VDI Zentrum Ressourceneffizienz

On behalf of:

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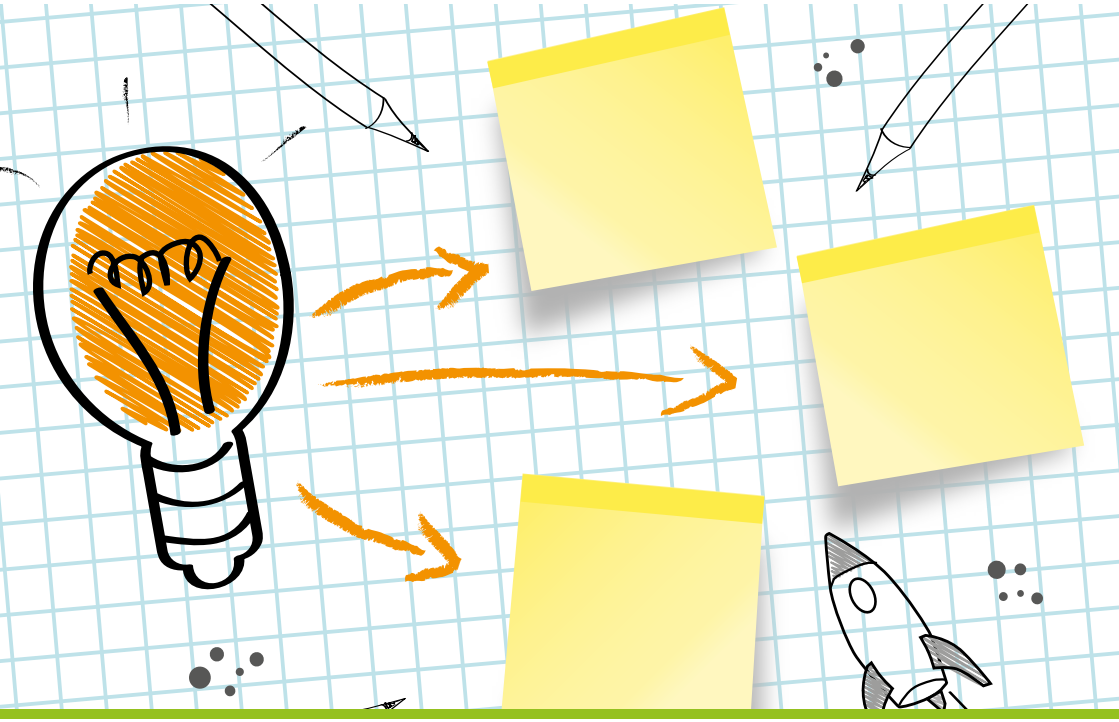
for the Environment, Nature Conservatio
Nuclear Safety and Consumer Protection

of the Federal Republic of Germany

VDI ZRE Publications: Brief analysis no. 29

New business models and resource efficiency



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VDI ZRE Brief analysis No.29: Business models and resource efficiency

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This brief analysis was developed on behalf of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection.

The brief analyses of the VDI ZRE provide an overview of current developments in the field of resource efficiency in research and industrial practice. They contain a compilation of relevant research results, new technologies and processes as well as best- practice examples. The brief analyses thus provide an introduction to selected resource efficiency topics for a broad audience with business, research and administration background.

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LIST OF ABBREVIATIONS

B2B	Business-to-Business
B2C	Business-to-Consumer
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (German: *Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz)*, formerly BMU
CO_2	Carbon dioxide
EMAS	Eco Management and Audit Scheme
GRP	Glass-reinforced plastic
HSB	Hybrid service bundle
HSG	University of St. Gallen
IAO	Institute for Industrial Engineering (German: *Institut für Arbeitswirtschaft und Organisation*)
IoT	Internet of Things
IPA	Institute for Manufacturing Engineering and Automation (German: *Institut für Produktionstechnik und Automatisierung*)
IPSS	Industrial product-service system
ISO	International Organization for Standardization
KrWG	German Circular Economy Act (German: *Kreislaufwirtschaftsgesetz*)
LED	Light-emitting diode
PSS	Product-service system

SLA	Stereolithography
SLM	Selective laser melting process
SLS	Selective laser sintering
SME	Small and medium-sized enterprise
VDI	Association of German Engineers (German: *Verein Deutscher Ingenieure e.V.*)
VDI ZRE	VDI Zentrum Ressourceneffizienz GmbH

PART 1: BRIEF ANALYSIS

1 INTRODUCTION

The worlds of business and industry have undergone some significant changes in recent years. Established institutions, including some that have been around for centuries, are being supplanted by competitors with completely new business models. Online lexicons are replacing encyclopaedias, the largest accommodation platform doesn't own a single one of the properties it offers, and new competitors with innovative business ideas are surging into the market, largely as a result of rampant digitisation. However, alongside the challenges of a world that continues to change at an ever-faster rate, these disruptive developments can present far-reaching opportunities when it comes to industry and resource efficiency.

"Megatrends" (cf. Figure 1) provide detailed explanations of the severe, ongoing processes of change that are taking place in the business world. These trends include continuous and global developments, such as digitisation and the emergence of platform economies, which are fundamentally changing public life and society for the long term. According to these trends, product-oriented services are expected to continue their growth. The neo-ecology megatrend refers to the growing need for sustainable economic and business models from an increasing number of stakeholders throughout business, politics and society.[1] Terms within this trend such as circular economy, sharing economy, green tech or sustainable consumption are being used more and more frequently in everyday language. The integration of these trends into existing and new business models brings with it huge potential for resource efficiency and a plethora of other economic opportunities. These trends also suggest that the inclusion of ecological factors is becoming increasingly significant for success and can represent a crucial feature that distinguishes a business from its competitors.

Even small and medium-sized enterprises (SMEs) can adapt their business models, e. g. by complementing the sale of products with marketable services. This is referred to as a product-service system (PSS) and can generate new sources of revenue. For example: selling value instead of a

[1] Cf. Zukunftsinstitut GmbH (2020).

product or offering a maintenance service can increase utilisation of machines or reduce downtimes through preventative maintenance, which can simultaneously lead to resource savings.

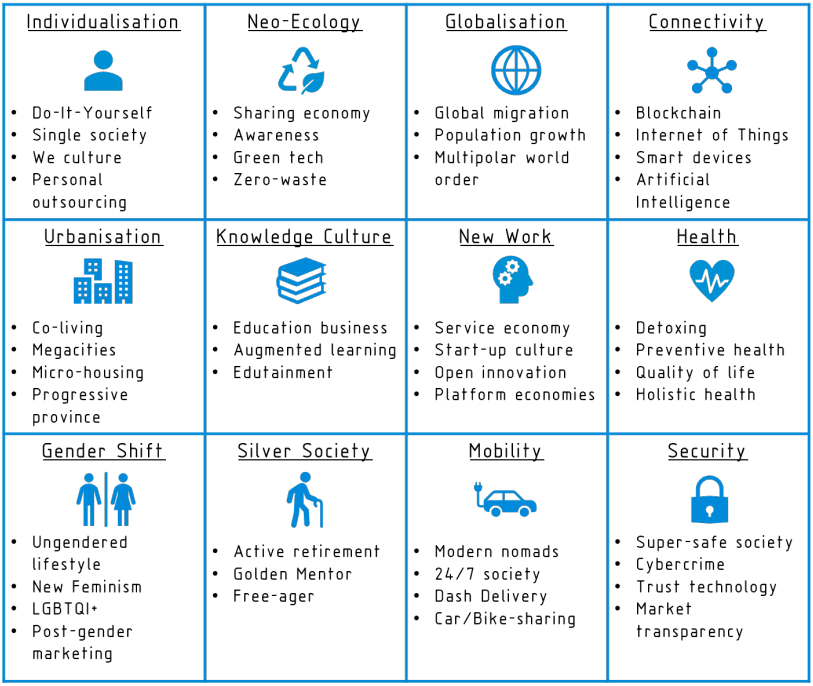

Figure 1: The current megatrends and a selection of subcategories[2]

According to the *VDI-Richtlinie 4800 (Blatt 1)* guideline, resource efficiency refers to the relationship between a defined value or result and the resource usage required to achieve this.[3] From a company's point of view, resource efficiency can be increased through material and/or raw material savings or by reducing energy demand. Increasing the service life of products also helps to increase resource efficiency and thus increases value. Any use of resources results in the emission of greenhouse gases. Measures to increase

[2] Cf. Zukunftsinstitut GmbH (2020).

[3] Cf. VDI 4800 Blatt 1:2016-02.

resource efficiency can therefore also play a significant role in protecting the climate.

This brief analysis aims to identify new and innovative business models and outline the opportunities and challenges that the potential for resource efficiency in present and future industry-related models represents. The focus will lie on the feasibility of such models for small and medium-sized enterprises. The term business model has no uniform definition. To start, then, it is necessary to have a basic understanding of business models and their application in practice. This will then be used to introduce basic business models and, using good-practice examples from the status quo, present an overview of potential business models in which resource efficiency plays a significant role.

2 WHAT IS A BUSINESS MODEL?

The term "business model" was coined with the emergence of IT companies in the 1970s, originating from business information systems. With the rise of the "New Economy" at the turn of the millennium, use of the term gradually gained popularity in business studies.[4] This ongoing process of change, however, means there is still no uniform definition.

To begin with, the term focussed largely on the modelling of business processes. Today, however, a business model is more and more frequently understood as part of a company's strategy due to the business context.[5] In this sense, the modelling concept supports businesses in achieving economic targets by providing the option for clear analysis, communication and planning.[6] In simple terms, a business model can be defined as follows:

> "A business model describes how an organization creates, delivers, and captures value."[7] [8]

Accordingly, the original business model of a mechanical engineer, for example, is based on developing and selling machines, while a plant engineer's business model is based on installing and maintaining heating and ventilation systems.

Companies today are already making efforts which are driving forward a more resource-efficient, environmentally friendly way of thinking. This chapter will look at the extent to which these successes are promoting the necessity for new business models while examining the development and objectives of these new business models.

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[4] Cf. Becker, W.; Ulrich, P. and Stradtmann, M. (2018), pp. 8.

[5] Cf. Ahrend, K.-M. (2016), pp. 9.

[6] Cf. Ahrend, K.-M. (2016), pp. 11.

[7] Osterwalder, A. and Pigneur, Y. (2011), pp. 11.

[8] The term "value" can also be understood as added value. The aim of a company is to always generate added value for customers through products or services. Classic examples of added value are time and money savings.

2.1 Emergence of new business models

The abrupt rise and fall of large market players is often attributed to the processes of change outlined in the introduction, caused by megatrends throughout business and society. An example of this is the Munich-based semiconductor manufacturer, Qimonda: With over 11,000 employees in 2008, the company was too slow to implement processes of change, such as more economical production processes, and had to declare insolvency in 2009. Even traditional companies like Kodak or Karmann completely underestimated the changes in their industries and suffered huge losses in market shares or, worse yet, disappeared altogether. This research, therefore, seeks to identify and present different business model types. The aim is to ascertain which basic business models help lead to the success of a company. Here, there are sometimes huge differences in the detailing and descriptions of business model paradigms.[9]

The University of St. Gallen's (HSG) approach is to identify tried-and-tested business models and create new and innovative models from these. This was the most comprehensive representation as part of the research carried out during this analysis. Other researchers also refer to these results.[10] The starting point for HSG was an analysis of 250 different business models and their applications between 1992 and 2017, spanning over five years. This analysis involved practical evaluation in collaboration with a variety of companies from various industrial fields and[11] resulted in the compilation of 55 paradigms which generated innovative business models within the observed scope of the study. The findings of the study can be summarised as follows:[12]

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[9] Cf. Ahrend, K.-M. (2016), pp. 16 – 23.

[10] Cf. Ahrend, K.-M. (2016), pp. 16 – 17.

[11] Collaboration with: BASF (chemistry), Bühler (engineering), Hilti (tools), Holcim (cement), Landis & Gyr (current measurement), MTU (turbines), SAP (software), Sennheiser (audio technology), Siemens (healthcare) and Swisscom (telecoms).

[12] Cf. Gassmann, O.; Frankenberger, K. and Csik, M. (2017), pp. 3.

In the most common cases, new business models are not based on revolutionary ideas. They are instead derived and developed as a targeted recombination using existing basic business models.

Digitisation in particular is giving rise to new opportunities that are seeing known business models established in previously atypical industries. This becomes clear when looking at everyday business life. The concept of leasing in the world of real estate is nothing new; on the other hand, using the same model in the automotive industry by implementing new tools such as mobile apps is innovative and revolutionary. The same applies for online mail-order companies. These companies have not reinvented the principle of mail-order business but they have adapted it to the world of the Internet. Therefore, it can be deduced from this that:

Innovative business models in industry can often also be considered to include existing business models that are used in previously atypical sectors.

A list of the business model paradigms compiled by HSG, including company examples, can be found in the Appendix. The basic business models presented in this analysis were selected using the selection and exclusion criteria below and are explored in the respective chapters:

- Excluded are business models based purely on digitality: some business models play out exclusively on digital platforms. This includes, for example, models based on data analysis and marketing. These models will therefore not be examined in detail. The analysis will, however, refer to potential synergies.

- Business models with materiality are selected: even where traditional transactions are no longer explicitly needed to contribute to the success of the business, a transfer of material goods is a basic prerequisite for examining resource efficiency potential within the industrial context.

Based on the HSG results and the trends already outlined, such as the ongoing growth of the services sector and digitisation, it is clear that, within the industrial context, innovative business models are arising primarily in

the form of hybrid value added (cf. Figure 2). Offering an integrated service alongside a product leads to the combination of previously separate business transactions. This is called a product-service system. The terms hybrid service bundle (HSB) or industrial product-service system (IPSS) are also used within the industrial B2B context. In the most extreme cases, revenue as part of PSS is no longer generated via a product. It is instead generated exclusively through the resulting services.

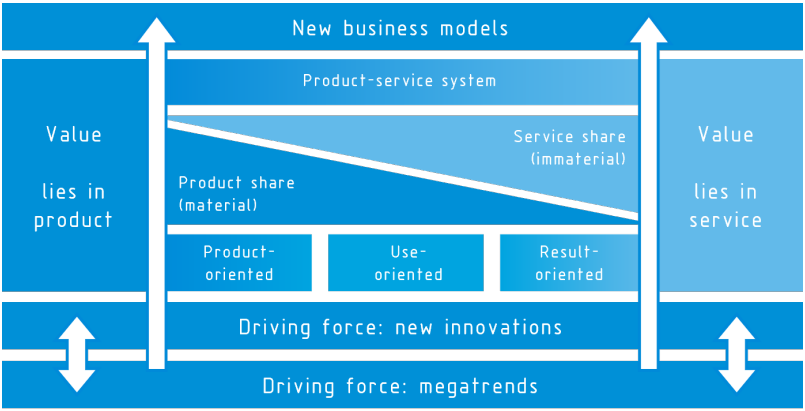

Figure 2: The emergence of new business models in the industrial sector[13]

It is highlighted once again here that the idea does not always need to be a new one. For example, someone building a cellar will probably buy the end result (excavation) and not the digger itself. In industry, one known example can be found in the aviation sector. Here, customers pay the UK-based turbine manufacturer for the use of its turbines rather than for the actual turbine itself (**performance-based contracting**). In similar sectors, PSS business models are implemented by metering energy demand and using this as the basis for calculating use.

Going further, the question of ownership is redefined in a PSS. While traditional transactions of products involve a change in ownership, today, sharing or time-limited transfers (renting, leasing) are becoming more and

[13] VDI ZRE figure.

more popular. Therefore, it is important therefore, to pay particular attention to these concepts. This leads to another important finding:

> Almost all business model innovation in the industrial sector comes from a combination of products and integrated services. Therefore they can generally be categorised under product-service systems.

A study carried out by the Fraunhofer Institute IPA and Dr. Wieselhuber & Partner GmbH in 2015 showed to what extent digitisation will change business models in mechanical and plant engineering. The results were used to simulate two future scenarios:

- **Evolution business model:** gradual further development of existing business models with strategic partnerships between mechanical engineers and IT companies. Consideration of machine-to-machine generation with technical innovation remains decisive.[14]

- **Disruption business model:** radical changes to industry logic. IT companies and their business models take root in mechanical engineering, with data and services representing a significant proportion of value added. Traditional mechanical engineering is pushed back into increasingly contested niche markets.[15]

As time has gone by, it is clear that none of these scenarios has become particularly prominent yet. Nevertheless, some larger companies with the relevant know-how are starting to lean towards more IT-heavy, disruptive business models.

2.2 Development of business models

In addition to a theoretical approach, the term “business model” has also established itself in the business world. Again here, the term can be seen to

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[14] Cf. Emmrich, V.; Döbele, M.; Bauernhansel, T.; Paulus-Rohmer, D.; Schatz, A. and Weskamp, M. (2015), pp. 38 – 39.

[15] Cf. Emmrich, V.; Döbele, M.; Bauernhansel, T.; Paulus-Rohmer, D.; Schatz, A. and Weskamp, M. (2015), pp. 41 – 42.

encompass wildly differing ideas – everything from a very abstract way of thinking to a clear, everyday business strategy (cf. Figure 3):

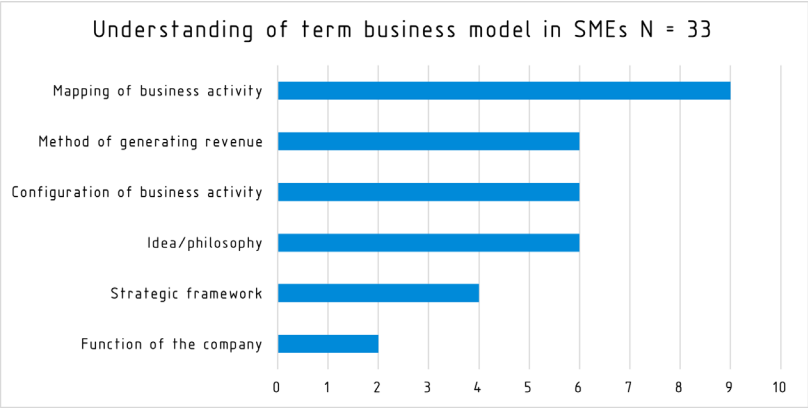

Figure 3: Survey on the understanding of the term business model in SMEs (N = 33)[16]

Researchers have therefore developed instruments for examining the various business models in a systematic manner. A frequently used model for presenting and identifying the different sub-sections of a business model is the **Business Model Canvas** proposed by Osterwalder and Pigneur.[17] The template provides a clear framework for visualising, structuring and developing business models and is used most notably by the German business founder platform, *Gründerplattform*, sponsored by the Federal Ministry for Economic Affairs and Climate Action (German: *Bundesministerium für Wirtschaft und Klimaschutz, formerly BMWi*).[18] The template is application-oriented and uses elements to describe business models (cf. Figure 4). Analysis of the segments is then taken as an effective starting point for determining strategic measures and identifying resource efficiency potential for both current and future business models.

[16] Cf. Becker, W.; Ulrich, P.; Ebner, R.; Holzmann, R.; Krämer, J. and Staffel, M. (2011), pp. 46.

[17] Cf. Osterwalder, A. and Pigneur, Y. (2011).

[18] Extensive support for developing new business models can be found at www.gruenderplattform.de.

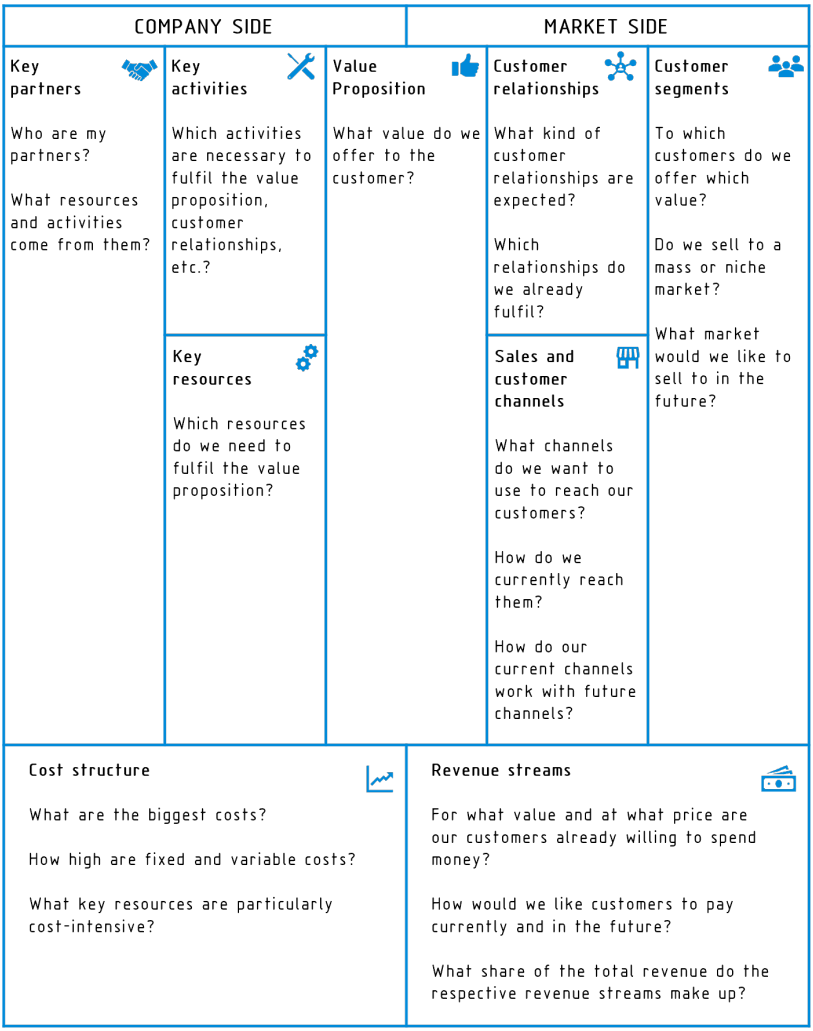

Figure 4: Business Model Canvas proposed by Osterwalder and Pigneur[19]

As shown in the figure, according to Osterwalder and Pigneur, the value proposition to the customer is at the centre of a business model. Ultimately,

[19] VDI ZRE figure based on strategyzer.com (2021).

the term value proposition is considered to be the added value that is promised to the customer by way of the product and/or service. All sub-sections of a business model can be seen as set screws which help to fulfil the value proposition through (strategic) measures on both the market and company side. The elements and sections should be seen as interconnected rather than separate entities.[20] This basic template is often expanded upon with further dimensions such as company image and company values, as a positive public image is becoming increasingly important for many companies.

As the elements of a business model are all connected, changing one element can affect another, subsequently impacting the whole model. New business models are therefore derived from all sub-sections of the template and/or value added.[21]

An example: The value proposition of a car manufacturer is the production of cars that take a person from point A to point B (added value: mobility). While previously this added value was provided through the sale of cars, today there are alternatives such as sharing or leasing options. This means that even partners such as car dealerships must adapt to the new circumstances or run the risk of being supplanted by the direct online trading business model, for example.

At the same time, many corporations are outsourcing large portions of their production and development to external partners which, in turn, is impacting the amount of resources and number of employees required (e. g. temporary staff). Customer and partner dependencies mean that flexibility and the ability to adapt a company's business model are becoming more and more important.

The Business Model Canvas and its focus on value proposition is also suitable for shifting new business models towards resource efficiency. According to the *VDI-Richtlinie 4800 (Blatt 1)* guideline, resource efficiency is defined as

[20] Cf. Ahrend, K.-M. (2016), pp. 14 et seqq.

[21] Cf. Osterwalder, A. and Pigneur, Y. (2011), pp. 142.

the relationship between a defined value or result and the resource usage required to achieve this.[22] In reference to the Business Model Canvas, resource-efficient business models are thus a result of an increase in the value proposition and/or reduction in the material and energy costs through measures in the individual elements on both the market and company side.

Reorienting individual segments in the Business Model Canvas – taking into consideration resource efficiency – creates more flexibility in existing business models and leads to the emergence of new business models.

Analysis of resource efficiency potential on the market and company side follows the BMUV's waste hierarchy guidelines as far as possible to comply with the German Circular Economy Act (KrWG), and forges potential strategies for issues ranging from raw material prevention to recycling approaches.[23] Considerations focus on measures for conserving resources as resource savings can be linked with aspects of resource efficiency with much more transparency than an increased value proposition. A practical example of this is the free-floating carsharing concept (flexible sharing instead of fixed stations). Here, the supposed sustainable promise of sharing consumer goods has proven to be questionable, environmentally speaking.[24] A study showed that the expected reduction in traffic did not materialise and the number of car owners in the test groups actually increased by up to 15% during the trial period.[25]

2.3 Green economy

Even if not every business defines its own explicit basic principles of value creation, every company has a business model according to the parameters outlined at the start. The fact that measures for increased resource efficiency

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[22] Cf. VDI 4800 Blatt 1:2016-02, pp. 12.

[23] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (German: *Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit)* and www.bmu.de (2017).

[24] Cf. Reintjes, D. (2018).

[25] Cf. Hülsmann, F.; Wiepking, J.; Zimmer, W.; Sunderer, G.; Götz, K. and Sprinke, Y. (2018), pp. 117 et seqq.

are already being put in place throughout the realm of business is confirmed by looking at the growing "green economy" market. The term "green economy" refers to an economy oriented towards innovation which limits ecological risks and takes advantage of economic opportunities. This results in far-reaching structural and transformative changes as opposed to mere surface-level adjustment measures. This also includes cross-sector environmental technology and resource efficiency and can be divided into the following lead markets (cf. Figure 5):

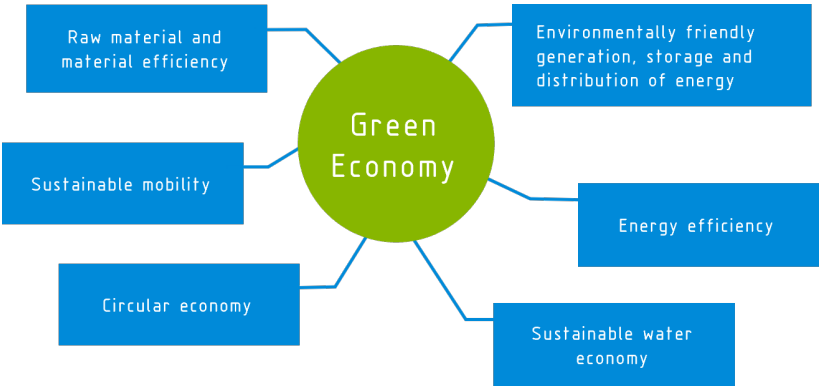

Figure 5: The lead markets of a green economy[26]

In 2016, the global green economy market volume amounted to 3,214 billion euros (Germany: 347 billion euros). In Germany, the sectors of raw material/material efficiency and recycling management are expected to grow from 63 to 155 billion euros and 20 to 32 billion euros respectively by 2025. Growth from 83 to 182 billion euros is forecast to take place by 2025 in the energy-efficiency sector across Germany. Globally, the overall market volume is set to reach 5,902 billion euros by 2025.[27]

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[26] VDI ZRE figure based on Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (German: *Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit)* and www.bmu.de (2018).

[27] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (German: *Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit)* and www.bmu.de, pp. 45 et seqq.

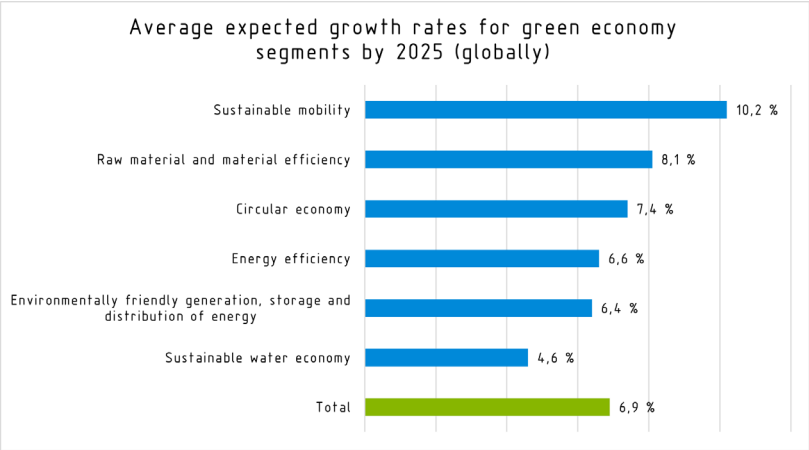

Figure 6: Average expected global growth rates for green economy segments by 2025[28]

In addition to the prospects of economic success (cf. Figure 6), the successes of resource-efficient enterprises can be illustrated by taking a look at the total raw material productivity (cf. Figure 7). This indicator shows the value of all goods output for the last application (in euros, inflation-corrected) in relation to the mass of the raw materials used domestically and abroad for the production of the goods (in tons). During the observation period between 2000 and 2016, a positive trend was identified showing that raw material use stayed almost exactly the same.

[28] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (German: *Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit)* and www.bmu.de, pp. 50.

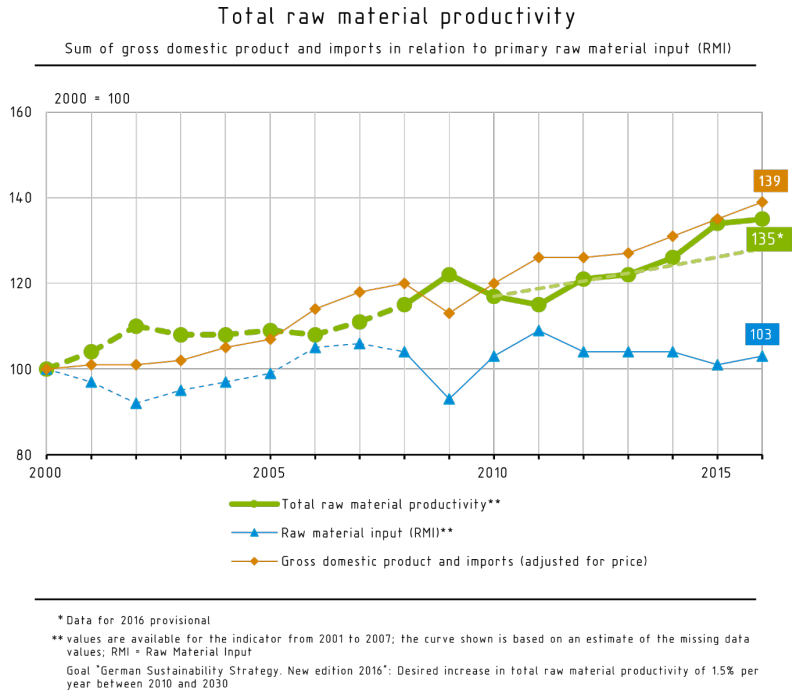

Figure 7: Development of total raw material productivity in Germany [29]

The growth forecast and long-term gain in productivity illustrate the huge potential for resource-efficient enterprises. This is also bolstered by measures related to environmental policy such as the "resource-efficient Europe" roadmaps, the European Union's flagship initiatives or the German government's amended Circular Economy Act (KrWG). Accompanied by ongoing digitisation and the new competition structures and framework conditions that result from this, competitive pressure is theoretically expected to increase which can in turn be countered through innovative business models. Making business models more flexible and adapting them

[29] Cf. Federal Statistical Office (German: *Statistisches Bundesamt*), pp. 54.

to include ecological and resource-efficient aspects is therefore extremely important for SMEs.

The green economy growth forecast combined with ongoing digitisation, increased networking of people and machines, and political efforts to advance aspects of the circular economy, create the ideal conditions for the evolution of new market players and increase competitive pressure. Considering new and innovative business models is therefore essential to remain competitive. In doing this, the following questions should be asked:

- Will changes eliminate demand for the proposed application cases?
- Will customer groups migrate due to the changes or will they relocate?
- How can a company profit from future changes?

3 RESOURCE EFFICIENCY POTENTIAL

The Business Model Canvas presented in section 2 (cf. Figure 4) provides a great method for working to make existing models more flexible and develop new business models in a structured way. It is expected that, in practice, companies will need to focus primarily on economic competitiveness. Here, measures for resource efficiency can help support economic optimisation while fulfilling an ideal aspect too. A positive company image is becoming increasingly important with regard to business success,[30] and resource-efficient measures are a crucial starting point for sustainable corporate management. Due to the connective character of new business models (cf. chapter 2.1), the basic business models outlined in this section are often considered to be partial aspects of a PSS business model. Secrecy of certain stakeholders, interactions and innovations play an important role in a company's strategic position.[31] Considering new business models is therefore only possible in sectors where companies interact with external parties, e. g. customers and/or partners. The business model paradigms outlined should therefore not be taken as absolute and full models. Instead, they represent partial aspects (plus unknown internal strategies).

Digitisation gives rise to an important exception when considering business models. It is not only a driving force for the development of new business models,[32] it can be simultaneously considered as a business model in itself.[33] Complete digitisation and the resulting dematerialisation represent the most radical and significant reduction in resource consumption for use. Nowadays management or administration sectors, for example, can largely avoid material-intensive means of production, but the potential within an industrial context is far more complex.

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[30] Cf. Ahrend, K.-M. (2016), pp. 47.

[31] Cf. Ahrend, K.-M. (2016), pp. 361.

[32] Cf. Becker, W.; Ulrich, P. and Stradtmann, M. (2018), pp. 20 et seqq.

[33] Cf. Gassmann, O.; Frankenberger, K. and Csik, M. (2017), pp. 6.

3.1 Resource efficiency on the company side

New business models can be created based on measures in all sub-sections of a company. The business models introduced are guided by the classifications outlined in the Business Model Canvas and are further divided into a company side and market side. The elements on the company side (cf. Figure 8) are considered to be internal strategies and are described from a user perspective. Section 3.2 presents business model concepts that can be derived from the market side.

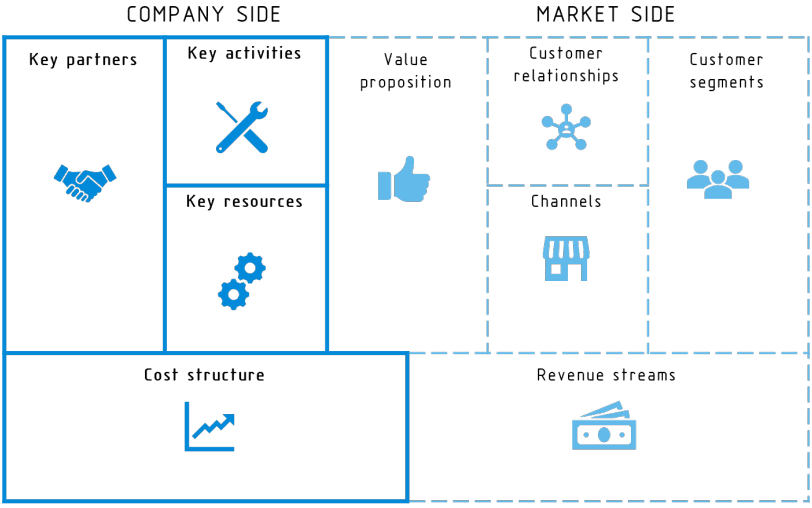

Figure 8: Business model elements on the company side[34]

The interconnectedness of different elements means it is not always possible to clearly separate aspects into distinct categories. For example, possible cross-segment strategic measures for saving resources include:

- Use of quality and environmental certifications (e. g. DIN ISO 14001, EMAS, eco-profit)
- Implementation of elements of lean management

[34] VDI ZRE figure based on Osterwalder and Pigneur (2011).

- Employees and project teams that span the entire value creation process
- Dematerialisation measures (e. g. digital pay slips, digital freight transport documentation, digital prototyping)

The rise of digitisation in the industrial sector is often described using the term Industry 4.0. When it comes to resource efficiency, the use of new technologies (e. g. new machines, sensors, software or data servers) represents an initial additional expenditure of raw materials, including some critical resources. Analysis of resource efficiency potential through digital measures, conducted on behalf of VDI ZRE, shows that savings resulting from the implementation of information and communications systems can still not yet be proven in all sections of the operational value chain.[35] An increasingly far-reaching use of such systems, however, can be expected as a result of ongoing digitisation and the subsequent increase in competitive pressure. Therefore, digitisation often acts as an "enabler" for the following basic concepts of new business models, making it much easier to implement them.

3.1.1 Increasing flexibility in key activities

The biggest changes in production sectors in recent years have been seen in the form of the integration of information and communications technology. This integration has fundamentally changed various processes that are crucial for business success, such as development, production or even marketing and sales, and made these processes much more flexible. While automating all production processes increases productivity, the development of status monitoring tools (condition-monitoring systems) also brings with it huge potential for saving resources. Predictive maintenance based on the obtained real-time data can be used to increase the service lives of machines or reduce scrap waste in production.

Alongside these internal process improvements, the Mass Customisation (cf. Table 1) business model has also grown in popularity, driven by the trends of networking and individualisation. This model involves the modularised

[35] Cf. Schebek, L. et. al. (2017), pp. 129.

and individualised customisation of mass products under competitive conditions.[36] A particularly attractive strategy for the industrial SME sector, and one that is often associated with the mass customisation model, is the use of additive manufacturing, or 3D printing.

The big advantage lies in flexible product design. 3D printing can be used as a new, stand-alone business model or be integrated into existing models. A few model examples here include the supply of niche markets (Long Tail), the guarantee of availability (Guaranteed Availability) or self-service which allows the customer to perform or make use of the service themself (Self-Service).[37] Thanks to continuous further development, 3D printing processes now stand in competition with drilling and milling processes and can save up to 40% of the waste generated by these processes.[38]

Table 1: Opportunities and challenges of the additive manufacturing business model

Business model: Additive Manufacturing	
Driving force: networking, neo-ecology, individualisation	
Opportunities	**Challenges**
• Partial exchange of defective machine parts for increased machine service life • Reduced material use thanks to reduced waste in production • Saving of storage space due to on-demand production • Less finishing required due to precision manufacturing • Customer-oriented production with extensive printer coverage • Extensive new and complex constructions possible • Increase customer retention and satisfaction thanks to quick, custom production • Use of a variety of materials on fewer machines • Expansion potential for quality leadership	• Limited construction volume due to printer size • High quantities sometimes (still) not economical • Potential conflict with copyright laws • Relatively long production time

[36] Cf. Gassmann, O.; Frankenberger, K. and Csik, M. (2017), pp. 8.

[37] Cf. Feldmann, C.; Schulz, C. and Fernströning, S. (2019), pp. 79 et seqq.

[38] Cf. Feldmann, C.; Schulz, C. and Fernströning, S. (2019), pp. 19.

Other promising prospects for successfully and resource-efficiently integrating 3D printing into business models come with the possibility of connecting with other companies and institutions via networks.[39] This mutual exchange can be used to develop prototypes and special or small series in various sizes and at competitive prices. The ability to save and send components entirely digitally, right up until a component is manufactured in the printer, significantly reduces storage and transport costs. In addition, exchange via networks is expected to lead to increased synergy, including new collaborations and innovations. The Covid-19 crisis throughout 2020/2021 can be seen as the first significant reference point for this type of successful networking. By joining 3D networks, many regions in Germany were able to produce custom face masks and shields quickly and flexibly at a local level.

Real life example: Additive manufacturing as a business model expansion

Rolf Lenk Werkzeug- und Maschinenbau GmbH is a mechanical engineering company based in Ahrensburg, Germany. The company uses additive manufacturing to manufacture highly complex components using the selective laser melting process (SLM). This process involves layering metal powder onto a panel and welding using a laser at predefined spots. The surplus metal powder can be removed and reused for the next process. If needed, the desired components can be modelled independent of location. As well as boasting material and weight savings, the process also makes use of a wide variety of metals such as stainless steel, tool steel, titanium, aluminium, Hastelloy and Inconel. This allows businesses to respond to individual customer needs or manufacture expensive replacement parts in a cost-efficient and resource-efficient way.[40]

[39] 3dnetzwerk is an independent cross-sector network. The user network provides a platform for over 690 companies, start-ups, universities and institutes to exchange knowledge on 3D printing and additive manufacturing. Find out more at: http://www.3dnetzwerk.com/

[40] Cf. Rolf Lenk Werkzeug und Maschinenbau GmbH (2017).

Real life example: Additive series manufacturing as a new business model

With around 280 employees, the Lupburg-based FIT Additive Manufacturing Group specialises in selective laser sintering (SLS), stereolithography (SLA), metal 3D printing and vacuum casting. In addition to traditional industrial metals, the group can also make use of other materials such as ceramics and plastics as part of individual or serial production. The group is also able to simulate component loads and translate the design into one that is suitable for additive manufacturing with the help of dedicated software. This means FIT AG can manufacture complex components with perfect material properties using minimal materials, breaking free from the construction restrictions seen with machine production, for example.

Taking into account the maximum packing thickness on the printer platform, serial products can be manufactured in a more cost- and resource-efficient manner. The use of a de-powdering station can also allow excess raw materials to be reused directly.[41]

3.1.2 Sharing key resources

The various aspects of key resources are closely linked with production and other core company activities. Resources, in this sense, can be understood as natural resources, expertise, machines and employees. Business models that adopt a cascading use system and convert supposed waste into new products (Trash to Cash) can be implemented directly in resource-efficient and innovative models.

However, the largest potential for new business models – created based on a more innovative approach to key resources – comes from the processes of change in the ownership structure. While machines, raw materials and

[41] Cf. SLM Solutions Group AG (2016).

employees used to be intrinsic to and/or affiliated with a company, recent sharing and leasing concepts are now replacing, or at least being used to complement, these traditional structures across a growing number of sectors (Rent instead of Buy).

The concept of leasing already has a long history in the agricultural industry in the form of labour leasing. German agricultural machine cooperatives, referred to as *Maschinenringe*, have been relying on leasing for their farm equipment and forest machinery since 1958 (Fractional Ownership). In addition to the ecological benefits for agriculture, removing the need to purchase this expensive machinery individually and only using it on an ad-hoc basis has subsequently removed the need to manufacture the machines in high numbers, translating to huge savings in resources. Extensive networking can also help avoid resource-intensive processes such as long transport routes. This idea of shared use of machines and other production factors can also be carried over to traditional industry (cf. Table 2).

Table 2: Opportunities and challenges of sharing concepts in industry

Business model: Sharing Concepts	
Driving force: Connectivity, neo-ecology, digitisation	
Opportunities	**Challenges**
• Reduced need for machines and vehicles and subsequently reduced raw material demand for manufacturing • Increased in-house production thanks to access to a larger variety of machines as part of a cooperative • Reduction of transport routes thanks to coordinated (disposal) logistics • Ability to profit from resource-efficient large-scale investments such as the acquisition of new machines or connection to green energy networks • Increased synergy, including innovation exchange thanks to improved networking as part of an association/cooperative • Improved processing possibilities thanks to transparent waste structure • Faster response to market changes • Increased bargaining power as part of an association/cooperative	• Legal issues (liability and protection of intellectual property) • Transparency required for coordination with partners • Reduced flexibility in some work processes

Alongside this, digitisation has given rise to a plethora of new possibilities and tools in recent years. In addition to information and communications platforms, the continued networking of machines (Internet of Things) can also provide the level of transparency required to make sharing concepts more appealing for industry. Such networking, for example, makes it possible for machines to provide data on current and future assignments to allow users to fill free capacities in other ways.[42]

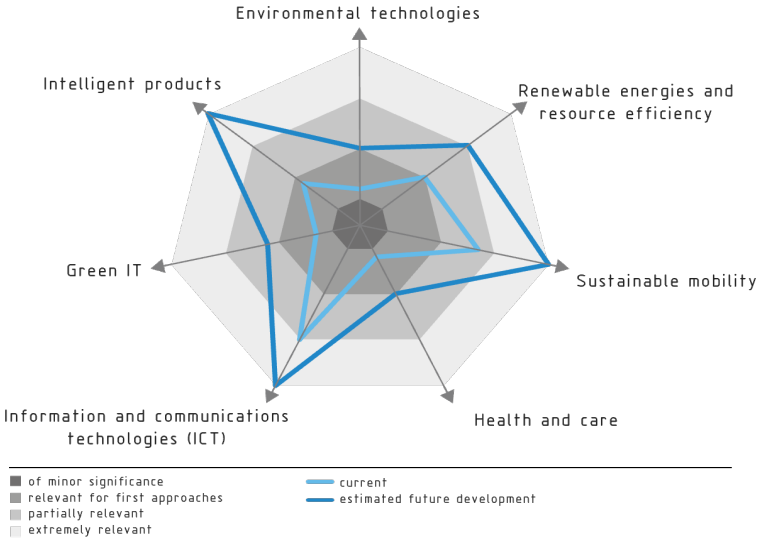

Figure 9: Current and estimated future relevance of the sharing economy in selected sectors[43]

The Fraunhofer Institute for Industrial Engineering IAO (German: *Fraunhofer-Institut für Arbeitswirtschaft und Organisation IAO*) investigated the concept of a sharing economy within industry in its 2015 Structure Study (German: *Strukturstudie 2015)* and expects that this model will become increasingly popular in specific segments (cf. Figure 9). While, from a

[42] **Useful B2B sharing platforms include V-INDUSTRY, Fabrikado or Klickrent. These platforms offer sharing options ranging from use of unused machine and storage capacities to resource and employee sharing.**

[43] **VDI ZRE figure based on Spindler, H.; Martinetz, S. and Friz, D. (2015), pp. 110.**

vendor's point of view, the sharing economy is seen as an economic opportunity to secure its financial future, over two thirds of the companies surveyed see the use of external resources as a source of huge potential from a user perspective.[44] The study also highlights further calls for action within the legal realm (liability issues and data protection) as well as with regard to the transparency of coordination centres[45], consequently underlining in its conclusion the urgent need for political intervention.[46]

Real life example: Increased machine utilisation through machine capacity sharing

Founded in 2018, the Stuttgart-based start-up V-INDUSTRY measures production capacities and offers them on an e-procurement platform for profit. This gives buyers of custom parts access to a regional production network that is always available. In the field of CNC machining, sheet shaping, additive processes and injection moulding, orders are forwarded to suitable companies that meet the relevant technical requirements and are able to meet the proposed deadline. To make this possible, hardware units are installed at the sites of various production partners to calculate machine times. These times are then encrypted and sent to the platform. The Wannweil-based company Brecht GmbH in the German Swabian region was able to generate a five-figure order revenue through its collaboration with V-INDUSTRY, optimising the capacity potential of its production. Production company FTSA GmbH, a corporate spin-off of Fritz Kaschiertechnik GmbH founded in 2012, was able to generate more than 40 orders within just two quarters using the V-INDUSTRY platform. The platform's transparent format makes it possible for enquiring companies to communicate directly with production partners and gain access to extensive expertise in the production industry. The quality of e-procurement is increasing and the risk is decreasing as a result.[47]

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[44] Cf. Spindler, H.; Martinetz, S. and Friz, D. (2015), pp. 77 – 78.

[45] Cf. Spindler, H.; Martinetz, S. and Friz, D. (2015), pp. 82.

[46] Cf. Spindler, H.; Martinetz, S. and Friz, D. (2015), 112 et seqq.

[47] Information based on discussion with V-INDUSTRY (2021).

3.1.3 Open partnerships

Every company has customers while also being a customer itself. Collaborating with and integrating partner companies and suppliers is therefore crucial to increase the resource efficiency of a company's business model (cf. Table 3). The following strategic approaches can be adopted:[48]

- **Substitution of operating supplies:** In addition to choosing sustainable energy suppliers and energy sources, cleaning products and lubricants should also be checked for their environmental compatibility. New business models also provide new economic incentives to implement these measures.

- **Substitution of raw materials and consumables:** While the ability to replace production materials can often be limited by technical guidelines, it is worth paying particular attention to the packaging waste generated. In 2017, Germany generated 18.7 million tons of packaging waste, half of which came from the industrial sector.[49] In addition to aspects of circular economy (reusable packaging) and cascading use for packaging, companies must also strive to substitute packaging types.

- **Regionality:** Although economic factors play an important role in the selection of business partners, choosing regional partners can allow long transport routes to be avoided and subsequently save resources. It also facilitates an efficient, transparent exchange between partners.

- **Industrial symbiosis:** For industrial symbiosis, a company or sector uses the byproducts and waste of another company (cascading use). These kinds of approaches have a long tradition in industry, where non-toxic waste is used to recover energy. Improving the interconnectivity of companies can facilitate a cascading use approach and, in turn, save resources.

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[48] You can find more information on customer and supplier integration at: https://www.ressource-deutschland.de/instrumente/ressourcenchecks/

[49] Cf. Brunnsmann, J. (2019).

In addition to the selection of business partners, the notion of partnership has fundamentally changed as a result of global networking. Phenomena such as crowdfunding turn customers into potential partners and, in ideal cases, accelerate resource-efficient innovation through rapid financing. Globalisation has also produced some unique business partnerships, known as joint ventures (Open Business Models). By combining knowledge from different fields, companies can share the economic risk of business expansion and drive resource-efficient innovation. Potential partnerships can be frequently found at a regional level, especially for SMEs. Partnering with start-ups poses huge, and often untapped, potential. In a study from 2018, just 38% of surveyed SMEs reported to have already worked with start-ups.[50] Intensifying this kind of partnership in the future will give companies the chance to successfully implement disruptive changes without their own IT or research department, e. g. through digitisation and new innovation. There is potential here for resource efficiency, for example in the form of more efficient communication or a better repair service. In turn, this can increase machine service life and improve productivity, leading to resource efficiency (cf. chapter 3.2.2).

Table 3: Opportunities and challenges of open business models

Business model: Open Partnerships	
Driving force: Networking, globalisation, knowledge economy	
Opportunities	**Challenges**
• Resource-efficient innovation through the combination of knowledge from different industries • Synergy such as transfer of expertise beyond a company's own projects • Sharing of business risk • Strengthening of market position • Advantageous innovation boost through collaboration with start-ups • Access to hard-to-access knowledge • Exploitation of new markets • New innovation drivers thanks to micro-investors	• Partnerships require effort and decision processes are complex • Legal issues • Risk of focus being solely on maximising profits without consideration of resource use

[50] Cf. Walisch, M. and Hemeda, A. (2018), pp. 16.

Types of inter-company collaboration can include all forms of partnerships, ranging from temporary/short-term cooperation to the establishment of a joint spin-off subsidiary. This brings with it various legal issues which may need to be clarified depending on the scope of the partnership.[52]

Real life example: Resource-efficient products through corporate collaboration

Zusmarshausen-based FISCO GmbH is a joint venture between Sortimo (automotive focus) and the company group Fischer (construction and fastening technology) founded in 2016. Combining the expertise in lightweight construction (Sortimo) and experience in the building industry (Fischer), FISCO was able to manufacture a non-combustible GRP material using pultrusion production. In contrast to traditional glass fibre-reinforced plastic with polymer-based matrix, the new material consists of glass fibres and a geopolymer matrix. According to FISCO, production of this new material saves 62% of CO_2 in comparison to conventional GRP, increasing to savings of 85% in comparison to steel, 90% in comparison to stainless steel and even 95% in comparison to aluminium.[51]

Real life example: Resource-efficient products through crowdfunding

Founded in Munich in 2016, Sono Motors GmbH has nearly 100 permanent employees and 300 external providers, and is striving to manufacture small electric cars with solar cells on the roof in an environmentally friendly way. The company relied on crowdfunding for its financing. The ambitious goal of offering a sustainably produced alternative, especially for inner-city and delivery vehicles, was at risk of falling apart at the end of 2019 after a large investor pulled out. Thanks to a community funding campaign, however, around 10,000 supporters raised almost 53 million euros in just 50 days. This saved the project.[53]

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[51] Information based on discussion with FISCO GmbH (2020).

[52] Cf. Fett, T. and Spiering, L. M. C. (2015), pp. 7 et seqq.

[53] Cf. Rudschies, W. 2020.

3.1.4 Adapting cost structures

From a business perspective, resource-efficient measures are an appealing tool for minimising costs. In addition to investments in more efficient machines and systems, this segment is also undergoing changes in the amounts of fixed and variable costs, e. g. through leasing and sharing concepts.

One common measure taken by companies to reduce fixed costs is outsourcing company business units. This can be done to varying degrees, ranging from the relocation of entire added-value segments to external service providers, to smaller outsourcing measures, e. g. in production, and follows the orchestrator business strategy (focus on core competencies). In certain conditions, this step not only makes economic sense, it is also an attractive approach with regard to resources (cf. Table 4). This is particularly true where there are certain location advantages to be had, such as "proximity to customers or employees" or "environmentally friendly location factors". For example, if a regular customer base can be localised to a particular region, relocating production, a branch or a warehouse reduces transportation distances and subsequently saves resources in distribution. Car dealerships are a classic example of this. By outsourcing sales to a third party, car manufacturers can concentrate on their core competencies. It also means that customers are not required to drive to the manufacturer's production site.

Outsourcing can have an important impact on resource efficiency. For example, if a company is planning a new production site as a subsidiary or choosing an external service provider, it is important to take into account the proximity to employees. The average commute distance back in 1999 was 14.59 km. By 2017, this had risen to 16.91 km with 18.4 million commuters.[54] Overall, personal car traffic in Germany is responsible for two thirds of pollution within the transport sector. And, although energy consumption has remained almost constant since 2010, energy demand now

[54] **Cf. Tautz, D. (2017).**

totals around 680,000 GWh a year.[55] For comparison: the annual injection of energy from Germany's largest coal power plant (and Europe's second largest emitter of CO_2) amounts to 31,300 GWh.[56] Reducing the daily commute distances required, e. g. by adopting urban planning approaches, can help to reduce this immense energy demand.

Energy- and raw-material-intensive sectors in particular are ideal areas for taking advantage of environmentally compatible location benefits for greater resource efficiency. Traditional examples can be found most notably in the metal processing industry, where the famous Ruhr district has been tapping into the locational advantage of the coal deposits for centuries. We must look to natural energy sources such as water, wind and solar power for a sustainable and resource-efficient projection for the future. It must be highlighted that outsourcing can also be limited by region. Outsourcing production facilities to local vendors, for example with a connection to the district heating and cooling networks, can help to achieve more resource efficiency through more efficient use of energy.

Table 4: Opportunities and challenges of sustainable outsourcing

Business model: Sustainable Outsourcing	
Driving force: Networking, globalisation, neo-ecology	
Opportunities	**Challenges**
• Production closer to customer for shorter transport routes • Product closer to employees for shorter commutes • Resource savings through the use of local natural location advantages • Increased recycling quotas through clear separation of areas of responsibility, resulting in increased purity of variety • Increased customer satisfaction due to potential proximity to customers • Increased employee satisfaction due to shorter work commutes • Reduction of fixed costs	• Risk of purely economic motivation • Potential uncontrolled flow of expertise • Potential failure to comply with expected standards • Loss of transparency in the selection of used materials to fulfil the desired service • Long decision-making channels

[55] Cf. Umweltbundesamt (2020).

[56] Cf. RWE AG (2020).

A study published in the Journal of Cleaner Production examined the optimal location planning of reprocessing networks for electrical waste in Europe. Here, a huge difference was established between the most economically sensible and most ecologically sensible locations. While outsourcing to states in southern Europe offers many economical advantages (lower cost structure), from an environmental point of view, a site in central Europe is sensible (highest refuse density and shortest channels).[57] In light of these findings, it should be noted that insourcing business units and/or value added can also increase resource efficiency (Integrator business model).

Adopting a transparent and speedy forward and backward-oriented decision structure and logistics is shown to increase resource efficiency as a result of homogeneous waste flows and shorter (decision-making) channels (cf. Table 5). It is up to the individual company, however, to determine which business model is more attractive from a resource perspective on a case-by-case basis.

Table 5: Opportunities and challenges of sustainable insourcing

Business model: Sustainable Insourcing	
Driving force: Neo-ecology	
Opportunities	**Challenges**
• Resource-efficiency thanks to shorter value creation channels • Resource-efficiency thanks to increased planning and quality assurance • Faster internal decision-making and implementation channels • Reduced dependency on suppliers • Strengthening of in-house production sites	• Potential for high investment costs and expenditure due to insourcing • Increased fixed costs • No longer able to focus on core competencies

[57] Cf. Messmann, L.; Helbig, C.; Thorenz, A. and Tuma, A. (2019).

Real life example: Urban production as sustainable location planning

Founded in 1906 and acquired by Wittenstein in 2001, Fellbach-based Wittenstein bastian GmbH produces metal products for use in machine and system construction. In 2011, the company decided to expand its production with the aim of improving accessibility for employees. The company opted for a space in close proximity to a residential area with access by rail. In addition to offering the benefit of shorter commutes for employees, the company was also able to devise innovative solutions to challenges such as limited space and noise pollution and other emission-related requirements. Wittenstein bastian GmbH was able to achieve large energy savings, saving 30% more than actually required under the German Energy Saving Ordinance with one third of the used energy being produced through heat recovery ventilation, a natural-gas-operated cogeneration unit and on-site solar panels. Connecting to the local public transport network also means that a large percentage of employees can commute to work without a car. The urban production plant is so unobtrusive that even a school can now be built in the surrounding area.[58]

Real life example: Resource-efficient insourcing through regional raw material sources

With 150 employees, Eisenberg-based EKW GmbH in Germany's Palatinate region develops and produces fire-proof building materials. Unformed fire-proof products involve particularly high material costs. Due to the volatility of the raw material market, the company was looking for price-stable alternatives. Working intensively with a research institute, EKW decided on the use of domestic luting sand. This enabled the company to reduce its dependency on the raw material market and cut out long transport routes, thus increasing its resource efficiency.[59]

[58] Cf. Institute for Work and Technology (2020).

[59] Cf. Sonntag, A. and Blaeser-Benfer, A. (2013), pp. 7.

3.2 Resource efficiency on the market side

The processes of acquiring new customers and providing services to existing customers have also undergone some huge changes in recent years thanks to new communication possibilities. While companies that were founded in the age of digitisation (known as “digital natives”) profit from their know-how and establish themselves in the industrial sector[60], it is also worthwhile for SMEs to implement the new opportunities in their business models too. In doing so, companies can successfully combine resource efficiency potential and economic opportunities on the market side as well. The presented concepts on the market side (cf. Figure 10) focus on changes in the offer structure of products and services.

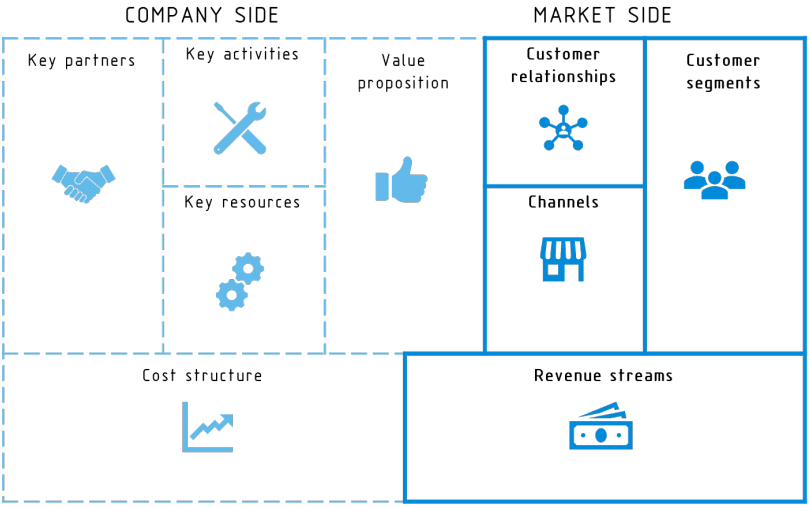

Figure 10: Business model elements on the market side[61]

[60] A well-known example is Alphabet Inc. (Google) with the subsidiary Waymo, the autonomous driving technology development company.

[61] VDI ZRE figure based on Osterwalder and Pigneur (2011).

3.2.1 PSS revenue models

The generation of revenue ultimately determines whether an enterprise is successful or not. New revenue models such as hybrid service bundles are becoming more and more commonplace, often complementing or completely replacing the traditional sale of goods or services. As outlined at the start, most new business models are based on a new combination of existing business concepts, e. g. in the form of a blend of products and services (cf. chapter 2.1). The basic business models already illustrated can therefore often be considered as part of a PSS model. Alternative revenue models to traditional sales are also based on PSS models. These revenue models can be categorised into product-, use– and result-oriented product-service systems.

- **Product-oriented PSS:** In product-oriented PSS, services such as regular maintenance, training or guaranteed return are also offered alongside a product. For example, potential business models are based on a low-priced value proposition with high-priced additional services (Add-on).

- **Use-oriented PSS:** In use-oriented PSS, products are no longer sold. Instead, the product is temporarily transferred to the customer. They follow the Rent instead of Buy business model.

- **Result-oriented PSS:** As the name suggests, result-oriented PSS focuses solely on the results that a customer receives from the buyer. Outsourcing can also be categorised under this model, as can the offer of payment types per service unit (pay-per-use).[62]

Resource efficiency potential can be created through new payment and accounting models, for example user fees or additional offers (cf. Table 6). The ecological opportunities here lie in the clear forward and reverse structure of used products and materials (take-back management) and subsequently increased service lives. For example, if the desired result is achieved solely in the form of a service, whereby the customer does not receive ownership of the necessary machines or materials, a homogeneous

[62] The VDI Centre for Resource Efficiency (German: *VDI Zentrum Ressourceneffizienz*) provides a detailed introduction to the development of PSS business models on its website at: https://www.ressource-deutschland.de/themen/pss/ (only available in German)

forward and reverse system and the associated increase in product and material reprocessing can be expected. A more efficient service life can also be expected due to more intensive use.[63] A long-lasting design can therefore also be significantly more attractive for vendors (cf. chapter 3.3). Companies that generate revenue solely through product sales have a lower interest in an extended service life than companies that also offer services alongside the product, for example. The offer of new PSS business models often goes hand in hand with extensive machine networking. This data can also be translated into a resource-efficient business model, e. g. in the form of consultation relating to optimised use of a product (Make More of It).[64]

Adopting PSS business models gives companies a chance to counteract the decreasing demand for products and/or machines, caused largely by new leasing and sharing concepts, with integrated and continuous revenue models. This involves improving training and other services to strengthen customer contact and make it more difficult to switch vendor (lock-in effect).

Table 6: Opportunities and challenges of PSS revenue models

Business model: PSS Revenue Models Driving force: Connectivity, neo-ecology, digitisation	
Opportunities	**Challenges**
• Increased product service life thanks to services such as maintenance • More efficient recycling and improved reprocessing thanks to clear flows of goods, resulting in increased purity of variety in waste • Resource and energy-efficiency through decoupling • Intensive and shared use of investment and consumer goods • Long-term customer retention through increased satisfaction • Promotes dematerialisation and digitisation • Economic motivation to develop long-lasting products and machines	• Purely commercial incentives instead of identification of resource efficiency potential • Potential shortening of product service life and increase in environmental pollution due to irresponsible user behaviour • Additional control and motivation mechanisms required to guarantee increased durability of product • Implementation expense and effort • Increased level of obligation and responsibility

[63] Cf. VDI Zentrum Ressourceneffizienz GmbH (2020).

[64] For example, tyre manufacturer Michelin offers payment concepts for cars based on usage. The collected data is used for driving recommendations which, in turn, help to reduce fuel consumption.

Real life example: Resource efficiency through integrated additional services

SAFECHEM is a Düsseldorf-based provider of products and services for the safe and sustainable use of solvents in industrial parts cleaning, textile cleaning and asphalt testing. The company offers customised service packages using chemical leasing. In addition to cleaning, these packages include services such as optimised monitoring (quality, solvent additives, labour analysis, solvent training, etc.), disposal management and bath exchange. Training on proper use and a clear forward and reverse strategy can help guarantee an improved product service life and ensure that used materials are better processed. According to SAFECHEM's figures, solvent demand can be reduced by up to 93% at a machine utilisation of 99%.[65]

Real life example: Lower entry barriers for resource-efficient products through new revenue models and services

Luxstream GmbH in Darmstadt produces all kinds of lighting, ranging from office, outdoor and hall lighting to industry-specific solutions and street/car park lighting. LED lighting produces 10 to 12 times as much light as comparable lightbulbs with regard to wattage. This means LED lights only require 8 to 10% as much energy as lightbulbs. However, switching to this type of lighting can entail large investment costs. The company therefore offers the option to lease the lighting in partnership with ENTEGA. In addition to the lower entry barriers for interested companies, the service bundle also includes warranties, planning, installation and light audit.[66]

[65] Cf. SAFECHEM Europe GmbH (2020).

[66] Cf. Luxstream GmbH (2020).

3.2.2 New customers and service segments

Thanks to extensive changes in communication and production, now even companies that previously served a mass market can supply to niche markets, and vice versa. The previously mentioned possibility for SMEs to tap into the mass market comes under the mass customisation business model (cf. chapter 3.1.1).

The development of new software tools in the B2B sector has led to the rise of mobile services, remote maintenance and augmented reality/ repair and is allowing traditional mechanical and plant engineering firms to rapidly expand into the software production mass market. These new opportunities are largely based on close collaboration with pilot users or large providers. Using these new tools, customers can fix problems in production themselves without the physical presence of the manufacturer (Guaranteed Availability and Self-Service). Resource savings come primarily from the reduced need for travel and improved real-time monitoring of machines that are less prone to defects. In addition to a boost in customer satisfaction, these measures increase the product's service life and improve productivity (cf. Table 7).

Digital twins are another way of expanding services for customers. This involves creating a virtual counterpart to a physical object in the digital realm which can then be linked with the physical object using sensors. By compiling real-time data, such as environmental conditions or machine position, digital twins make it possible to perform complex analyses and simulations. Analysis and simulation options range from 3D models to production sequences or parameters. In addition to time savings in product development and process design, the resulting smooth operation start-up (thanks to pre-simulation) and holistic view of all sequences are particularly useful in increasing resource efficiency (Digitisation business model).

Going the other way (from mass to niche), large vendors must tailor their services to the individual needs of companies. These niche markets can be served by offering training and consultation services which equally contribute to resource efficiency (albeit indirectly). Here, consultation does not necessarily need to come from the developer of new software and products; it can also be a result of a user's own practical experience (Make More of It). It is therefore reasonable to expect that the correct operation of

machines and maintenance tools can only be guaranteed through targeted training and the adjustment of new technologies.

Table 7: Opportunities and challenges of new customer and service segments

Business model: New Customers and Service Segments	
Driving force: Networking, digitisation, individualisation	
Opportunities	**Challenges**
• Resource savings through repairs and maintenance without the need for physical presence • Expected increase in service life of machines thanks to real-time networking with customers in B2B sector (predictive maintenance) • Lower number of incorrect orders and related reduction of transport channels and packaging waste • Resource efficiency through dematerialised simulations and prototyping • Improved customer retention through increased satisfaction • Expansion of a company's business field • Direct feedback for accelerated improvement of products and services • Acquisition of new customers in the mass and/or niche market	• Legal issues such as data protection • Risk of purely economic motivation • Resource expenditure and investment risk through implementation of necessary tools • Risk of cyber crime • Extensive knowledge required to prepare offers

Real life example: Resource efficiency through digitalised services
Reiskirchen-based Weiss Umwelttechnik GmbH is a manufacturer of environmental simulation systems. The diverse external areas of application make the services sector an important business field. By introducing a field-service management system, the company is now able to coordinate over 200 service employees across Germany in a more targeted manner. The digitisation measures replaced long, drawn-out correspondence between the customer and manufacturer while reducing the amount of travel required thanks to the targeted assignment of technicians. The improved planning of employees and resources improves efficiency while increasing customer satisfaction.[67]

[67] Cf. Weiss Technik (2020).

Real life example: Resource efficiency through digitalised customer services

SSI Schäfer is a global corporation focussed on the creation of warehouse and logistics systems. The aspects of sustainability are implemented in customer service and support through activities aimed at conserving resources, increasing energy efficiency and reducing CO_2 emissions. A preventative maintenance strategy records system-specific data to prevent non-defective parts being replaced unnecessarily. Augmented support can resolve problems in real time, helping to reduce the amount of travel required due to service call-outs. Even maintenance management is digital, meaning no more excessive printing of maintenance schedules, protocols or reports.[68]

3.2.3 Platform-based order processing and communication

Giving rise to diverse communication channels, digitisation has also brought with it substantial changes in the areas of order processing and customer communication. Six of the ten most valuable brands worldwide are now based on the concept of online platforms. For example, the sale and/or analysis of data and advertisements has resulted in completely dematerialised business models (Leverage Customer Data). As a result, the question of how to launch successfully on the market must be continuously reexamined and is just as important as a good product (go-to-market strategies). Social media and search engine platforms are the best-known examples from everyday life. Going beyond these platforms, however, it is becoming more and more common for customisable, data-based services to be offered via platforms (smart services) too.

From a business perspective, these “platform economies” can be used as advertising platforms and for acquiring new customers, and can have a positive impact on resource efficiency (cf. Table 8). In concrete terms, the success of these platforms can be attributed to the effects of networking. This includes, for example, the increasing use of networks by everyone alongside

[68] Cf. SSI SCHÄFER FRITZ SCHÄFER GMBH (2020).

an increase in the number of network partners. A high number of members on the platform automatically increases the potential regular customer base, fostering direct contact between manufacturer and customer. This cuts out the middleman, resulting in fewer interim stages in logistics. This form of direct sales translates to a reduction in transport routes and savings in storage space. Potential interim steps can also be cut out in packaging and unloading (direct selling and e-commerce). Online classified-ad sites are perfect for buying (and selling) spare parts and components in the desired quantity without creating excess capacity.

Table 8: Opportunities and challenges brought by the use of platforms

Business model: platform economy	
Driving force: Networking, globalisation, knowledge economy	
Opportunities	**Challenges**
• Facilitated exchange of innovation and knowledge through network effects • Direct customer contact without intermediaries reduces transport routes, storage space and packaging material • Use of platforms for sharing offers • Cost-efficient expansion of customer base • Use of new forms of investment such as crowdfunding • Large reach for company's public image and advertisements • Decoupling of products and supply • Flexible adjustment to customer demand • Ability to obtain and offer small batch sizes	• Dependency on platform provider • Platform agency fees and registration fees can be expensive • Elimination of customer interface • Legal issues such as data protection • High server computing power means high energy demand • Global sales potential leads to global transport flows

Real life example: Company internal platforms as point-of-sale for resource-efficient products

Founded in 2011 and now boasting around 100 employees, BAM GmbH based in Weiden in the Upper Palatinate region of Germany is a precision manufacturing and special engineering company. In 2019, it launched its on-demand manufacturing platform. The platform makes it easier for BAM customers to order custom components and make use of the company's various machining, erosive, additive and forming processes without having to go through long, tedious inquiries. In the first year alone, BAM was able to process 37,000 requests from 12 different countries. This streamlined process increases resource efficiency by reducing delivery times and, more importantly, making the manufacturing process more cost-efficient. It is common, especially in the spare parts trade, for parts to be produced in excess quantities without there actually being a demand for them. By optimising procurement, production can be made more efficient right from the first batch, avoiding the unnecessary use of raw materials for manufacturing.[69]

Real life example: Resource-efficient collaboration via platforms

The growing variety of building products and materials means that a large number of products in trade can no longer be used for follow-up jobs. The result: many warehouses become full of brand-new materials which, ultimately, must be thrown away unused. Conversely, many tradespeople require materials in quantities significantly smaller than those offered. To fix the problem, roofer Simon Schlögl founded the Munich-based platform materialrest24.de as a virtual warehouse. The concept of material sharing eliminates the possibility of over-capacities and reduces production and disposal costs.[70]

[69] Cf. BAM GmbH (2020).

[70] Cf. Handwerk.com (2018).

3.3 Resource efficiency through extended service life

Business models focus largely on the value proposition that a company aims to offer to its customers (cf. Figure 11). To meet a potential customer's needs, however, a company must first identify them. Extending the service life of a product can therefore unlock potential for resource efficiency. As outlined above, measures on both the market and company side can go a long way in increasing the service lives of machines and products. For the sake of completeness, it should be noted that the generation of a value proposition, especially within the field of B2B, is a whole topic in and of itself, and targeted influencing remains largely reserved for corporations with large marketing departments.

Digital end devices with ecologically questionable concepts of increasingly shorter periods until a product or market reaches maturity are examples of this (in keeping with the motto: create a problem that the customer is unaware of, and fix it).

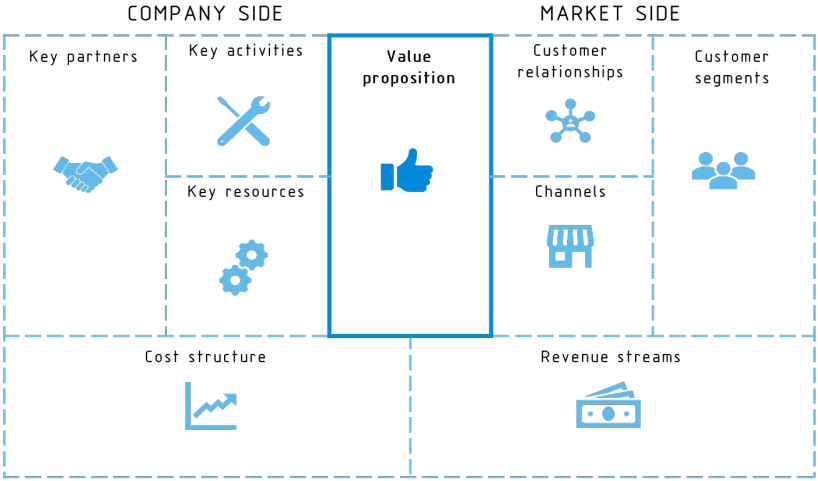

Figure 11: Value proposition in the Business Model Canvas[71]

[71] VDI ZRE figure based on Osterwalder and Pigneur (2011).

One approach for ensuring that sustainability and resource efficiency is at the centre of a product is the “ecodesign approach” (also referred to as sustainable design). This approach aims to provide maximum value with as little environmental impact as possible through the intelligent use of the necessary resources. This can be achieved by focussing on durability or easy maintainability, for example. The ecodesign approach is centred around the quality of the product and sustainable value creation. It takes into account all areas of the value chain (including the supply and disposal of used materials or social conduct with employees). In the area of electronic end devices, in 2009, the EU published its ecodesign directive which was expanded in 2019 to include the aspect of better maintainability. Mobile phones, tablets and computers are still excluded from the new regulations.

Potential company implementation strategies include supplying a high-price market (Ultimate Luxury) or the Ingredient Branding strategy**.** This involves using a branded product as part of a larger product (an example of this is Shimano brakes in bicycles). The principles of ecodesign can be defined as follows:

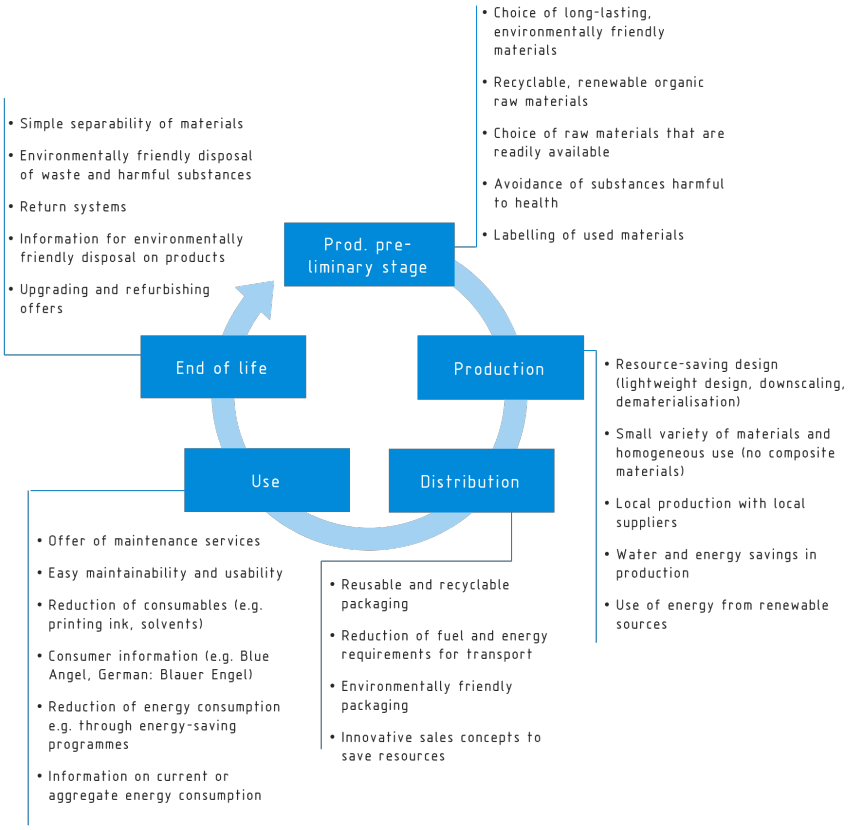

Figure 12: Guiding principles of ecodesign in the various process steps[72]

In addition to creating ecological and economic saving potential, these measures are also suitable for improving a company's public image.

[72] VDI ZRE figure based on Internationales Design Zentrum e. V. (IDZ) (2020).

Table 9: Opportunities and challenges of ecodesign as a business model

Business model: Ecodesign	
Driving force: Neo-ecology, knowledge economy	
Opportunities	**Challenges**
• Resource efficiency through extended service life • Development of an innovative and sustainable leading position • Improved cascading use through high ecodesign standards (reduced use of composite materials) • Networking across an increasing number of versatile scenes • Media attention thanks to positive environmental impact • Positive company image for customers and employees through increased sustainability • High customer satisfaction through commitment to quality	• Capital expenditure for research, development and new machines if necessary • Reduced number of markets possible • Ecodesign requires consideration of numerous recommendations/constraints and technical requirements

The aspects of sustainability (cf. Table 9) also combine well with offers under PSS business models. Where companies only offer a service with the product serving only as an accessory, it is in the seller's economic interest to make its products last as long as possible. This counteracts strategies such as those involving a limited service life with the aim of increasing revenue.

Real life example: Sustainable packaging according to the principles of ecodesign

The Cologne-based Papacks has made it its mission to reduce the high amount of packaging waste. The company develops sustainable and intelligent packaging solutions and company concepts. Here, the focus lies on developing packaging concepts, closed-loop systems, reducing waste in the packaging sector, and consulting industry-related companies and SMEs as early on in the value chain as possible. According to the company's figures, packaging designed based on the principles of a circular economy can help save 1,800 tons of plastic waste and 892 tons of fossil fuels a year. The company is also a prime example of how follow-up services (cf. chapter 2.1) can contribute to resource efficiency: sustainable consultation and optimisation has helped customer companies reduce overall costs by 10%.[1]

Real life example: Use of alternative materials for long-lasting structures

The oxidisation and corrosion of steel are a big problem in the construction industry and limit the durability of structures significantly – especially bridges. Glass and carbon reinforcements do not oxidise, making them far superior to steel when it comes to environmental impact. This allows companies to avoid follow-up costs for renovation or demolition of structures damaged by corrosion from the outset. Founded in 2013, the 240-employee, Albstadt-based solidian GmbH develops fibre-reinforced plastic-based products for the construction industry. Textile-reinforced concrete not only positively impacts the service life of a structure, it can also lead to extensive savings in the amount of materials needed. For example, using textile-reinforced concrete can reduce the amount of concrete needed by up to 80% in facade panels. The improved CO_2 balance is also reflected in the supply and disposal: while the significantly lighter panels require less concrete and boast a lower transport weight, the textile structures can also be reused thanks to newly developed processes.[73]

[73] Cf. solidian GmbH (2020).

4 CONCLUSION

A business model describes the way in which a company intends to generate profit and outlines the processes required to achieve this. Megatrends such as the forecasted growth potential of the green economy or ongoing digitisation, as well as political developments such as revisions in German recycling law, are all expected to further increase competitive pressure. It is therefore important that SMEs also familiarise themselves with new and resource-efficient business models in order to stay competitive in the future. Economic aspects are ultimately the driving force for increasing resource efficiency. At the same time, a positive public image is becoming more and more important for SMEs whereby a more efficient handling of resources can lead to more sustainable corporate management.

An application-based approach such as the Business Model Canvas by Osterwalder and Pigneur is recommended when developing or adapting a business model. The business models presented as part of this analysis often require a new approach with regard to exchanges with customers and partners. A company's willingness to be more flexible and open up its business world is vital here.

Largely due to digitisation, networks between people/machines and products/services are becoming more and more frequent which means extensive coverage in production sectors is increasingly important. Almost all of the business models outlined can be considered to be at least partial aspects of a larger PSS business model. One important aspect here is the newly developing issue of ownership structures; an issue that is emerging more and more frequently as leasing or sharing approaches become more widespread in almost all added-value segments.

The most common measures for increasing efficiency with regard to new business models include reducing the number of machines, transport routes and errors in value creation, and ensuring a homogeneous forward and reverse system for products as part of closed-loop circulation. From a user perspective, the low economic entry barriers offered by sharing and leasing concepts represent an attractive opportunity to adapt a company's business model to achieve greater resource efficiency. For example, business models

such as the leasing of LED lights accelerate the substitution of older concepts with less energy and raw material-intensive concepts.

From a vendor perspective, PSS revenue models enable new sales strategies. Hybrid service bundles help to combat the economic problem of lower product and machine demand, while more intensive use of commodities and a homogeneous reverse structure contribute to resource efficiency. In this way, the increasingly popular trend of moving away from the traditional sale of products towards the generation of profits through integrated (smart) services can go a long way towards achieving resource efficiency.

When it comes to the consumption of resources, the biggest challenge lies in the fact that incentives for new business models are purely economic in nature. There is also the risk of abuse with companies improving their public image without generating any real ecological added value (greenwashing). Here it should be noted that successful and resource-efficient business models can, in themselves, lead to a higher demand for raw materials due to an increased number of customers (rebound effect). Scientific analyses of free-floating carsharing also show that business models that appear to be resource-efficient lead to some environmentally questionable results in practice (cf. section 2.2).

Integrating additional tools such as a life cycle analysis or use-value analysis is recommended to properly consider aspects of resource efficiency in the development and restructuring of a company's business model. Ultimately, saving resources brings with it economic profits and allows sustainable companies to live up to their claims.

PART 2: EXPERT TALK

5 DOCUMENTATION OF EXPERT TALK

5.1 Programme of the Expert Talk

Moderation:	Dr Martin Vogt, Managing Director at VDI Zentrum Ressourceneffizienz
Top 1	**Presentation of selected aspects of the brief analysis entitled "New business models and resource efficiency"**
	Speaker: Jakob Rothmeier, VDI Zentrum Ressourceneffizienz
Top 2	**Sharing economy in industry Collaboration as a new business model**
	Speaker: Thorsten Eller, Managing Director of V-Industry
Top 3	**Discussion group part I**
Top 4	**Digitisation and resource-efficiency in networked value-added systems**
	Speaker: Prof Dr Björn Häckel, Fraunhofer Institute for Applied Information Technology FIT
Top 5	**Enabling transformation through an innovation-friendly corporate culture**
	Speaker: Dr Moritz J. Maier, Center for Responsible Research and Innovation of Fraunhofer IAO
Top 6	**Discussion group part II**

5.2 Documentation of the Expert Talk

Digitisation and the ambitions of environmental policy have both led to substantial changes in the business world, forcing companies to adapt or completely rethink their business models to achieve more sustainability and resource efficiency.

The Expert Talk on 2 December 2020 hosted representatives from the worlds business, politics and science as well as various organisations, and was used to discuss the opportunities and challenges of new business models in industry that can lead to greater resource efficiency. The focus of the event was the implementation of additional supplementary services (PSS). The discussion also sought to clarify the prerequisites for a successful transformation of the business world, including in terms of resource efficiency.

The audience of experts and specialists included representatives from associations and young companies (start-ups) in addition to participants from the worlds of science and politics.

5.2.1 Presentation of selected aspects of the brief analysis "New business models and resource efficiency"

Due to the differences in the use and understanding of the term "business model" in both theory and practice, one objective of the panel was to establish a mutual basis for further discussions. It was also highlighted to participants that most new business models are considered as more of a transfer of existing models into new areas rather than completely new concepts. External driving forces such as societal change and the trend towards more environmental awareness, as well as political claims through legislation and the green economy growth market, also helped to underline how important the reorientation of industrial business models could be in the future. For companies, this means that, especially in the area of PSS, new business models requiring an increased commitment to transparency and networking with customers and partners are possible.

Together with the participants, the question of how SMEs can take the leap towards more resource-efficient business models was discussed.

Participants from associations shared that, in general, the topic of climate protection is becoming very popular. Here, the consideration of “scope-3 emissions” (emissions resulting from activities prior to and following the companies own activities) will play an important role going forward, with preliminary supply chains becoming crucial for future business models. There are still not concrete ideas for the mass market. According to these participants, however, design thinking (creative processes for brainstorming), is one method that can be used to approach the topic more effectively.

From the start-ups’ point of view, it was noted that many companies do not have the space to promote new business models due to time limitations and a lack of consideration of new internal suggestions. Start-up companies that are already successful may also reject new business models as the subsequent changes appear too expensive.

With regard to the question of how institutions could help to improve willingness to adopt new business models, the following aspects were outlined:

- Opportunities to creates spaces in which companies can break out of old thinking patterns
- Support in the networking of companies to promote the exchange of knowledge and experience.

5.2.2 Sharing economy in industry Collaboration as a new business model

Through increased machine utilisation and the subsequent reduced demand for machines, machine parts and machine capacities, machine sharing has an impact on resource efficiency. Mr Eller introduced a business model that makes B2B sharing possible within industry. The offer to the customers lies in the creation of components (using free capacities at external companies) and significantly reducing the related transaction costs. An integrated hardware and software solution is proposed for this purpose. The hardware provides the opportunity to record machine data which is then used to connect the vendor with the consumer via a platform. In addition to increasing transaction and processing efficiency, the business model can also help to improve the interconnectivity of smaller companies in the future, promoting regional symbiosis. The B2B sharing model can also make structural change in the automotive industry more palatable by creating new opportunities for sales.

5.2.3 Discussion – part one

The first part of the technical discussion focussed on the area of B2B sharing. According to experts, the goal of sharing must be to create a certain level of transparency among the companies involved using available data, and this notion was used to counter concerns that sharing models within industry may promote price dumping. For example, a certain price framework (which must contain an offer) can be proposed to machine vendors. From a technical perspective, participating companies are ready for any potential future implementation of environmental certificates. However, it was noted that the economic interests and the needs of the companies involved must be the primary consideration. According to the experts, the strategic desire for sustainability is, in practice, already present but has not yet moved into operative business. Nevertheless, concentrated networking of regional companies can be established from previous experiences in B2B sharing and this contributes to resource efficiency.

Another topic of discussion was the general implementation potential of platforms and what opportunities and limitations these pose with regard to resource efficiency. Experts from relevant organisations asserted that

implementation in the German mechanical and plant engineering sector has initially only been met with success in companies, noting however that digitisation and platforms still contain unused potential, especially for SMEs. Experts cited time constraints as a potential reason preventing companies from exploring these new fields. Another reason could also be limitations in the networking of companies as mechanical and plant engineering involves a high degree of individualisation, leading to a decrease in potential interfaces. In the field of industrial start-ups, representatives presented the counter argument that a critical quantity and/or size of vendors and consumers must first be generated (network effects) for extensive use of platform offers (e. g. sharing concepts). This would then allow availability of the desired products and services to be guaranteed. The first signs of success can be seen in the construction sector, where platforms are being used to share excess components regionally, leading to an increase in resource efficiency according to industry representatives.

5.2.4 Digitisation and resource-efficiency in networked value-added systems

The aim of the talks was to present the state of practical research into digitisation within industry and illustrate the contribution to resource efficiency using selected practical projects. “Megatrends” were introduced as large driving forces for transformation within the industrial sector. These ongoing and extensive changes in many areas of life are reflected in the increase in the relevance of issues of environmental protection, for example, as well as the increasing interconnectivity and concentration of people. The megatrend of digitisation is thought to play a particularly important role here, influencing all other trends. Networking in particular offers huge potential for new business models and other measures, arising through the development of new technology trends such as IoT, intelligent systems and even smartphones. The projects introduced showed the development of innovative analytics solutions and data-based business model innovations focussing on process mining and predictive maintenance services,and illustrated success stories in grid-stabilising energy supply management. In addition to the opportunities for resource efficiency in energy matters, it has also been shown that the networking of value-added systems leads to

material savings, e. g. through predictive maintenance and reduced emissions as a result of a future integrated energy approach.

In response to the question of whether further PSS could contribute to resource efficiency, Prof Dr Häckel presented another example from the field of wash systems. This sector is offering customisable services. As explained by Prof Dr Häckel, these services are customer-driven but can also include ecological factors such as environmentally friendly wash programs.

5.2.5 Enabling transformation through an innovation-friendly corporate culture

New and innovative business models often require changes in the corporate culture. The aim of Dr Maier's presentation was to highlight the necessity and opportunities of a transformation towards more innovation. Using different market penetration times, Dr Maier illustrated how clear the acceleration effects were for innovation. He used the internet as an example: it took almost 46 years for just one quarter of the US population to establish a power connection compared to just seven years for establishing an Internet connection. He also showed that the corporate culture has a tangible impact on a company's innovative strength. The following aspects were outlined as the most important components for promoting an innovative environment:

- **Creating entrepreneurial freedom:** The aim should be to create an environment separate from work in which ideas can be generated and tested in a cost-efficient manner.

- **Communication, conflict, cooperation:** A company's future vision should be discussed as often and consistently as possible and these discussions should include as many areas as possible. Incentive systems such as bonuses and awareness across all levels can be used to promote willingness to participate. Companies should also actively seek contact with customers and suppliers.

- **Barriers:** Early criticism of new ideas can be combatted with symbolic sanction systems, for example.

- **Error handling:** Customers and employees must be able to submit complaints easily. Conversely, companies should also actively seek out errors.

From the participant field, it was noted that pre-defined stakeholder processes and/or requests often require certain hierarchies and structures within a company. However, the possibility of hybrids of hierarchal and dynamic/flexible corporate cultures can be used to counter this. It is asserted that movements towards hierarchal structures are generally identified in companies of a certain size occupying a certain market position.

Another central point made by participants was that the corporate culture could play a much more important role in the future. According to participants, significant change can already be identified for the first companies and organisations in the search for junior employees: it is more common among the younger generation to search for a sense of purpose and opportunities to grow in their careers. Potential strategies for companies and organisations include early cooperation with schools and universities and a clear management of expectations together with a mutually created vision within the company.

5.2.6 Discussion – part two

The central question of the second part of the discussion related to the potential external drivers that could advance innovation and new, resource-efficient business models. One potential influence was made by an audience member who suggested that politics could push companies towards greater resource efficiency e. g. by introducing stricter CO_2 pricing. Another important point is the opportunities of digitisation which are being seized upon by more and more companies. In construction, the Building Information Modelling (BIM) method (which is becoming increasingly accepted) allows companies to record and assess climate-related and resource-efficient factors for the entire life cycle of structures or for urban planning, as well as increase efficiency. Participants representing the start-up sector noted that the willingness to pay large amounts for digital services in particular is not widely accepted within society. Potential approaches for improved market penetration include e. g. free test phases to better illustrate use value. Again

here, the first indications of paying for digital services can be seen in the construction sector.

Platforms and the resulting data in particular will be an important basis for new business models in the future. While the competition on global non-industrial platforms is too widely spread, the world of industry still has a lot of potential when it comes to using data in the interests of resource efficiency. From a practical perspective, participants communicated that, on one side, there are still problems in creating a relationship of trust with the companies concerned when it comes to disclosing data. On the other side, there is, to a certain extent, a lack of imagination with regard to the practical value this data could have for companies and future business models.

To strengthen the general willingness to achieve more resource efficiency using digitalised business models, the promotion of efficiency programmes from an institutional point of view must go further. Application-oriented research has suggested that attitudes of practice partners are slowly shifting towards more climate and resource protection. According to the research, it is important to integrate customers and partners as early as possible during any processes of change in order to be able to clearly outline the value and potential.

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APPENDIX

Table 10: Overview of the 55 business models from the "St. Gallen Business Model Navigator" (2017). Note: The examples are from the original source.

Business model	Description	Example (selection)
Add-On	Price-competitive core offer with a variety of extras that push up the end price. Customers profit from variable and specifically tailored offers but risk paying more in the end.	Ryanair (1985), SAP (1992), Sega (1998)
Affiliation	The focus lies on the support of others for sales. Affiliates usually profit from a type of pay-per-sale or pay-per-display commission. On the other hand, the seller has access to a potentially much larger customer base without needing to make any extra effort with regard to sales and marketing.	Amazon Store (1995), Cybererotica (1994), CDnow (1994), Pinterest (2010)
Aikido	Aikido is a Japanese martial art in which the strength of the attacker is used against them. As a business model, this involves adopting the strategy of offering something that is opposed to the image and mindset of the competition. The attraction for customers lies in prioritising concepts that go against the mainstream.	Six Flags (1961), The Body Shop (1976), Swatch (1983), Nintendo (2006)
Auction	Sale through bidding. In general, the end price is reached when no higher bid is submitted. This means that companies sell at the highest price that the customer is willing to pay. The customer benefits from the possibility to co-determine the price.	eBay (1995), Google (1998), Elance (2006), Zopa (2005), MyHammer (2005)
Barter	Bartering involves giving goods to customers without the exchange of actual money. In return, companies receive something valuable such as e. g. customer data or customer loyalty.	Procter & Gamble (1970), Lufthansa
Cash Machine	For the cash-machine concept, customers pay for the purchased products upfront before the customer can cover the related costs. This leads to increased liquidity that can be used to clear debts of fund investments in other areas.	American Express (1891), Amazon Store (1995), PayPal (1998), Groupon (2008)
Cross-Selling	The offer of essentially atypical goods and services through the use of available key competencies and resources. This enables companies to gain new revenues with relatively small changes to the existing infrastructure.	Shell (1930), IKEA (1956), Tchibo (1973), Aldi (1986),
Crowdfunding	Funding products or projects (or entire start-ups) by multiple investors mostly using online platforms. Upon realisation of the product/project etc., investors receive benefits usually in proportion to the amount of money they donated.	Marillion (1997), Brainpool (2011), Pebble Technology (2012)
Crowdsourcing	Solving problems or tasks with the help of anonymous contributors, who in return receive a reward or a chance at a prize. Customer interaction or integration can promote a positive customer-company relationship and subsequently increase revenue.	Threadless (2000), Procter & Gamble (2001), MyFab (2008)

Business model	Description	Example (selection)
Customer Loyality	Maintained customer loyalty through value propositions beyond the actual product. The aim is to foster loyalty through an emotional connection and/or special offers.	Sperry & Hutchinson (1897), Payback (2000), Apple (2011)
Digitisation	Transformation of originally analogue products into digital versions. Benefits lie largely in quicker and simpler distribution and operation.	Spiegel Online (1994)
Direct Selling	Sale of products without intermediaries. The benefits comes in the form of close customer contact and the avoidance of fees for intermediaries. These savings can be passed on to the customer and a standardised sales experience can be developed.	Vorwerk (1930), Tupperware (1946), Nestlé BabyNes (2012)
E-Commerce	Offer of products exclusively using online channels. Customers benefit from higher availability and convenience, while the company is able to integrate its sales into other internal processes.	Amazon Store (1995), Dollar Shave Club (2012)
Experience Selling	The value of a product or service increases with the related customer experience. This, in turn, increases demand and prices which then leads to the customer experience being adapted (e. g. coordination of promotion campaigns or shop fittings).	Harley Davidson (1903), IKEA (1956), Nestlé Special.T (2010)
Flatrate	Payment of a fixed fee for a product, regardless of actual use. The user benefits from a simple cost structure while the company profits from a constant source of income.	SBB (1898), Buckaroo Buffet (1946), Netflix (1999)
Fractional Ownership	Division of a certain asset class between a group of owners. In general, the asset value is high but the asset is only required occasionally. While the customer benefits from the rights as an owner, they do not need to provide the full capital on their own.	Maschinenring (1958), Mobility Carsharing (1997), HomeBuy (2009)
Franchising	The franchiser owns the brand name, the products and the corporate identity. These are licensed to independent franchisees which then assume the risk for local activities. The franchisees profit from the use of a known brand, as well as the related expertise and support.	Singer Sewing Machine (1860), McDonald's (1948)
Freemium	The basic version of an offering is gifted for free to convince the customer to pay for the premium version.	Hotmail (1996), Skype (2003), Spotify (2006), Dropbox (2007)
Push-to-Pull	The strategy here is to decentralise a company's processes to gain more flexibility to be more customer-oriented. This can be adopted at any stage of the value chain – including production or even research and development – with the aim of being able to respond quickly and flexibly to new customer needs.	Toyota (1975), Zara (1975), Dell (1984), Geberit (2000)
Guaranteed Availability	Guaranteed availability reduces downtimes for customers to almost zero but is often linked to a high level of expertise and high prices.	ABB Turbo Systems (2010)
Hidden Revenue	The main source of revenue is no longer the customer but rather a third party that co-finances the (often free) use by the customer. This financing is often provided by advertisers.	JCDecaux (1964), Google (1998), Spotify (2006), Zattoo (2007)
Ingredient Branding	Selection of ingredients or a brand originating from certain suppliers and contained within another product. This product is then labelled and advertised with the ingredient product which represents added value for the customer and increases the appeal of the end product.	DuPont Teflon (1964), Intel (1991), Carl Zeiss (1995), Shimano (1995), Bosch (2000)

Business model	Description	Example (selection)
Integrator	The control of all resources and competencies with regard to value added lies with the company. Increased efficiency, scale effects and reduced dependency on suppliers lead to reductions in costs and can increase the stability of value added.	Carnegie Steel (1870), Ford (1908), Exxon Mobil (1999), BYD Auto (1995)
Layer Player	A company's offer is limited to just a few value-adding components but can be sold across different industries. The aim is often to create a market standard through specialist knowledge.	Dennemeyer (1962), Wipro Technologies (1980), Amazon Web Services (2002)
Leverage Customer Data	Creation of value through the use or sale of customer data, often through the processing of data and targeted sale to advertisers.	Amazon Store (1995), Twitter (2006)
Licence	Focus on commercialisation of intellectual property instead of a company creating its own product. The value created through licencing allows the company to concentrate on R&D and provide knowledge that is potentially valuable for third parties.	BUSCH (1870), IBM (1920), Duales System Deutschland (1991)
Lock-In	Customers are integrated into the product world of a vendor. The use of another vendor is only possible with substantial switching costs, protecting the company against customer loss. This integration is achieved through technological mechanisms or through significant dependencies on the products.	Gillette (1904), Lego (1949)
Long-Tail	Focus on generating revenue through a variety of niche products. Individually, this does not require large quantities but also means high margins are not possible. Profits from the resulting small number of sales can be significant if the company offers an abundance of these products in sufficient quantities.	Amazon Store (1995), eBay (1995), Netflix (1999), Apple iPod/iTunes (2003), YouTube (2005)
Make More of It	Knowledge and other internal company assets are used for more than just product development and offered in the form of training, consultation and more.	Porsche (1931), BASF (1998), Sennheiser Sound Academy (2009)
Mass Customisation	Customisation of mass products to the needs of the customer, largely using modularised products and product systems.	Dell (1984), Levi's (1990)
No Frills	Concentration of value-added aspects on the central value proposition of a product, usually in the most basic way possible. The focus often lies on customers with lower purchasing power.	Ford (1908), Aldi (1913), Dow Corning (2002)
Open Business Model	Opening and expansion of your own business through collaboration with partners, suppliers and other general collaborators etc.	Valve Corporation (1998), Abril (2008)
Open Source	In software development, the source code of a software product is not protected and made available for anyone. Money is earned through services such as consulting and support.	IBM (1955), Wikipedia (2001), Local Motors (2008)
Orchestrator	The company is focussed on core competencies in value creation. Other areas are outsourced to and actively coordinated by external parties.	Procter & Gamble (1970), Nike (1978), Bharti Airtel (1995)
Pay-per-Use	Payment based on actual use of the product. The company is able to gain customers that are looking for more flexibility which can potentially be more expensive.	Hot Choice (1988), Google (1998), Car2Go (2008)
Pay What You Want	The buyer pays a discretionary price for a product. This usually leads to a higher number of buyers. Social norms means that buyers rarely take advantage by paying prices that are too low.	One World Everbody Eats (2003), Panera Bread Bakery (2010)

Business model	Description	Example (selection)
Peer-to-Peer	Provision of a platform on which people – usually in the form of a homogeneous group – can offer services to other people.	Couchsurfing (2003), LinkedIn (2003),
Performance-based Contracting	The price of a product is based on the service or result in the form of a service. Contractors are often strongly integrated into the value-added process of their customers. The product remains under partial ownership of the company and is operated by it.	Rolls-Royce (1980), Smartville (1997), BASF (1998), Xerox (2002)
Razor and Blade	Cheap or free base product. Consumables required for its use are, however, sold with high profit margins. The original price lowers purchasing barriers and subsequent sales of the product over-finance it.	Gillette (1904), Hewlett-Packard (1984, Nestlé BabyNes (2012)
Rent instead of Buy	The customer rents the product instead of buying it. This lowers the entry barriers. Both parties benefit from a high efficiency in product use as non-use resulting in tied up capital is reduced for each product.	Saunders System (1916), MachineryLink (2000), CWS-boco (2001), Car2Go(2008)
Revenue Sharing	Revenue is shared with stakeholders such as general partners or even competitors. Therefore, in this business model, advantageous properties are merged to create symbiotic effects in which additional profits are shared with partners participating in the extended value creation. A party can obtain a share of the revenue of another party which profits from a higher value for its customer.	CDnow (1994), HubPages(2006), Apple iPhone/AppStore (2008), Groupon (2008)
Reverse Engineering	A competitor's product is taken apart and this information is used to create a similar product. The elimination of costs for research and development means products can be offered at a lower price.	Bayer (1897), Pelikan (1994), Brilliance China Auto (2003), Denner (2010)
Reverse Innovation	Sale of simple, cost-effective products from newly industrialised countries. The term "reverse" refers to the process in which new products are generally developed in industrial countries and then adapted to the needs of newly industrialised countries.	Logitech (1981), Haier (1999), Nokia (2003), Renault (2004), General Electric (2007)
Robin Hood	The same product is sold at different prices for different buying publics. The high-price buying public generates profits, the low-price buying public creates scale effects that other vendors cannot match.	Aravind Eye Care System (1976), One Laptop per Child (2005), TOMS Shoes (2006)
Self-Service	A part of the value added is transferred to the customer in exchange for a lower price of the service or product. This is particularly suitable for process steps that offer a relatively low value for the customer but incur high costs. Customers benefit from increased efficiency and time savings in exchange for increased effort on their part.	McDonald's (1948), IKEA (1956), Car2Go (2008)
Shop-in-Shop	Use of partner branches. Both parties benefit from the presence of the other, e. g. through more customers and shared fixed costs.	Tchibo (1987), Deutsche Post (1995)
Solution Provider	Full coverage of products in a certain area, intensified via a unique contact partner. Special expertise is provided to the customer to increase their efficiency and performance. A full-service provider can avoid loss of sales by expanding its service and adding the product.	Lantal Textiles (1954), Heidelberger Druckmaschinen (1980), 3M Services (2010)
Subscription	The customer pays a regular fee, normally monthly or annually, to gain access to a product or service. Customers benefit from low usage costs and general service availability, companies generate stable income.	Spotify (2006), Next Issue Media (2011), Dollar Shave Club (2012)

Business model	Description	Example (selection)
Supermarket	A company sells a variety of readily available products and accessories under one roof. Generally, the product range is large but prices are kept low.	King Kullen Grocery Company (1930), Merrill Lynch (1930)
Target the Poor	Focus on low-income customers. The company generates low profits through products sold but benefits from higher sales numbers.	Grameen Bank (1983), Arvind Mills (1995)
Trash-to-Cash	Used products are collected and either sold in other parts of the world or transformed into new products. The profit scheme is essentially based on low to non-existent purchase prices. Resource costs are practically eliminated while appealing to the environmental awareness of customers.	Duales System Deutschland (1991), Greenwire (2001), Emeco (2010)
Two-sided Market	A two-sided market facilitates interaction between several customer groups that are all dependent on one another. The value of the platform increases when more members in each group use it. Both sides usually come from different groups, e. g. companies and private interest groups.	Diners Club (1950), JCDecaux (1964), Amazon Store (1995), eBay (1995), Groupon (2008)
Ultimate Luxury	Focus on a high-cost product range. This allows a company to strongly distinguish its products or services from others. The focus is on quality and exclusivity.	Lamborghini (1962), Jumeirah Group (1994)
User-designed	A customer is both the manufacturer and the consumer. As an example, an online platform provides the customer with the necessary support through software or an online shop. The customer is supported in their enterprise and shares the revenue generated with the provider.	Spreadshirt (2001), Lego Factory (2005), Amazon Kindle (2007), Ponoko (2007)
White Label	A white-label manufacturer allows other companies to distribute its goods under their brand so it looks like they manufactured themselves. The same product is often sold under different brands by several marketers. This way, different customer segments can be satisfied with the same product.	Foxconn (1974), Richelieu Foods (1994), Printing-In-A-Box (2005)

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