry on the sustainability of business models. These three categories are explained in section 7.2 and summarized in Table 70. The literature review indicated that authors often distinguish two degrees of biomimicry practices. Blok and Gremmen (2016) distinguish between a strong and a weaker concept of biomimicry. Ivanic (2015) and Cohen & Reich (2017) distinguish between a reductive and a holistic biomimicry design approach. In a reductive biomimicry design approach focus is strictly on mimicking few characteristics or functions of particular organisms or biological processes but does not necessarily create sustainable products or processes. This could be compared to a technical view on biomimicry since nature's solutions are transferred into the domain of design and engineering. The holistic approach perceives biomimicry as a measure to achieve more sustainable businesses.

**Table 70 Overview of categories based on role of biomimicry on business model**

	<b>Transforming</b>	<b>Supporting</b>	<b>Instrumental</b>
<b>Phase</b>	Proactive	Active	Reactive
<b>Fulfilment elements sustainable business model</b>	Successful	Successful/semi-successful	Unsuccessful
<b>Archetypes</b>	Operationalize 7 or 8 archetypes	Operationalize 3 to 6 archetypes	Operationalize one or two archetypes
<b>Life's Principles</b>	Often conscious use of Life's Principles	Life's Principles are used in some cases	No use of Life's Principles
<b>Impact biomimicry design approach</b>	Directly impacted sustainability of business model	(In) directly impacted sustainability of business model	No sustainable business model
<b>Restrictions caused by biomimicry</b>	Appreciate nature's rules and guidelines, do not feel restricted	Are not bounded to using biomimicry design approach, do not feel restricted	Only use biomimicry design approach for the creation of product, do not feel restricted.

The differences between the Transforming and Supporting classifications might be perceived as vague. And it could be argued whether this research could also lead to two categories instead of three. However, creating two classifications just as Blok and Gremmen (2011b), Ivanic (2015), and Cohen & Reich (2017) will lead to confusion since the groups are distinguished based on some noteworthy differences. The main difference is that business models of businesses in the Transforming classification are entirely created based on biomimicry and its principles. Biomimicry transforms business models, and generates sustainable business models. In this category nature is seen as a role model. In the Supporting category, a biomimicry design approach supports the formation of sustainable business model characteristics but did not initiate this. Biomimicry in combination with other approaches and a general focus on sustainability results in sustainable business model characteristics. The business model is not only based upon nature and established from nature and focus is not only on sustainability. In the Transforming classification score highest on all three included assessments, while businesses classified in the Supporting group score highest on two of the three assessed models. Businesses in the Supporting group can shift their business models to having more sustainability characteristics by moving towards the proactive phase, fulfilling more elements identifying a successful sustainable business model, and by operationalizing other archetypes. Classifications are not set; businesses are able to transfer to a different classification by altering their business models. In the Instrumental category only the products of companies are influenced by a biomimicry design approach, and the business model does not show any other sustainability





characteristics. Since there are clear lines between the different influences of biomimicry on the sustainability of business model the researcher decided upon these three categories.

The researcher found another author that distinguished three groups (Mead, 2017). Mead identified three distinctive orientations regarding the use of biomimicry/bio-inspiration as an innovative design approach for sustainability: Ambiguous, Accountable, and Aspirational. The three orientations and their differences are displayed in Table 71.

**Table 71 Three orientations regarding use of biomimicry/bio-inspiration as an innovative design approach for sustainability (Mead, 2017)**

	<b>Ambiguous</b>	<b>Accountable</b>	<b>Aspirational</b>
<b>Sustainability is..</b>	..political and economically motivated.	..practice and ethically motivated.	..purpose and intrinsically motivated.
<b>Sustainability activities..</b>	..are mentioned in annual reports.	..must be measured for everything.	..must be modelled for others.
<b>Our sustainability culture is..</b>	..very weak.	..very strong.	..to compare ourselves to nature.
<b>Innovation is..</b>	..usually incremental.	..an important part of our culture and highly managed.	..something that happens, but we don't try to manage it.
<b>Bio-inspiration is approached..</b>	..as an experimental approach to innovation.	..as one of the several approaches to innovation for sustainability in our usual R&D processes.	..as a mind-set that guides our company-wide approach to sustainability innovation.
<b>Our leadership..</b>	..is not really involved in bioinspired innovation processes.	..is fully supportive of our sustainability efforts, but view bio-inspiration as a project in the R&D department.	..is intimately familiar with bio-inspiration and views it as an important part if the company's agenda.

Companies categorized as ambiguous aim to simply “learn from nature” within their biomimicry projects. Other parts of the company are not engaged in biomimicry or sustainability practices and activities. Companies categorized as Accountable see sustainability as a core aspect of their brand and identity. Sustainability is who they are and will be, however they are stuck in their existing cultural identity, which makes them unable the leap to more radical sustainability approaches. Accountable companies strive to “act like nature” in their use of biomimicry approaches. Companies categorized as Aspirational are constantly reinventing their sustainability approaches, these companies are trying to create sustainability on product, process and system level; they aim to “be like nature” in everything they do (Mead, 2017).

These three orientations more or less relate to the three categories specified in this research. The Ambiguous orientation relates to the Instrumental category; companies learn something from nature and only apply this in their projects/products. Sustainability is left out of consideration in other parts of the business model, and during other business activities. The Accountable orientation relates to the identified Supporting category; businesses act like nature and have sustainability characteristics, but their current perspectives and mind-sets restricts them from becoming more sustainable. And the Aspirational orientation relates to the identified Transforming category; businesses try to be like nature throughout the company and sustainability is incorporated on product, process and system level. The main difference between the results of this research and the categories of Mead (2017) is the focus on sustainability reports of the different categories. Outcomes of this research indicated that only two companies focused on sustainability reporting, while Mead (2017) indicated that even companies



in the Ambiguous category focus on this and that the Aspirational category model all sustainability activities. This difference might be explained by the differences in research participants; Mead (2017) only included multinationals within her research.

## 8.2 Limitations

This part presents the reflection on the research and the researcher with clarifications and interpretation of the project process. This section reflects on the obstacles during the process and on the main limitation of this research. The first obstacle the author encountered was the problem that knowledge about what you can learn from nature exists but that it is not yet commercialized on a big scale. A lot of researchers and institutes are really enthusiast about biomimicry design approaches, however there are not that many companies that have implemented it. This caused some struggles; it was hard to find any potential cases for this research. The author encountered this problem during the search for potential cases and decided to change the study population from Dutch companies to companies from all over the world. The author contacted ca. 50 companies, of which only 15 agreed to participate. The problem here lies in the criteria and the willingness to cooperate. It is hard to address the willingness to cooperate. The author could not change the scope of the research, and adapted the criteria in such a way to have the highest chance of finding enough participants.

Another struggle the author encountered was the problem related to the universal understanding of biomimicry and its different levels. Different authors interpret biomimicry differently (Blok & Gremmen, 2016; Cohen & Reich, 2017; Ivanić et al., 2015; Mead, 2014b). This makes it hard to analyse the level of biomimicry applied by the cases included in this research. Also, which practices are included in the concept of biomimicry are under discussion. Some authors argue that genetic modification is one practice of biomimicry, while others are opposing to this statement. Due to the great amount of disagreement regarding the inclusion of genetic modification as biomimicry practice, genetic modification is left out of consideration in this research. To overcome the interpretation problems three different levels of biomimicry are included in this research: product, process and system level. Whether these levels relate to weak/strong/, reductive/holistic concepts of biomimicry is held aside during this research. The three different levels are elaborated upon in the method section of this report.

Confidentiality also caused some obstacles during some interviews. Some of the participants were not able to answer certain interview questions in-depth since confidentiality issues restricted them. The author tried to gain trust to make companies share as much as possible.

Another limitation is that companies of a variety of different industries were included in this research. The author decided to include different industries otherwise there would not be a sufficient amount of cases available. However, since only one or a few companies from each industry are included the author is unable to draw any conclusion about specific industry characteristics.

The cases included in this research applied different levels of a biomimicry design approach. 6 companies practice biomimicry on product level, 1 company applied biomimicry on product and system level, 3 companies applied biomimicry on product and process level, and 4 companies applied biomimicry on product, process and system level. These amounts are unequal and make it more difficult to compare the companies based on the level of biomimicry design approach applied.

In addition, due to the limited amount of included cases it is hard to compare the cases on other factors than being an established firm or a start-up. Upfront the author assumed that established firms changed their businesses and business models and incorporated a biomimicry design while they already operated for multiple years, and that start-ups started their businesses with a biomimicry design approach from the start. However, 6 companies are specified as established firms of which 3 implemented a biomimicry design approach from the start. This might influence the comparisons between established and start-up cases. In addition, an extended research would make it possible to analyse and compare the cases on multiple characteristics, like country of origin, industry, size etc. Additional research is required in order to make generalizations.

The conclusions are only based on the results from the interviews and lack external validity. The cases included in this research are not assessed from a broader perspective by deploying more than one outsider for external validity, as this is a limitation of the research.

It is also possible that there is a difference between doing interviews face-to-face and via Skype. The way of communication might influence the interviewee in a certain way and it could have influenced the responses. The author of this research conducted 5 interviews face-to-face and 8 interviews through Skype and 2 interviews were conducted through phone.

It should be noted that especially start-ups are constantly engaged in the creation and modification of their business model. They are still in the developing phase, and this might have impacted the results obtained from these companies. The start-ups are self-aware and in order to apply for funding they often have to prove their sustainability for example. This means that sustainability is fresh on their mind, and that they are trained in answering sustainability related questions. In addition, biomimicry related fundings are focused on the use of the Life's Principles, this resulted in the fact that a lot of start-ups analysed the Life's Principles and consciously embedded them in their business model to increase their chances on getting funding. This fact might also have influenced the high positive scores of businesses that use Life's Principles on all assessed constructs.

## 9. Conclusion

This section describes the overall conclusions of this research and the conclusions for the used models in this research.

The aim of this research was to assess and identify the (sustainable) characteristics of business models of businesses that applied a biomimicry design approach. Assessment is necessary in order to validate/disprove the promising potential of biomimicry to solve current global challenges. Businesses with strong sustainable business models are necessary to solve these challenges; the current take-make-waste economy is unable to solve them. Literature identified biomimicry as one approach to make business model more sustainable; however current research lacks in explaining the relationship between biomimicry and sustainable business models. This research gap resulted into the following main research question: *What are the characteristics of the business models of start-ups and already established businesses that implemented a biomimicry design, and how is sustainability operationalized?* This research contributes to existing knowledge by assessing whether a biomimicry design approach can contribute to the generation of successful sustainable business models.

An explorative research consisting of multiple case study design approach has been conducted in order to answer the main research question. Semi-structured interviews have been executed with general managers of fifteen companies that already applied a biomimicry design approach on Product, Product & Process, Product & System, and Product & Process & System level. Start-ups (n=8) as well as established companies (n=6) were included in this research (one of the interviewed companies is not yet an officially founded company). The sustainable characteristics of the different cases were assessed based on three models: Four Phase Model of Sustainable Entrepreneurship, Elements identifying a Successful Sustainable Business Model, and the Eight Archetype Model.

The Four Phase Model is analysed in order to assess whether companies included in this research are proactively involved in sustainability (van Tilburg et al., 2012). When businesses are in the proactive phase their business strategy is closely connected to sustainability. Companies in the proactive phase have a Sustainable Business Model. Presence of the proactive phase can be assessed based on eight constructs: Vision on sustainability, Orientation towards external developments, Business case elements, Transparency, Reporting, Stakeholders, Supply chain approach, and Dominant functional discipline. The results of the interviews indicate that all included cases have an Orientation towards external developments. Thirteen out of fourteen companies have a Vision on sustainability and focus on Dominant functional discipline. Eleven out of fourteen companies focus on Business case elements and Transparency. Ten out of fourteen companies focus on Stakeholders and a Supply chain approach. In addition, only 2 companies focus on sustainability Reporting. The conclusion about the Four Phase Model is that companies can be divided into three phases based on their scores on the constructs: proactive phase (N=6), active phase (N=6), and reactive phase (N=2). Differences in the amount of positive scores between start-ups and established companies are really small. However, it should be noted that differences in the amount of positive scores between companies that use the Life's Principles of nature and companies that do not use the Life's Principles are big. In addition, the level on which biomimicry is applied also influences the amount of positive scores; businesses that applied biomimicry on more than one level scored positive on more constructs.

After assessing the presence of a sustainable strategy and business model, the successfulness of this business model was assessed based on the elements identifying a successful sustainable business model in general. Literature provided twelve elements as key factors indicating a successful sustainable business model in general. These twelve elements can be divided into four categories of the business model: Boundaries and Goals, Stakeholders, Value Proposition and Firms' processes. The conclusion about the elements of success is that cases could be divided into three different groups based on their scores: businesses that successfully fulfilled the elements (N=9), businesses that semi-successfully fulfilled the elements (N=3), and businesses that unsuccessfully fulfilled the elements

(N=2). Again the difference between the scores of start-ups and established companies are unnoticeable. And there are again differences in the amount of positive scores between companies that use Life's Principles and companies that do not use Life's Principles. This indicates that embedding the Life's Principles in companies' strategies, practices, designs and decisions-making processes will positively influence the successfulness of a company. The same applies to companies that applied biomimicry on more than one level.

The Eight Archetype Model was incorporated in this research to check how businesses operationalize sustainability within their company. The different archetypes are: Maximize material and energy Efficiency, Create value from Waste, Substitution with Renewables and Natural Processes, Deliver Functionality rather than Ownership, Adopt a Stewardship Role, Encourage Sufficiency, Repurpose for society/environment, and Developing Scale-up solutions. The assessment of the Eight Archetypes revealed that thirteen out of fourteen companies focus on encouraging efficiency. Twelve companies focus on the repurpose, Scale-up, and Efficiency archetypes. Eleven companies focus on adopting a stewardship role. And finally, eight companies focus on the Waste, Substitution, and Functionality archetypes. Based on the interviews it can be concluded that businesses with a biomimicry design approach operationalize sustainability in many different ways and the execution of the operationalization differs per company. The conclusion about the elements of success is that cases could be divided into three different groups based on their scores: cases operationalizing seven or eight archetypes in different ways and in different parts of the business models (N=9), cases operationalizing five archetypes in different ways and in different parts of the business model (N=3), and cases operationalizing one or two archetypes within the product part of their business models (N=2). Also for this model it can be concluded that differences between start-ups and established companies are small. Differences between companies that use and do not use the Life's Principles are bigger, and also businesses that apply biomimicry on more than one level score positive on more archetypes.

Combining the three divisions made for each model results in three overall groups. These classifications come forwards from the role of biomimicry on the sustainability of business models and an overview is provided in Table 70.

**Table 72 Overview of categories based on role of biomimicry on business model**

	<b>Transforming</b>	<b>Supporting</b>	<b>Instrumental</b>
<b>Phase</b>	Proactive	Active	Reactive
<b>Fulfilment elements sustainable business model</b>	Successful	Successful/semi-successful	Unsuccessful
<b>Archetypes</b>	Operationalize 7 or 8 archetypes	Operationalize 3 to 6 archetypes	Operationalize one or two archetypes
<b>Life's Principles</b>	Often conscious use of Life's Principles	Life's Principles are used in some cases	No use of Life's Principles
<b>Impact biomimicry design approach</b>	Directly impacted sustainability of business model	(In) directly impacted sustainability of business model	No sustainable business model
<b>Restrictions caused by biomimicry</b>	Appreciate nature's rules and guidelines, do not feel restricted	Are not bounded to using biomimicry design approach, do not feel restricted	Only use biomimicry design approach for the creation of product, do not feel restricted.

This table indicates that the answer to the main question is that the influence of a biomimicry design approach on the sustainability characteristics of a business model depends on the category the business belongs to. Businesses in the Transforming category are in the proactive phase of the Four Phase Model and do have a sustainable strategy. These companies successfully fulfil the elements identifying a successful sustainable business model. And operationalize (almost) all archetypes within



their products, processes and systems, and operationalization is often related to the Life's Principles. These companies want to be living examples of a next generation company necessary to solve global challenges. Companies in this category seek to cause revolutions in the current take-make-waste-economies and shift towards sustainable economies. In addition, biomimicry and the Life's Principles directly impacted the sustainability of their business models. While literature often suggests that sustainability restricts businesses, these companies do not feel restricted. The rules and guidelines following from a biomimicry design approach are appreciated and experienced as something positive. Overall, a biomimicry design approach and the Life's Principles resulted in successful strong sustainable business models in which business intentions to become sustainable are important in a first phase, but more important are the actions that are concretely executed.

Businesses in the Supporting category are in the active phase of the Four Phase Model and sustainability is important for the companies. In this category businesses successfully or semi-successfully fulfil the elements identifying a successful sustainable business model. In addition, 3 to 6 archetypes are operationalized in the products, processes and systems of the companies. Operationalization sometimes relates to the Life's Principles. Overall, a biomimicry design approach indirectly influenced the sustainability of business models of businesses in this category; application of biomimicry resulted in a general approach towards sustainability. Companies in this category often use biomimicry as an example to show and market their sustainability. Companies in the Supporting category do not feel restricted by applying a biomimicry design approach since they are not bounded to just focussing on this approach. For businesses in the Supporting category a biomimicry design approach resulted in successful sustainable business model characteristics. Overall, sustainability is important to businesses in this category, but it is not the main focus in all characteristics of the business model.

Businesses in the Instrumental category are in the reactive phase of the Four Phase Model. This indicates that these businesses have a traditional business strategy and thus a traditional business model. Successfulness of these companies should be determined by comparing the business models to successful traditional business models; since they do not have a sustainable business model. Operationalization of the archetypes often relates to the product/product designs of the companies, and is thus instrumental. In this classification a biomimicry design approach led to the development of sustainable products/products designs, but did not influence other parts of the business. Overall, a biomimicry design approach of businesses in this category did not result in sustainable business model; it only resulted in sustainable products.

In general, the outcomes and different classifications function as roadmap to potential biomimicry practitioners and show which activities, perspectives, decisions and operationalizations lead to which sustainability outcomes and characteristics.



## 10. Recommendations for future research

This section describes the recommendations for further research. Throughout this research process the author encountered some topics that could be addressed in future research. The recommendations resulted from the conceptual model and the interview outcomes. Since this research is an explorative research that combines biomimicry and business model theories, future researchers that combine these topics should take these recommendations into consideration.

After analysis of the interviews the Life's Principles became a central part of this research, however the Life's Principles and their application have not been researched in depth. Future research should be focused on the implementation and the operationalization of the Life's Principles in business model creation, strategy formulation, business practices and decision-making processes. This information provides insights in how businesses use the Life's Principles, and might help other businesses to quickly become more sustainable. Adding to this, it would be recommended to analyse the relation between the Life's Principles and the Eight Archetype Model. As mentioned in the discussion Bocken et al., (2014) see biomimicry as one example to operationalize the Substitution archetype. Results however show that biomimicry can support businesses in the operationalization of the other archetypes as well. Therefore future research can result in a biomimetic variant of the Eight Archetypes Model explaining the relationship between sustainable Life's Principles provided by nature and the operationalization of sustainability.

Future research should also focus on how businesses can move from the Instrumental category to the Supporting and Transforming category, and if businesses aspire to move to another category. Furthermore, it would be interesting to research the hurdles businesses encounter during the transition to another category, and what the underlying motivations are.

Another recommendation concerns the number of cases and the validity of the research. In order to increase the validity of the research, one should include more cases. Increasing the number of participants may also indicate that quantitative research is possible in the future. The current number of included cases is too small to make specific generalizations based on industry, country, company size etc.

Since the results showed that applying biomimicry on more than one level results in more positive scores on the assessed models, research should be conducted towards the specific characteristics of companies that apply biomimicry on multiple levels. Leaving businesses that apply biomimicry on just product level out of consideration will most likely lead to more positive scores, and these positive scores could be analysed in depth on their characteristics and intensities.

Another recommendation for further research is to put numerical performance values to the realized sustainability of businesses that apply a biomimicry design approach. By measuring the sustainability performances it becomes easier to compare different cases and to draw conclusions based on their established sustainability. In order to add another dimension to this research the sustainability of the included cases could be measured to see if the values match the interview outcomes. This will also increase the reliability of the results and conclusions.

Adding to the previous recommendation future research could also be focused on other approaches used to create more sustainable businesses. The methods used in this research could be copied and applied to other research areas, since the assessed models are focused on sustainability and business models in general and are not specifically designed to research biomimicry design approaches.

And finally, comparative research will increase the validity of the outcomes. More research that combines biomimicry and business model theories is necessary in order to conduct comparative research. In addition, results from researches towards other approaches applied to create more sustainable businesses could also be compared to this research in order to identify differences in characteristics.

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## Appendices

### Appendix A Operationalization matrix

Theme	Model	Constructs	Operationalization	Questions	References
Sustainable Business model	4-Phase Model	<b>Vision on sustainability</b>	Holistic, strategic	How important is sustainability for your company? What is the role of sustainability within your company?	Van Tilburg et al., 2012
		<b>Orientation external developments</b>	Cosmopolitan, society	Is the business responsive towards events and developments in society? How does this show?	Van Tilburg et al., 2012
		<b>Business case elements</b>	Costs, clients, law, reputation, identity, long-term continuity	To what extent is sustainability part of your business model	Van Tilburg et al., 2012
		<b>Transparency</b>	Full transparency (transparency vs. competitive advantage)	How transparent is your company at this moment regarding sustainability?	Van Tilburg et al., 2012
		<b>Reporting</b>	Integrated with intertwined strategy	Can I have a copy of your sustainability report?	Van Tilburg et al., 2012
		<b>Stakeholders</b>	Society	How does your organization see itself regarding sustainability within the society?	Van Tilburg et al., 2012
		<b>Supply chain approach</b>	Co-creation	What do you think of the role of the suppliers regarding sustainability issues? What is the role of suppliers regarding sustainable entrepreneurship?	Van Tilburg et al., 2012
		<b>Dominant functional discipline</b>	Management/ board strategy	What is the vision on sustainability for the organization and what are the long-term plans for sustainability?	Van Tilburg et al., 2012
		<b>Boundaries and goals</b>	Integration environmental, social and monetary values; Intentional and unintentional impacts; impacts outside firms system; tri-profit measurement; goals are based on standards of stakeholders	Can you define success for the company? How is profit being measured? What is being considered as benefits and what as costs? How are goals regarding profit set/defines? Where are decisions regarding profit measurements based on? Are you familiar with the tri-profit? If yes, how is it applied?	Boons & Lüdeke-Freund, 2013; Bocken et al., 2014; Morioka et al., 2017



<b>Elements of successful sustainable business models</b>	<b>Elements that define general successful sustainable business models</b>	<b>Stakeholders</b>	Human and nonhuman actors; needs/purposes of multiple stakeholders are considered; stakeholders are proactively engaged in processes; current and future legitimacy and power of stakeholders	Who are the main stakeholders of the company? Do you take other stakeholders into account? Do you also consider non-human stakeholders? Can you describe your relationship with different stakeholders? Are stakeholders engaged in the processes of the company? If yes, how (examples)? How is your supply chain organised? Do you consider power and legitimacy of stakeholders over the long run? If so, how?	Upward & Jones, 2016; Morioka et al., 2017
		<b>Value Proposition</b>	Economic, social and environmental value; positive and negative value generation; explains how decisions are made; short medium and long run consideration	Can you describe the value proposition of the company? Do you take into account negative value generation? If so, how is this incorporated in the value proposition? Can you provide examples of negative value generation? Where are decisions related to the value proposition based on? Who makes decisions related to the value proposition? Is the medium and long run present in your current value proposition?	Upward & Jones, 2016; Morioka et al., 2017
		<b>Firms' processes</b>	Limited by biophysical stock and ecosystem services; social costs are taken into account; considers impact of process; is related to resources, capabilities and partners	How does the company decide on the used resources? Who decides on the used resources? Are the biophysical stock and ecosystem services taken into account during the decisions relating to the firms processes? Are there any sustainable initiatives incorporated in the processes? Does the company consider the impact of their processes on human and nonhuman users of the ecosystem?	Upward & Jones, 2016; Morioka et al., 2017; Bocken et al., 2014
<b>Operationalization sustainability in</b>	<b>Eight Archetypes of a Sustainable</b>	<b>Efficiency</b>	Low-carbon manufacturing costs; lean manufacturing; dematerialization	Does your organization focus on maximizing material and energy efficiency? If so, how?	Bocken et al., 2014

<b>Business Model</b>	<b>ble Business Model</b>	<b>Waste</b>	Circular economy; reuse; recycle; remanufacture	Does your organization focus on creating value from waste? If so, how?	Bocken et al., 2014
		<b>Substitution</b>	Renewable energy resources; biomimicry; green chemistry	Does your organization focus on the substitution of renewable energy and natural processes? If so, how?	Bocken et al., 2014
		<b>Functionality</b>	Product oriented PSS- maintenance, extend warrantee, use oriental PSS- rental, lease, share; result-oriented PSS pay per use; private finance initiative; design, build, finance, operate; chemical management services	Does your organization focus on delivering functionality rather than ownership? If so, how?	Bocken et al., 2014
		<b>Stewardship</b>	Biodiversity protection; ethical trade; choice editing by retailers; radical transparency; resource stewardship; consumer care- promote consumer health and well-being	Does your organization take responsibility for your actions, processes and materials towards society and the environment?	Bocken et al., 2014
		<b>Sufficiency</b>	Consumer education; demand management; product longevity	Does your organization focus on encouraging sufficiency? If so, how (consumer education, demand management)	Bocken et al., 2014
		<b>Repurpose</b>	Not for profit; hybrid businesses; localization; base of pyramid solutions	Does your organization focus on more social and environmental goals besides making profit? If so, how?	Bocken et al., 2014
		<b>Scale-up</b>	Incubators; open innovations; crowdsourcing/ funding;	Does your organization focus on developing scale-up solutions? If so, how?	Bocken et al., 2014

## Appendix B Results Elements successful sustainable business model company 1

Model	Constructs	Company 1
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	I would say that the business is successful once we have 5% market share. However, the fact that my invention caused the whole anti-foiling industry to change and start looking for sustainable initiatives is also success. The environment benefits from this development, and we contributed to it. You need financial means and profit in order to survive. If I look at our value proposition I could have asked I higher price for the products. However, since it is more important to me to quickly gain market share and offer a good sustainable alternative that everyone can afford, we do not ask the higher prices. Money is a tool in order to achieve our higher sustainable goal
	<b>Stakeholders</b>	Consumers are our main stakeholders. Consumers are eventually the ones that decide and we notice that consumer's value sustainability more and more and we want to be able to meet their current and growing future demands. Furthermore, legislators are important since they are currently debating about all kind of sustainability issues. The power of the government is important when deciding on our processes, since they make rules and regulation regarding the use of materials and the way products should be produced. The environment is also an important stakeholder. My environmental concerns about the impact of the toxic anti-foiling paint made be start this business. I want to make sure that the ecosystems in which the anti-foiling wrap is presence will not be harmed by the wrap. Our supply chain is international. And a German manufacture plant produces the wraps.
	<b>Value Proposition</b>	The value is that this anti-foiling product does not cause any harm to the environment, it is effective and the durability is longer in comparison to the anti-foiling paints. We are well on our way to make boats more sustainable in the Netherlands and Belgium. The next step is to spread our sustainable value more globally.
	<b>Firms' processes</b>	Decisions regarding materials are primary based upon the functionality and eco-friendliness of the materials. So, when two types of materials have the same effect we will choose the most sustainable option. But functionality is the most important factor. We also take sustainability into account during the processes. We use water-based glue to glue the stings/hairs instead of solvent-based glue for example. Our suppliers are involved in the decisions regarding the materials. Furthermore, we deliberately made the decision to choose a production company in the European union instead of Asia our Africa. This will keep our ecological footprint low, and production needs to comply with European legislation. European legislation is more and more focused on sustainable producing. Our processes also have social benefits; the toxic paint is unhealthy for the painters that inhale the paint. Applying the foil does not create any unhealthy situations. We do not keep scarcity in mind during our decision-making processes

## Appendix C Results Elements successful sustainable business model company 2

Model	Constructs	Company 2
Elements that define general successful sustainable business	<b>Boundaries and goals</b>	When we decide upon our profit, social values are extremely important. Economic value is necessary in order to achieve this. The same accounts for ecological value. Economic value is a means but not our goal. We try to do everything as good and sustainable as possible and make a living out of it. In our profit determination is system-thinking extremely important, however we cannot always incorporate everything.

models	<b>Stakeholders</b>	Our clients are eventually the ones who decide; they have to agree with our designs. But all clients we have fit our business and value system thinking and sustainability. Besides the clients, nature and other systems also important stakeholders. The systems are kept in mind during decision-making processes regarding the design and used materials etc. The government is also an important stakeholder; they have to agree with certain designs and projects otherwise you will not get permission. At some projects we have dozens of stakeholders, and we are not always able to please each and every one of them. The future power and impact of systems and government are also taken into account, since our designs have a long life span.
	<b>Value Proposition</b>	The value that we create is that we solve spatial issues for our clients while at the same time solving other problems. Besides spatial problems are there also social, ecological and cultural problems in areas. We try to tackle all these problems at once. Of course we also generate negative value; mainly caused by the (raw) materials used. We are aware of our negative value generation and try to minimize it. Our value proposition is really focused on the here and now, and we did not create a long-term vision.
	<b>Firms' processes</b>	We try to use as much biological and natural (raw) materials as possible. Eventually the client, and the budget of our clients determine the sustainability of the materials. During material decisions we try to advice our clients and we take scarcity into account. Tropical hardwood for example is scarce and causes social trouble; we try to use European Softwood instead. We are constantly trying to improve our designs and make them more sustainable. And we also base decisions regarding materials and processes on the Life Principles. Of course we have to deal with considerations, sometimes there is no sustainable substitute for building materials.

### Appendix D Results Elements successful sustainable business model company 3

Model	Constructs	Company 3
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	If you would ask the CEO he would say that we are successful when the whole world would be using our shapes so we could save half the energy that we are using. And that we show people that nature is far more valuable if we learn from it instead of exploit it. If you come down to much more practical terms we would say that the company would be growing and expanding and getting more and more clients every year, so just the standard business desires. If you take it to one more level you would say that all of our shareholders, that all of the money they invested would be paid back. In terms of profit we do not track any environmental social matrix.
	<b>Stakeholders</b>	We have over 200 shareholders that all invested small amounts of money, so they are important stakeholders. Our small team of employees are also important stakeholders. And clients with whom we have are on-going relationships are important stakeholders as well. And the environment is an important stakeholder; we started the company in order to protect the environment by showing the people that nature is far more valuable if we learn from it instead of exploiting it. At this moment we do not analyse our clients on sustainability; it is kind of a challenge to convince clients to adopt these designs. So, that puts us in a positions of taking the clients we can get. This makes us motivated to just get our designs out there, and try to gain credibility and not worry so much about the sustainability.

	<b>Value Proposition</b>	The value proposition for our clients is to give energy and noise savings for the same manufacturing costs. We do not consider negative value generation, however our assumption is that we are using the same or less material in our designs. If we are using less energy then it would generate more positive impact than negative. It is true that any of our designs could be used to do harm. We have not licensed anybody for any weapons. We have not licensed anyone for what we see is a clear path to that type of harm. But certainly, since our focus is always on energy efficiency, we would say that any license that we make would be saving the environment. In the medium value proposition we would like to continue to expand; we want large companies to take on the geometries and apply them from the internal side. So instead of just using us as an external consultant, that they would have trained people inside. The value proposition in long terms would be that the whole world is using our designs in order to decrease global energy use.
	<b>Firms' processes</b>	We are a designing firm. We do make decisions about the materials used in our own manufacturing firm and consider biophysical stock. Since we have a small team we are able to make decisions very collaboratively. When we have internal decisions we discuss them with the team and several of them are focused on sustainability and sufficiency opportunities. So we consider sustainability and it impacts our decisions. We try not to make an easy decision for the company; if we have to buy some equipment you know we try to not make an easy decisions but make a decisions that is environmentally aware as possible. We try to promote energy efficiency so we have to also put our money where our mouth is.

#### Appendix E Results Elements successful sustainable business model company 4

Model	Constructs	Company 4
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	We tried to deliver a restorative impact to the planet and the society. We wanted to create a positive impact and eliminate our negative impacts. We have almost reached this goal and, and therefore we made our goals even more ambitious; we want to go from restorative to regenerative and work like an ecosystem in order to tackle climate change. We want to create factories as a forest and products as plants. If you think that businesses are solidary to making profit think again. We want to create ecological and social value. Profit is a necessary resource in order to sustain, a lot of social enterprises are to focused on the social and ecological goals and go bankrupt since they forget about the economic goals. We especially focused on the ecological dimension, however the social dimension is getting more and more attention. Because we use nature as a source of inspiration, ecological and social values weigh heavily. We have a holistic view regarding all decisions; in this way we make sure that decisions that have a positive impact on one field do not have any negative influence on other fields. Our goals are formulated multidisciplinary and all kind of stakeholders are involved in order to make sure that they include everything and positive values are generated in all fields.
	<b>Stakeholders</b>	I would say everyone and everything; nature. Humans are often set aside from nature, but we are part of nature. At the same time we are a listed company and our shareholders want to see financial successes. Having nature as a stakeholder and being financially successful is not contradictory. We have experienced that due to sustainability we have lower costs, and a better reputation, engaged employees, we work together on higher end goals, and we are more innovative and are leaders in the field of scarcity and circular economy. We are constantly working on our future-proofness and future-proofness of our supply chain. We work together with our supply chain and stimulate and support them to become more sustainable.





	<b>Value Proposition</b>	We contribute to the creation of inspiring interiors and a healthy indoor climate. We create positive spaces for our clients, on how can positive spaces not be sustainable? The positive spaces are healthy for people that work/live there; they are happier, more creative and productive. Biomimicry and the Life Principles function as guidelines in order to create these values for our clients. We make our positive and negative value visible on product level with the environmental product declarations. Life cycle analyses learned us that 98% of the impact of our carpet tiles expressed in co2 is not generated within our company, therefore we work together with our suppliers and clients in order to decrease our negative values.
	<b>Firms' processes</b>	All business decisions are reviewed on the 7 pillars of the strategy. Decisions regarding the use of (raw) materials are often based on life cycle analysis. During all decisions the negative impacts are considered as well. It is nice if something has a positive effect of some aspect of the sustainable development goals but we have to make sure that that decision negatively influences another sustainable development goal. In addition the positive and negative impacts of processes on human and nonhuman stakeholders are considered during decision-making practices.

#### Appendix F Results Elements successful sustainable business model company 5

Model	Constructs	Company 5
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	We want to become a big market leader in the field of stabilisers. I see money as a resource but not as a goal. We are not in this business because we want to become rich, we want to increase the comfort level on yachts, decrease fuel consumption, and improve working conditions on fishing ships. We just want to become a big player in the market, and profit in necessary in order to keep our independency. The bank is an important stakeholder that has power and legitimacy when deciding upon revenue goals.
	<b>Stakeholders</b>	The co-owner of this company and I are the most important stakeholders. In addition the market is our stakeholder including the customers. In the end we are all doing this to satisfy the customers. But actually all people and businesses involved in one of the processes and or projects or other activities like suppliers and the bank are our stakeholders. We are unable to satisfy the needs and opinions of all stakeholders, we have a priority list.
	<b>Value Proposition</b>	We offer our current clients comfort and additional pleasure of their yachts. Our clients have a luxury lifestyle, and we increase their comfort. Yachts will never be sustainable, since they are used for pleasure; we try to make them a bit more sustainable by increasing the energy efficiency. And to be honest whole economies rely on the pleasure yacht industry, losing the pleasure yacht will also cause a lot of social damage. On the long run we want to become a leader, not in terms of revenue but in terms of quality.
	<b>Firms' processes</b>	We designed our stabilisers in such a way that they are maintenance free. Other stabilisers need maintenance that causes all kind of greases between the axles to be released in the water. We notice that scarce resources are becoming more expensive, and we try to find alternative solutions for them. We decide upon partners in our supply chain based on experience and feelings. And some producers are picked based on there social sustainability. Customers value sustainability more and more, even though it does not seem like it since they own pleasure yachts, in this way, and due to more international rules and regulations we are forced to make our processes and products more and more sustainable. At the moment we consider energy recovery when there are no waves.

## Appendix G Results Elements successful sustainable business model company 6

Model	Constructs	Company 6
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	We are successful if we can guarantee continuity. From a biomimicry viewpoint you can compare this with nature; something that survives. It is important to make sure that we can provide all our employees with income and to guarantee a future for them. It is hard to measure profit while including social and ecological value. We measure profit based on economic value. Profit provides perspective of continuity. It is hard to set any goals regarding revenue or profit since our revenue streams are really fluctuating.
	<b>Stakeholders</b>	Our clients and employees are really important stakeholders. And our suppliers are important stakeholders as well. In addition we consider the local community as an important stakeholder, and we are engaged in a local projects to create a good work and living climate for our employees and their families, and to contribute to the local environment. Our supply chain is a local network of suppliers and advisors on the field of energy systems and control technology. The suppliers are decided upon based on quality, and I believe that companies that deliver quality are also the businesses that are "clean" and sustainable. We do not have a checklist with standards our suppliers need to reach but a certain type of business attracts a certain type of suppliers. Some of our stakeholders are engaged in our business operations, we are global partners of a big mass food production company and they have standards we need to reach regarding safety, sustainability, gender equality etc. We especially consider the future legitimacy and power of our big clients; mergers and acquisitions or movements of headquarters can have big impacts on our company.
	<b>Value Proposition</b>	We deliver added value through technology and are able to put a marge on it in order to guarantee business continuity. We are aware that the machines we design are used in mass production and have a negative impact on the environment, however we try to make the machines as efficient as possible and try to reduce the negative impact of those machines. In addition, 95% of the materials we use to build the machine can be recycled. Our long-term goal is to contribute to the creation of more sustainable production chains especially in the food industry and agriculture sector. We want to make production companies more sustainable with smarter and cleaner technology inspired by nature.
	<b>Firms' processes</b>	Some decisions regarding the use of (raw) materials are based on sustainability. Our cleaning materials for example, and we also do not use chemical solvents we use biodegradable solvents. We use steel to built our machines, this is pure steel and is recyclable. In order to use less steel we are currently focussing on 3D printing to make our designs more material efficient. However 3D printing is still really expensive, but this can be different in 5 years. Aside from the purchase of the steel we do not have that much negative influence on ecological and social systems. This is caused by the fact that the impact of the machines is created at the clients. We try to make the machines as sustainable as possible; energy efficient, cleanability, used materials, less dropouts and standstills to lower the impact of the machines when clients use them.

## Appendix H Results Elements successful sustainable business model company 7

Model	Constructs	Company 7
Elements that define general successful sustainable	<b>Boundaries and goals</b>	We are very successful when products all over the world are modified by using tubercles shapes. It is happening more and more, we have products in China, the US, Canada and Europe. We already have a big market.
	<b>Stakeholders</b>	I consider the core group of employees as main stakeholders.



business models	<b>Value Proposition</b>	We offer designs to our customers explaining how they can use tubercles in their products. With the tubercles products like fans, mixers, turbines, blowers and compressors can move more air while using less energy. We want to expand in order to move more air with less energy all over the world.
	<b>Firms' processes</b>	Our company does not fit into conventional material sourcing and sustainability is not the focus. We do not particularly take environment and ecosystems into consideration during the design and manufacturing processes. I hope we will find more important shape changes that can increase energy efficiency.

#### Appendix I Results Elements successful sustainable business model company 8

Model	Constructs	Company 8
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	The company is successful if we reach a certain revenue goal each year. In the long run we want to capture a certain part of the market.
	<b>Stakeholders</b>	I am the main stakeholder of this business. In addition my financial partner is also a stakeholder. We try to understand the demands of the customers and base our prices on the willingness of the customers. And I do consider rules and regulations during decision-making processes, but I do not include ecosystems or the like.
	<b>Value Proposition</b>	The value we offer is that we offer consumers an alternative for non-renewable oil based raw materials. And way less energy is needed during the production phase.
	<b>Firms' processes</b>	We produce the materials, process them and produce them into end products, so basically we have everything in-house. The products that we use are not scarce and we cultivate a lot of those materials, like bamboo, ourselves. Suppliers of other materials are analysed on quality not on sustainability. We try to make our processes more sustainable. We use lignine and cellulose from our waste streams and make resin out of it.

#### Appendix J Results Elements successful sustainable business model company 9

Model	Constructs	Company 9
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	We are a commercial organisation, so we are successful when we achieve our commercial goals. Our commercial goals are based upon micro and macro economic factors and are decided upon by the board, country directors and other employees of the company. But we are also successful if we can contribute to the development of society. We value society, and our employees and want to stimulate a live long learning for our employees and the rest of the society. Profit is one of the things necessary in order to guarantee future-proofness, however social and ecological values are becoming more and more important. This is visible in the way we build our new building for example.
	<b>Stakeholders</b>	Our stakeholders are the market with our clients, and our employees, the owners. We take stakeholders into account during our decisions, actions etc. since we want to guarantee future-proofness of the company. In order to guarantee this nature is a main stakeholder as well. First of all we get inspiration from nature to design innovative new products but secondly we need the nature to be in good conditions in order to be able to sustain in the future. Nature and ecosystems guide decision especially when we build new processing plants and buildings. One of our buildings in Germany is the most sustainable building in the country.

	<b>Value Proposition</b>	Our value proposition is that we are great at delivering standard but also very specific components and products on the market. Our bionic network is a big part of this; we learn how smart nature is and we try to copy this. This results in our great standard and specific products and by learning from nature we try to have a big market share in the upcoming years. We are more and more aware of our negative impact and try to reduce it. Negative impact does not only include environmental impact but also social impact. The social impact of the movement of a production location is taken into account during decision-making processes. With the help of our value proposition we try to be future-proof, and we also formulated medium and long-term commercial goals.
	<b>Firms' processes</b>	Our suppliers are decided upon based on the functionalities the products must have, they are not analysed on sustainability. We do consider scarcity; a certain type of motor needs magnets, but there is a global scarcity for those magnets. We try to redesign our products in such a way that they do not need those magnets but that the products keep its functionality. And this happens with a lot of other products as well. Our wood for example is all certified. We continuously try to make our processes more sustainable starting with the processing plants; energy neutral, renewable energy, closed water cycles and cooling systems etc. Goals related to energy efficiency are shared with all employees, and employees can come up with plans to realise these goals, in this way we also create more awareness.

#### Appendix K Results Elements successful sustainable business model company 10

Model	Constructs	Company 10
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	The company is successful when I keep implementing biomimicry in my designs. And keep providing examples to other businesses of how they can implement biomimicry and sustainability. Intuitively I take social and ecological values in consideration during profit calculations but I am not familiar with tri-profit. I do not set up revenue goals upfront.
	<b>Stakeholders</b>	The commissioners and the suppliers are important stakeholders and of course all systems impacted by my designs. I am currently designing a biomimicry academy and all materials used during construction will be planted back in the garden. In this way the building does not have any impact. I work with ecological performance standards; I give values to ecosystem characteristics before I design something for that area, when I build something in that area I want those standards to at least be the same. All of my stakeholders are open to the way I work, and I analyse them on their sustainability. I really try to build long-term relationships; since previous clients are potential future clients that are important for my business.
	<b>Value Proposition</b>	The value that I create is to provide an example of how businesses and other architects can integrate sustainability. In today's society sustainability is seen as a container concept and no one knows what to do with it, I want to show people what sustainability is and support them. I try my best not to generate any negative value, however construction remains polluting. I did not establish any long-term goals.

	<b>Firms' processes</b>	Decision regarding materials rely on sustainability and technical and functional aspects. I always analyse how materials and products are made, where the raw materials come from, information regarding the chemical solutions, lifespan etc. I want to use as little as possible product from the petrochemical industry. And scarcity is an important topic during material decisions. The building processes are also analysed on sustainability and how it impacts systems. I also provide courses and workshops for suppliers and commissioners about sustainability and biomimicry and how they can put it in practice.
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#### Appendix L Results Elements successful sustainable business model company 11

Model	Constructs	Company 11
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	The company is successful when we caused a revolution in water using industries and reduce the global water usage and the problems caused by it. Our motivation is 100% ecological; solving the water problems is our number one priority and profit is a resource to achieve our goals. We do not use any measurements tool to calculate our social and ecological value. We do not set clear revenue boundaries yet, we first need to have stable yearly sales for that, survival is more important than reaching revenue goals.
	<b>Stakeholders</b>	I consider humanity as the main stakeholder of our company. Everyone is using and wasting water in highly inefficient ways. In order for humanity to survive, we need to change the ways we use water. And this company tries to bring the change. But we also consider nonhumans as stakeholders. I would like for everyone to take an example from Ecuador where nature has constitutional rights. We always consider nature as a stakeholder with power and legitimacy during decision-making processes. Nature also gives direction and guides us in our goals and innovations. We basically have 2 supply chains; one for our plastic products and one for our biodegradable products made from paper pulp. Our suppliers and clients are not analysed on their sustainability. However, we do not cooperate with companies and projects where land grabbing is part of the business model.
	<b>Value Proposition</b>	The value we offer is that we tackle one of the many global challenges the world is facing by creating innovative water saving technologies that produce food while using 90% less water. This will combat erosion, create the production of saleable products, help produce food, create approximately 1 direct and 1 indirect job per hectare, can help revitalize the rural areas and this way diminish migration and change the soil into a sponge, stimulate the harvest of rainwater. Our long-term goal is to create a revolution in the agricultural sector but also in for example city irrigation systems concerning water usage. But we especially want to offer a solution to small local farmers with no/limited access to water. In order to reduce our negative impacts we decided not to travel to potential clients and use online marketing instead. And we try to diminish our other negative values.
	<b>Firms' processes</b>	Scarcity can be translated into price, and since we want our cost price to be as low as possible we definitely take scarcity into account. The low cost price is necessary in order for poor farmers to be able to afford our products. Decisions regarding materials are also based on functionality, efficiency and sustainability and are made by the owners of the company. The products make use of natural services since they make use of rain and condensation water. Our processes in the plastic industry are focused on sustainability and there is a lot of innovation in that industry. In the paper pulp industry there is less innovation and less sustainability. We cannot really influence this. But since the energy usage during the paper pulp processes in Mexico are highly inefficient and transportation is so inefficient as well we decided to move to another country.



## Appendix M Results Elements successful sustainable business model company 12

Model	Constructs	Company 12
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	Once we get the feedback that our prototype really works, than we are successful. But when this happens we need to keep pushing it and make next steps. One of the key things we wanted to achieve with setting up this business is making sure that we closely collaborate with students and the university, and provide students learning and developing opportunities. We even invite students to come up with own ideas, and we want to teach them how a group of random people can collaborate and start a business, about product development, and about the horse industry. And of course we want to contribute to animal welfare by reducing the stress and increasing the water uptake of racehorses. At the moment we do not measure our social and environmental values.
	<b>Stakeholders</b>	We, the employees of the company, generally take votes during decisions. During decision-making we keep the users/buyers of our products in mind. They provide us with feedback about our products and we try to incorporate that. Our clients are mostly owners of racehorses. Other main stakeholders we consider are the horses. We design products for them, so we need to adjust our products to them and make sure the products cannot be broken by horses, but also that the products do not scare the horses. The environment around our products and processes is also considered as stakeholder. We do not want to harm people and nature around our products and processes. Our stakeholders can make or break us and therefore we continuously looking at their current and future power and legitimacy.
	<b>Value Proposition</b>	Racehorses get stressed easily, and when this happens they do not drink water and get injured. We are offering products to minimize the stress and maximize their water uptake. We are aware that too much technology or products near horses can have negative impacts on the horses; therefore we try to minimize this as well. And sometimes our solution is not to have any technology around the horses. And we also try to minimize our use of plastic, since it can come in horse feed when a product breaks. We also understand that the race horsing industry is not sustainable, but it is out there and we try to make it a bit more sustainable. In the future we want to look whether these products and their values can be translated into other industries.
	<b>Firms' processes</b>	We are not fully considering our supply chain yet, but we do work with local and sustainable suppliers. In the future we want to make sure that our whole supply chain is not polluting, pays minimum wage etc. And we even want to make this company a b-corporation. Our designer does not use toxic materials and uses biomaterials where possible. We consider the whole life cycle of all the materials. We created a kind of red list including materials we do not want to use in our products to protect the environment and the horses. And of course scarcity is taken into consideration during the creation of the list. When we are in the position to scale up we are also going to consider sustainability during our processes. At the moment we do not consider the impact of the manufacturing of the prototypes. But when we scale up it is something we will consider.

## Appendix N Results Elements successful sustainable business model company 14

Model	Constructs	Company 14
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Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	I think our success is measured by the social, economic and environmental impact of our business model. The biggest success would be the implementation of a network in any city and that farmers are able to make profit; this means that people can generate profit by becoming an urban farming and that is will become a trend. We will measure our social impact through the network, through projects that we implement like education, through customer engagement, through awareness. We are going to be able to measure our environmental impact when our systems are actually producing just by analysing how much we are producing, and by measuring how much waste from other industries we recycle. Since we are still in the developing phase it is hard to measure this all and take it into account during calculations. One advantage of our product is that it is digitalised, so we can measure and calculate things precisely in the future.
	<b>Stakeholders</b>	Our supply chain is very important; our manufactures are the ones that define the sustainability of our product. At the moment our piloting clients are also very important; they help us to create awareness and to gain visibility, and of course to test our products and services. Supporting organisations are also important stakeholders; they help us with the expansion of our network. One organisation helps us to improve our circularity, and another organisation helps us to find more sustainable materials. Another stakeholder is the government; soilless produced products cannot be labelled as organic at the moment. And we have to deal with rules and regulations. Nature is also an important stakeholder and influences the decisions we make since we are trying to reduce our footprint and to tackle the environmental challenges of the current food supply chains. Our stakeholders can empower us, and there future power is important to take into account.
	<b>Value Proposition</b>	The solutions that we are developing are modular, scalable, exponential, easy to use and automated. These are like the main differentiators from other industries. And most especially, the most honourable thing of our business model is decentralizations of manufacturing, of food production and the generation of communities for local farming. We have a very strong focus on communities and that is why we empower these communities by offering a system and a service. No other company is doing this right now, and therefor our goal is to be successful in this in the future. Of course we know that there will be a footprint and we try to reduce it, but there will also be environmental services. Because in the end we are producing food. So if we are producing food in cities, we avoid that food is produced in fields were pesticides are used for monoculture lands. And we avoid a lot of transportation and distribution and preservation of food, which is very energy intensive. So I think that as little footprint that we will be generating by producing our products will be redeemed with environmental services that we are offering.
	<b>Firms' processes</b>	Decisions regarding materials are based on technical and mechanical properties, sustainability and esthetical properties. We use a lot of waste from other industries as materials, we use biodegradable materials and we use 3-d printing techniques to avoid waste. The solutions that we provide are based on soilless farming which needs 90% less water when growing the food, and it also does not need any pesticides. During the manufacturing processes 3-d printing techniques are used to make processes more sustainable, and we try to decentralize manufacturing as much as possible. It is hard to influence the decisions of our technical manufacturers, they provide us with standard technical materials and we cannot influence their sustainability. We take scarcity into account during our own decisions. We are currently trying to make our processes more sustainable by; improving the circularity of our products; redesigning our products; and by finding new material options.

## Appendix O Results Elements successful sustainable business model company 15

Model	Constructs	Company 15
Elements that define general successful sustainable business models	<b>Boundaries and goals</b>	We have several goals that define our successfulness. We want to establish a connected community where for example solutions discovered in Colombia can be used in Congo. So we want to become pollinators of solutions. Another goal is to create a profitable and stable business. And another goal is to make a difference as community when the community is strong enough. Together with our community we want to be able to co-develop things. At the moment we try to better understand how the market works. We know that our sustainable impact is getting better and better and is organically developing, but we do not measure it at the moment. Economic indicators are crucial right now because we are looking for investors. We believe than once our economic value is doing well we will be able to create more social and environmental impact. When financial key indicators are stable we start measuring the other values.
	<b>Stakeholders</b>	We are focusing on education; so all experts that try to transfer knowledge with our tool are important stakeholders. One of our goals is that anyone in the world can use our tool, so anyone is our stakeholder. Nature is also an important stakeholder; we try to better understand nature and if we better understand nature we can have a bigger impact. We partnered with IT companies. We consider the future legitimacy and power of our stakeholders, because they are important in our growth process.
	<b>Value Proposition</b>	We are trying to find the balance between humans and nature, as a tangible step we have created our own platform to create, gather, connect, curate and transfer knowledge in a beautiful way. We consciously try not to generate negative value. We have not yet experienced that our platform is being used for the wrong purposes. And nature taught us things about different types of relationships; we are trying to not extract energy from anyone, but we try to add more value to everyone.
	<b>Firms' processes</b>	Our decisions are based upon the Life Principles. We are only not able to comply with the life friendly chemistry principle.

