

SMART LIVING OF THE FUTURE

TREND REPORT 2021



Smart Living of the Future

© 2021 Center for Digital Technology and Management, Munich, Germany

ISBN: 978-3-9822669-1-6

B/S/H/

Kindly supported by BSH Hausgeräte GmbH

BSH Hausgeräte GmbH is one of the world's leading companies in its industry and the largest home appliance manufacturer in Europe.

Driven by individual consumer needs globally, BSH aspires to continuously improve quality of life at home and make people smile through exceptional brands, high-class products and superior solutions.

Even though "home" can assume many different forms, there is one unifying factor: Home is the most precious place for most people.

Visit www.bsh-group.com for more information.



A project of the Center for Digital Technology and Management (CDTM)

The Center for Digital Technology and Management (CDTM) is a joint, interdisciplinary institution for education, research, and entrepreneurship of the Ludwig-Maximilians-Universität (LMU) and the Technische Universität München (TUM).

It offers the add-on study program „Technology Management“ for students from various backgrounds, which provides students with tools and knowledge at the intersection of business and digital technologies.

The entire trend report was written by CDTM students under the close guidance of research assistants.

Visit www.cdtm.de for more information.

PREFACE OF THE EDITORS

As Herman Kahn, one of the founding fathers of modern scenario planning, nicely states, it is tremendously important for strategy and policymakers to get a deep understanding of possible future developments in order to be prepared for them.

The Center for Digital Technology and Management (CDTM) aims to connect, educate and empower the innovators of tomorrow. It is our mission to equip our students with the tools and knowledge they will need to become responsible leaders, who actively shape their future environment, rather than only react to changes.

This Trend Report is the result of the course Trend Seminar, which is part of the interdisciplinary add-on study program "Technology Management" at CDTM. About 25 selected students of various disciplines, such as Business Administration, Psychology, Architecture, Computer Science, Electrical Engineering, and others, work together on a relevant topic of our time. Over the course of seven intense weeks of full-time

Prof. Dr. Jörg Claussen (LMU)
 Prof. Dr. Frank Danzinger (University of Applied Sciences Augsburg))
 Aaron Defort (CDTM)
 Michael Fröhlich (CDTM)
 Ana Garcia (CDTM)
 Dennis Giese (Northeastern University)
 Robin Godenrath (Picus Capital)
 Lucas Grabmaier (CDTM)
 Dr. Clemens Hage (BSH)
 Dr. Felix von Held (IICM)
 Jeremiah Hendren (Hendren Writing)
 Pranjal Henning (Innovation Consulting Munich)
 Dr. Jacqueline Lemm (RWTH Aachen)
 Chrissie Muhr (Content&Form)
 Jan Rodig (Struktur Management Partner GmbH)

work during their semester break, the participating students dive deeply into the topic of the Trend Seminar.

Working in several interdisciplinary sub-teams, students apply the knowledge of their main studies and learn new perspectives from their team members. They conduct trend research, develop scenarios of the future, generate ideas for innovative products or services, and detail them out into concrete business concepts.

We would like to take the chance to thank everyone who contributed and made this CDTM Trend Report possible. We want to thank BSH Hausgeräte GmbH for supporting this

Maximilian Rogg (IICM)
 Dr. Hartwig Rüll (Freelance Consultant)
 Sebastian Schaal (luminovo.ai)
 Tom Schelo (CDTM)
 Renate Schmid (Wilde Beuge Solmecke Rechtsanwälte)
 Nadine Schmidt (HEJMO)
 Andreas Schrems (Freelance Consultant)
 Jose Adrian Vega Vermehren (CDTM)
 Prof. Dr. Matthias Wählich (FU Berlin)
 Dr. Felix Wehrle (IICM)
 Dennis Wetzig (PIXRAY GmbH)
 Adrian Ziegler (CDTM)

Last but not least, we would like to thank the CDTM students of the class of Spring 2021. They put great energy and enthusiasm into this project, which made it a pleasure for us to supervise the

“ **Everybody can learn from the past. Today it is important to learn from the future.** ”
 Herman Kahn

Trend Seminar. Particularly, we want to thank Tanja Haberlander and Frank Schäfer for their collaboration, their valuable insights, and their feedback throughout the whole project. We hope our findings support you in driving innovation in the context of Smart Living in the future!

In addition, we very much thank all our lecturers, who shared their knowledge and largely contributed to this project's success:

Quirin Bachmeier (CDTM)
 Christian Beck (BSH)
 Vincent von Bühren (CDTM)

course and coach the individual teams.

Special thanks to the Heads of the layout -, editing -, and QA-team (Anna-Lena Zelder, Frederic Martin, Philipp Engel) for finalizing the report.

Philipp Hofsommer and Franz Xaver Waltenberger
 Center for Digital Technology and Management (CDTM)

PREFACE OF THE PROJECT PARTNER

At BSH, our purpose is to improve quality of life at home and make people smile through our exceptional brands, high-class products, and superior solutions.

No matter where or how our consumers live, whether they are a family living in sub-Saharan Africa or a single person in a studio apartment in Manhattan – we want to excite all of them with innovative products and inspiring experiences along each individual consumer journey.

To address individual needs, we focus consequently on the consumer. We are providing them with the right product portfolio and information when and where they are needed. During the orientation phase, most of our brand websites offer tools like product finders, which help to identify the product that best fulfills individual needs. Consumers can then purchase the selected appliance directly from our brand stores or our retail partners – both online and offline – depending on their location and personal preferences.

Throughout the usage phase, our Home Connect ecosystem offers additional services to increase our consumers' experience. Among others, users can search for tasty recipes from partners like Kitchen Stories or our Home Connect Cookbook, and send the right settings right to their connected ovens. When uncertain about the best dishwashing or washer program, our Easy Start assistant directs consumers in the right direction. And when it comes to appliance care, our brands and customer service teams offer helpful cleaning and maintenance tips as well as different care packages for the longest possible appliance lifetime. They include appliance installation, accessories like special cleaning products, and remote diagnostics for connected appliances.

“ **Future interests me more than the past because I intend to live there.** ”
Albert Einstein

We work continuously to learn about our consumers' preferences as well as their current and future needs because they are essential elements of our innovation process.

This is why we were very happy that we had the opportunity to cooperate with the CDTM and participate in the seven-week long Trend Seminar. Together with a diverse group of highly motivated students, we had a look into “Smart Living of the Future”. Starting with lectures of various industry and academic experts, the students were able to identify relevant trends, developed future scenarios, identified insights and key drivers and generated very promising ideas for potential business. All of this will serve us as great source and inspiration for innovations to improve people's quality of life at home also in the future.

We would like to thank the Class of Spring 2021 for their enthusiasm and curiosity towards the topic. Their interdisciplinary backgrounds and passion were a great source of inspiration and have led to a multitude of very interesting ideas. It was a pleasure to experience the work with you at CDTM throughout these seven intense weeks. We wish you all the best in your promising future paths.

A special thanks goes to Philipp Hofsommer and Franz Xaver Waltenberger for the great organization, the excellent communication and the great support.

Tanja Haberlander and Frank Schäfer
BSH Hausgeräte GmbH, Munich

TABLE OF CONTENTS

Editorial	3	List of Contributors.....	103
Methodology	7	Sources	107

TRENDS

Technology Trends	11
Social & Environmental Trends.....	19
Legal & Political Trends.....	26
Economic Trends.....	36
Business Model Trends.....	43

SCENARIOS

Scenario Overview Driver & Scenario Matrix	51
Scenario 1 On-Demand Convenience	55
Scenario 2 Garden of Eden.....	58
Scenario 3 Smart Home Islands	61
Scenario 4 My HomeOS	64

IDEATION

Team 1 MOKI	71
Team 2 SPYNE	75
Team 3 Trashly.ai	82
Team 4 Cooklings.....	89
Team 5 HelpingHand.....	96

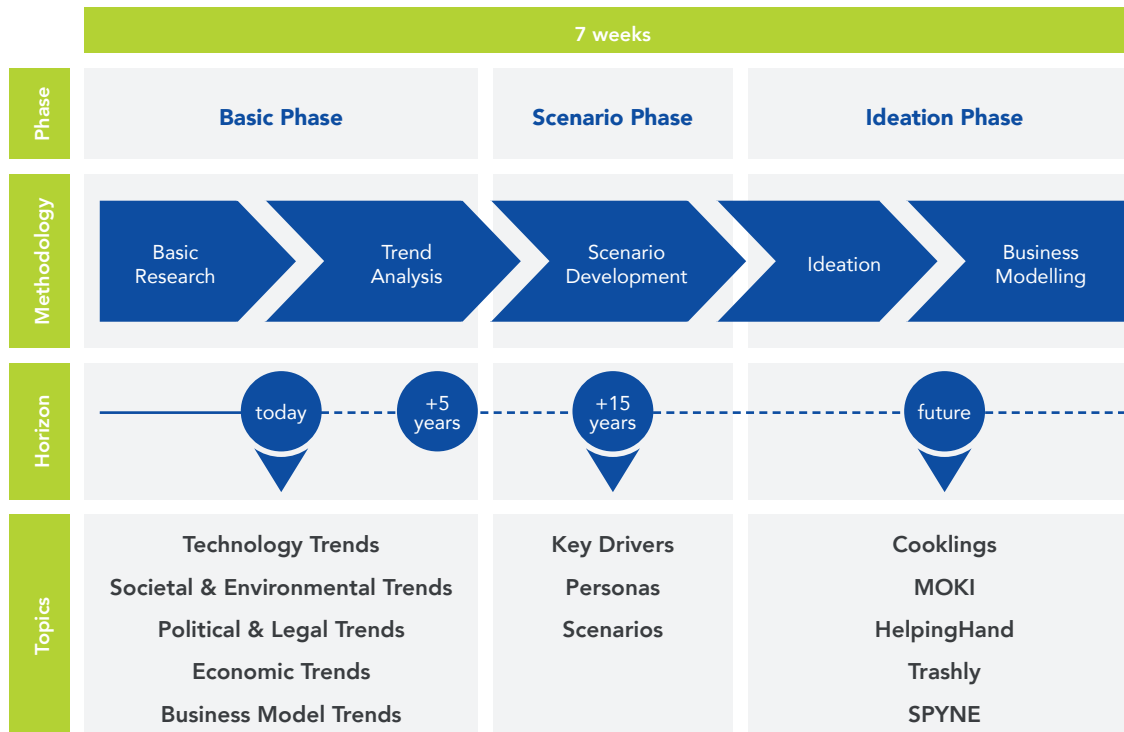
METHODOLOGY

For a given topic that is highly impacted by digital technologies, the Trend Seminar pursues three main goals:

- To analyze the status quo and recent developments in order to identify important trends
- To develop extreme scenarios of the future in order to be prepared for upcoming challenges
- To develop future-proof product and service ideas and to detail them out into business concepts.

These goals are represented by the three phases of the trend seminar: the Basic Phase, the Scenario Phase, and the Ideation Phase.

Twenty-six students, supervised by two doctoral candidates, pursue the Trend Seminar in seven weeks of intensive full-time work alongside with their project partner. In each phase, interdisciplinary subteams are formed including students from technology, business, and various other backgrounds to combine versatile ways of thinking.



The **Basic Phase** yields a holistic overview on recent developments and trends in the environment of the overall topic. Based on the commonly used STEEP approach (Social-Technological-Economic-Ecological-Political), the status quo and trends in the fields society & environment, technology, economics, politics & legal, as well as emerging business models are analyzed. Knowledge is gathered by literature research, preceded by a series of input presentations by experts on the topic. The class is split into five teams, each working on one of the thematic scopes. At the end of the Basic Phase, the teams present their key findings to each other in order for everyone to get a holistic view on the topic to build upon in the following phases.

The **Scenario Phase** builds upon the analyzed trends in order to create four scenarios of different futures in twenty years ahead. Driving forces behind developments are identified and specified as drivers with bipolar outcomes. Once specified, all drivers are ranked according to their respective impact on the overall topic and the perceived degree of uncertainty regarding their outcome. Two key drivers that are independent from one another and have both a high impact and a high degree of uncertainty are chosen and, with their bipolar outcomes, used to create a scenario matrix of four scenarios. A timeline for each of the scenarios is created and the scenarios are sketched out using persona descriptions and visualizations. The Scenario Phase starts with a two-day workshop followed by group work in four teams. Teams are newly formed in order to include experts from each subtopic of the Basic Phase in each new Scenario Team.

In the third phase, the **Ideation Phase**, the goal is to develop innovative business concepts, which are then tested against the previously developed scenarios. Within a two-day workshop on structured ideation following the SIT approach (systematic inventive thinking), a large number of business ideas are developed. Out of these, the most promising five ideas are selected and further developed into detailed business concepts. The business model canvas by Alexander Osterwalder and Yves Pigneur serves as the base structure. At the end of the seminar, the business model concepts are presented to the project partner and guests.

LIST OF ABBREVIATIONS

AAL

Ambient assisted Living

ADL

Activities of daily living

AI

Artificial Intelligence

AR

Augmented Reality

B2B

Business-to-Business

B2C

Business-to-Consumer

BEEG

Bundeselterngeld- und Elternzeitgesetz

BGG

Behindertengleichstellungsgesetz

BM

Business Model

CAGR

Compound annual growth rate

CDTM

Center for Digital Technology and Management

CRM

Customer relationship management

DPA

Data Protection Act

ECB

European Central Bank

EMS

Energy Management System

ESG

Environmental, Social, and Corporate Governance

EU

European Union

GDP

Gross domestic product

GDPR

General Data Protection Regulation

GHG

Greenhouse gas

HAIs

Healthcare-Associated infections

HEMS

Home Energy Management System

ICO

Information Commissioners Office

ICT

Information and communications technology

IoT

Internet of Things

LTC

Long-term care

Mbps

Megabits per Second

MEP

Member of European Parliament

ML

Machine Learning

NATO

North Atlantic Treaty Organization

NLP

Natural Language Processing

OECD

Organisation for Economic Co-operation and Development

PV

Photovoltaic

R&D

Research and Development

SDG

Sustainable Development Goal

SDK

Software Development Kit

List of Abbreviations

SEO

Search Engine Optimization

SPA

Smart Personal Assistance

TWh

Terawatt-hour

UK

United Kingdom

UN

United Nations

UNESCO

United Nations Educational, Scientific and Cultural Organization

US

United States

USD

United States Dollar

USP

Unique Selling Proposition

VBHC

Value based health care

WEF

World Economic Forum

TRENDS

The following chapter lists current trends that have a strong impact on smart living of the future. In accordance with the Basic Phase methodology, trends and related driving forces are structured into five areas: technological trends, societal and environmental trends, legal and political trends, economic trends, and business model trends.

TECHNOLOGY TRENDS	11	ECONOMIC TRENDS.....	36
SOCIETAL & ENVIRONMENTAL TRENDS	19	BUSINESS MODEL TRENDS	43
LEGAL & POLITICAL TRENDS	26		

TECHNOLOGY TRENDS

INFLUENCING THE FUTURE OF SMART LIVING

Individualized Personal Assistance
Ubiquity of Computing
Home Energy Management Systems
Domestic Robots
Data Protective Technology

TECHNOLOGY TRENDS

Influencing the Future of Smart Living

Technology is advancing at a more rapid pace than ever. It has transformed professional and private lives. People carry computers more powerful than those that sent mankind to the moon in their pockets. They use these devices to connect with each other, entertain themselves, and manage their lives. The home of 2021 may superficially not differ much from homes of the past, yet technology accompanies people's daily routines and lives. Understanding the technological trends of today allows us to examine which technologies will have the largest impact on Smart Living in 2025.

All of these devices in typical homes are intelligent, but the sum of their intelligence is their true potential. That is why people use personal assistants like Google, Siri, or Alexa to manage all of the intelligent devices in their homes and to have an intuitive, consistent interface for interacting with physical appliances. One can interact with them as one would with a human by speaking to them. What makes these assistants personal is the knowledge they possess about a person's habits and the data they have about their behavior. Computers have become an integral part of our daily lives and are an omnipresent companion to peoples' pockets, at

their workplaces, and in front of their sofas. Most lives no longer only take place in physical spaces but also in digital ones. This trend continues with the advance of Augmented and Virtual Reality technologies further blurring the line between the digital and physical realities we live in.

The electrification of mobility and heating unifies multiple sectors of energy consumption into one connected system. This sector coupling will lead to a large increase in electricity demand. The introduction of more diverse, renewable energy sources has led to the inefficiency of the traditional grid system, making it challenging to handle such a huge power demand and facing challenges like distribution, sustainability, or reliability. Technology enables us to efficiently manage the electricity consumption and supply of peoples' homes and support their modern lifestyles.

Cleaning homes, doing the dishes, making food, or tending to plants, while simple tasks in principle, appear daunting: modern robots can take some of that weight off their owner's shoulders by taking care of these chores or assisting them in doing so, leaving more time to wind off after a long day.

Homes are filled with intelligent devices, some of them having access to the most personal moments of their owners. Furthermore, all of these devices and services collect, exchange, and process data to be able to adapt dynamically to the context. However, the existing approaches to ensure users' data privacy and security in their most vulnerable spaces are outdated. Thus, it becomes very important for all involved stakeholders to grasp the significance of developing secure systems that protect their users' privacy.



INDIVIDUALIZED PERSONAL ASSISTANCE

Services Will Provide Personalized Assistance Using Diverse Data Sources

Smart Personal Assistants (SPA) are increasingly becoming a part of homes. Their true potential exceeds by far the task to answer questions and give information, but with the increasing interconnectivity of home appliances, those smart assistants aim to become a centralized control unit for various Smart Home functions. SPAs will access diverse data sources such as past behavior, calendar entries, wearables, and weather forecast and combine this knowledge to provide personally adjusted assistance. They will enable enjoyable, smart comfort by intuitively managing home devices and individualizing the living environment according to personal behavioral habits [1]. Automated home configuration from the SPA complements the possibility to control home appliances remotely [2]. Several potential communication channels between SPAs and humans, such as mobile phones, wearables, and voice assistants, are seamlessly connected and provide a holistic assistance experience. With the improvement of voice technologies, voice assistants are expected to become the preferred choice of communication interface [2], [3]. In addition to all these benefits and the increase in the use of this technology, there are also critical debates about Smart Home technologies. The main topic of this criticism relates to data protection issues.

Facts:

- The worldwide number of SPA users is expected to grow from 390m in 2015 to 1.8bn in 2021, which will result in a total revenue increase from 1.60bn USD to 15.80bn USD [4].
- While in 2017, one was able to control 7,000 physical devices with Amazon Alexa, this number has increased to 100,000 by 2020 [2].
- An average German household owns 7.13 IoT devices, which has increased from 6.30 since 2017.

- The global Smart Home appliances market is expected to grow 14% annually until 2027 [5].

Key Drivers:

- Technological advancements in the areas of NLP, ML, and AI will strengthen a smart environment [4].
- Covid-19 has drastically accelerated the digitalization of homes. 70% of surveyed respondents upgraded their homes, while half of them acquired smart devices [6].
- Smart Home devices are becoming faster and cheaper. This enables the majority of the population to adopt smart home devices [7].
- As more people gain access to the internet and network speed increases, more people can use Smart Home devices. At the same time, the possibility of using these devices increases the demand for them [8].

Challenges:

- A SPA provides the greatest value if it can access many data sources. Heterogeneous technical systems represent a challenge for holistic integration [1].
- Intelligent personal assistance requires knowledge about individuals. However, data security and privacy risks are concerns that prevent people from sharing personal information [9].
- SPAs need to gain users' trust. It demands an intuitive user interface and the ability to explain decisions transparently [10].
- A constant exchange with technologies implies health risks like overstimulation of the brain and dependence on the internet. Thus, technical detox becomes more difficult [11].

Impact on the Future of Smart Living:

By providing support to the user at home, digital assistants make life more convenient and reduce complexity. As a result, they will have more time and energy left to spend on their interests. Combined with interconnected devices, this will allow the user to take full advantage to personalize their living space. This trend will have significant implications on how people live in their homes and affect the product portfolio of home appliance manufacturers. Quality and price will decide over the success of their products, as well as the option to connect to the internet and interconnect with related devices.

UBIQUITY OF COMPUTING

Lives Will Take Place In A Blend Of Digital And Physical Realities

People are surrounded by computing devices in their homes: the laptops used for work, the smartwatch worn on the wrist, the Smart TV used to wind down after a long day, or the Alexa and Siri that do every bidding. An average German household in 2020 owns 7 IoT devices [12]. Modern humans are constantly connected, receiving, and sending information using these devices. Many of the things for which separate, analog devices were needed in the past can be done by small, handheld gadgets nowadays [13], [14], [15]. New, emerging technologies like Augmented and Virtual reality have the potential to take this to the next level. Technology giants like Microsoft, Google, Facebook, and Apple are investing in these technologies [16], [17], [18], [19], [20]. Augmented Reality will provide a permanent computing interface, transforming personal computing as smartphones did in the past. Why would someone need a keyboard or external screen when their reality is already augmented with them? Virtual Reality allows people to be in any place they want from the comfort of their homes, be it at work, in a movie, or a lecture. Even further, merging human and machine has become an option with devices like Neuralink [21].

Facts:

- The amount of global mobile augmented reality users worldwide has increased from 200m in 2015 to 2bn in 2021 [22].
- Virtual reality device shipments worldwide have increased from 9m units in 2018 to 24m units in 2020 [23].
- Since 2010, the global average number of connected devices per person has increased from 1.83 in 2010 to 3.96 in 2020, with a projected 9.27 by 2025 [24].
- Consumer spending on smart home systems worldwide has increased from \$40bn in 2014 to \$103bn in 2019, with a projected \$157bn by 2023 [25].

Key Drivers:

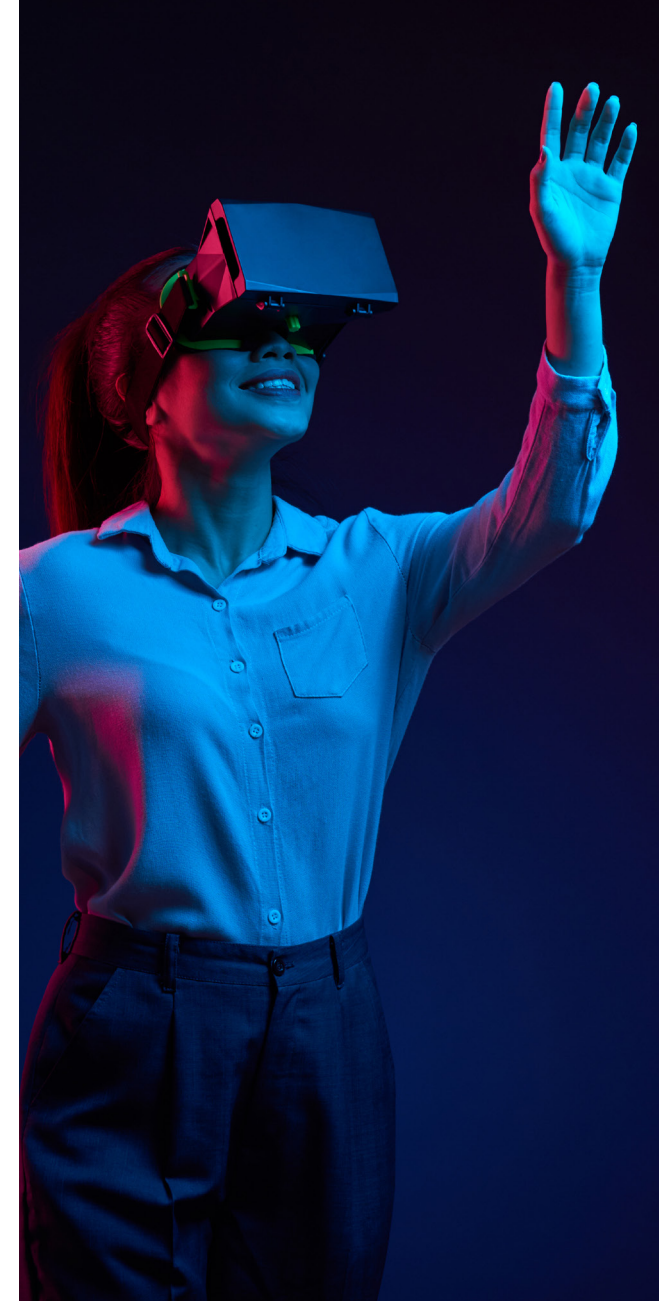
- Over the last 40 years, processors have become faster, cheaper, and more efficient, enabling us to put powerful processors in all kinds of devices and deliver realistic graphical performance [7].
- Tech companies are investing large amounts of money in Virtual and Augmented Reality technologies and building teams dedicated to these technologies (e.g. Facebook with over 400 employees in their Virtual Reality department) [26].
- Average internet speed across Western Europe has increased from 45.6 Mbps in 2018 to 72.3 Mbps in 2020, enabling us to stream and download larger and more sophisticated digital content [8].

Challenges:

- Surrounding oneself with computing devices poses the danger of privacy invasion, with Augmented and Virtual Reality technologies being particularly susceptible to privacy and security risks (eye-tracking, permanent filming of the environment) [27].
- Digital technology use can have harmful effects on many areas of mental health, such as impaired emotional and social intelligence, addiction, social isolation, and sleep disorders [28].
- More and more people have become aware of the health risks of technology use, and many are limiting their use, with companies starting to build mechanisms into their operating systems that aid in limiting technology contact [11], [29].

Impact on the Future of Smart Living:

Lives do not only take place in the four walls of the home. A large part of peoples' lives now takes place in the four corners of their screens, their smartphones, their laptops, or their televisions. Being surrounded by these computers and devices impacts the way homes are designed, and the way peoples' lives are lived. In the future, computing will become even more ubiquitous, and reality will be augmented through glasses and lenses, blending the digital space of the computer and physical space. This will change the way people interact and perceive their living spaces.





HOME ENERGY MANAGEMENT SYSTEMS

Connected Devices Will Enable Intelligent And Flexible Energy Management

Residential buildings in Europe account for almost 40% of the total power consumption [30], [31]. The urge to reduce greenhouse gas emissions increases. The transition towards renewable energy results in volatile energy production. Consequently, energy storage and the flexibility of energy consumption become critical. In addition, electrification of mobility and heat supply further increases the overall electricity demand. This highlights the urgent need for optimized energy management systems. Particularly for residential buildings, whose operation is dependent on the behavior of its occupants. To solve these issues, the concept of smart systems such as HEMSs has been integrated to control energy consumption and reduce consumers' energy bills. These Smart Grids incorporate techniques like auto-monitoring, bi-directional communication, two-way power flow. Various approaches like ML and data mining could be used to forecast the power demand. For coordination of different IoT devices, Game Theory techniques could be implemented [32]. These technologies can further help the energy management units plan and make efficient decisions for flexible power demand in Smart Homes. However, to successfully build such a system, customers' engagement in such products and services in the residential space will be inevitable [33].

Facts:

- The global Smart Home Energy Management market takes almost 30% of the EMS market size. Growth has been driven by companies like Nest, Google Home, or Samsung SmartThings [34].
- Adopting HEMSs with controllable distributed energy resources (DER) could decrease consumers' energy bills by 16% to 25% [30].
- An annual growth rate (CAGR 2021-2025) of 15.3% in the Energy Management Segment revenue results in an ex-

pected market volume of \$14bn by 2025 [34].

- Residential Energy Storage in Europe increased by 57% in 2020. Being coupled with only 7% of Europe's residential PV plants, growth potential remains [35].

Key Drivers:

- The rapid development of enabling technology (e.g. better IoT connectivity, increasing CPU power) will empower the full automation of HEMSs.
- The necessity for reducing greenhouse gas emissions will make the development of sustainable electrification systems inevitable [36].
- Smart HEMS are one of the EU's 10 priority action areas in its Strategic Energy Technology Plan, and governments subsidize HEMS solutions [6], [37].
- Smart Meter rollout enables the digitalization of the energy market, which leads to greater clarity of consumption behavior and helps cut down electricity usage [38].

Challenges:

- The diversity of communication technologies from different stakeholders, the integration of old home appliances, and the lack of consistent standard communication protocols are leading to challenges in interoperability [33].
- Devices that are connected wirelessly to the internet require strong authentication and authorization controls to avoid severe security and privacy issues if a third party gets access to such sensitive data [39].
- The willingness to pay for Smart Grid systems is still low, with only 40% among the silent generation, compared to around 86% of millennials [40].

Impact on the Future of Smart Living:

The Smart Home of the future knows its inhabitants' behavior and preferences. The rise of IoT and connected house appliances allow access to energy-related information laying the foundation for efficient energy management. This minimizes electricity costs and has environmental advantages. Furthermore, the electricity sector will be coupled with transportation and heat supply and mostly run on renewable power. Smart Homes will be integrated into a Smart Grid with its neighboring buildings. Residential energy storages play a substantial role within these Smart Grids. Volatile electricity availability and dynamic pricing set incentives to shift energy-intensive processes to feasible times.

DOMESTIC ROBOTS

Robots Will Assist In Household Tasks And Create A Feeling Of Comfort

Time-consuming and unpleasant chores are a substantial part of everyday life. But robotic systems undergo technological advancements in cognition, interaction, and manipulation and will be able to take over or support household chores in the future [41], [42], [43]. Today's most popular robotic applications in households are floor cleaning, window cleaning, and lawn mowing [44]. These robots continue to improve; for example, the latest vacuum robots are connected devices with voice recognition capabilities [45]. The robot "temi" [46] is an example of emerging personal home robots. It navigates freely and serves as a platform for all kinds of assistance and entertainment purposes. Moreover, temi aims to be interconnected with home devices to act as a Smart Home Hub. The interaction between robots with dynamic environments is intensively studied in research projects [42]. Research robots demonstrate their ability to actively support humans; however, these robots would currently be too costly for private use [47]. Other robots such as Car-O-bot illustrate carefully discussed emotional design to make the product appealing and attractive for humans [48]. Another valuable application is assistive robots which will support elderly and disabled people to live independently [49].

Facts:

- 55m household robots are expected to be sold in 2022. The household robot market is expected to have an annual growth of 20.50% between 2021 and 2026 [50].
- Full-time employees in Germany spend on average more than two hours per day on household work, part-time employees significantly more [51].
- Gen X and Gen Y value leisure time more than Boomer [52].
- People of all ages are generally open to robots in their homes. Older adults in the US even prefer robot assistance over human assistance for chores and information management [53], [54].

Key Drivers:

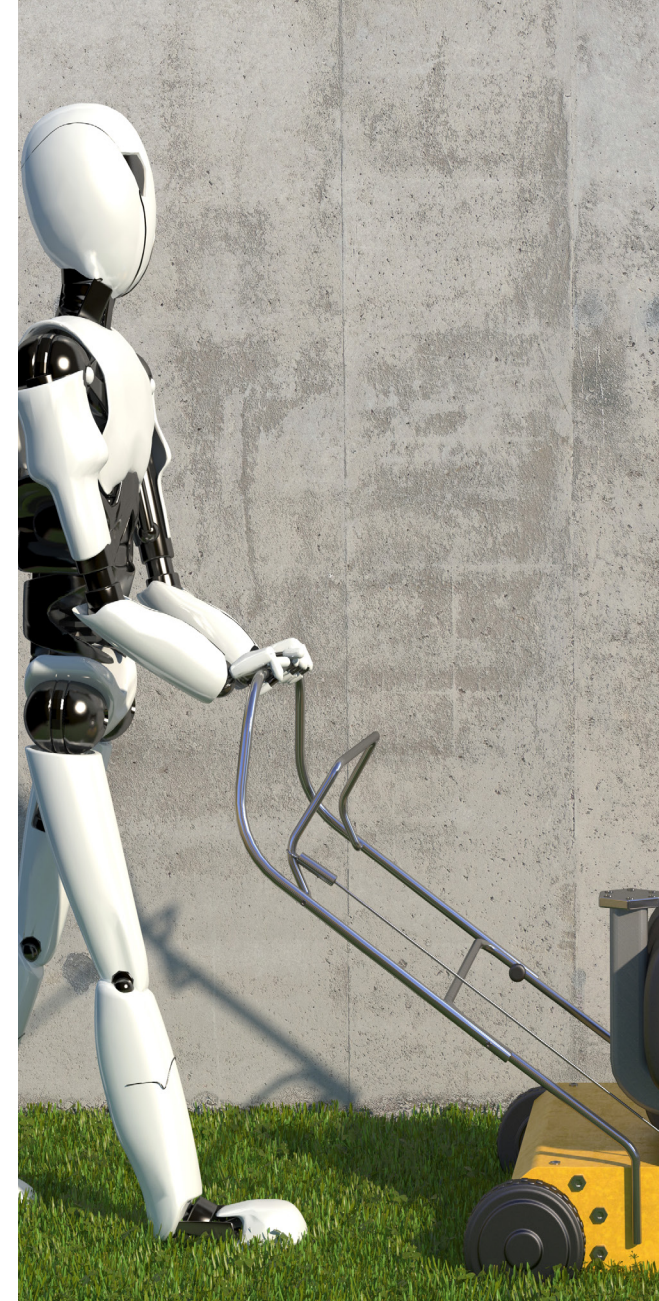
- Advancements in ML, cognition, interaction, and manipulation make robots more intelligent and capable [41], [42], [43]. Robots can take over more difficult and more complex tasks.
- There is a high investment for research and development in robotics [55]. Driving forces for robotic innovation are mainly logistics, industry and healthcare. However, innovations from various robotic applications can be transferred to domestic robots.
- Computing is becoming ubiquitous in all areas of life. People are becoming increasingly used to computers and robots. Hence, an increasing acceptance of domestic robots can be expected.

Challenges:

- Robots excel at executing repetitive tasks, but the variety of household tasks is huge. Narrow household tasks that are feasible for robotic automation, such as vacuuming, are already largely exploited.
- Costs for the robotic system are currently very high. The aforementioned temi robot costs 3999 USD and does not have a robotic arm or the ability for object manipulation. Costs of home robots need to fall to be appealing to the mass market [56].
- The deployment of robots at homes poses safety risks. Regulators are expected to set high safety standards for domestic robots [57].

Impact on the Future of Smart Living:

Domestic robots will disturb the execution of dull and tedious household chores. In the short-term, robotic systems will continue to assist with executing specific narrow tasks like cleaning or mowing the grass. In the long-term, generic robots may be capable of performing more universal functions. For example, the mentioned Car-O-bot aims to become a gentleman butler. This will not only impact the concept of household appliances known nowadays but change the organization of the whole living space. The automation of household chores will save working time which will be spent on more enjoyable activities. Furthermore, robots will contribute to a feeling of comfort, safety, and companionship in living spaces.





DATA PROTECTIVE TECHNOLOGY

Interconnected Smart Homes Will Require Secure Data Protection

With the rapid development of the Internet of Things (IoT) in the context of Smart Living, the number and diversity of connected devices to home networks are promptly growing. These interconnected devices and services collect, exchange, and process information to adapt dynamically to the context. Individualized services provide great value; however, they rely on personal behavioral data. Especially in private homes, the users' most vulnerable space, privacy is critical. Whereas cloud services revolutionized many areas of everyone's daily life, traditional cloud computing is most often not conformable to privacy regulations. This is one reason for the emergence of edge computing in the IoT ecosystem [58]. This represents a countertrend to the rise of cloud computing. Novel approaches such as federated learning enable collaborative but decentralized ML to preserve users' privacy. In addition to privacy concerns, the threat of unauthorized external access is crucial. Every additional connected device presents a new potential point of attack. Traditional cybersecurity practices are outdated, and many current Smart Home devices have been proven to be insecure [9]. Secure systems must be developed to prevent cyberattacks with possible consequences for the health and safety of the inhabitants.

Facts:

- In 2018, 22bn connected IoT devices were used worldwide, and this number is expected to expand to 38.60bn by 2025, reaching a CAGR of 22.60% [59].
- In the past year, 35% of US broadband households reported having a data security problem with at least one of their IoT-connected devices, including malware or spyware infection, loss of privacy, and data identity theft [60].
- 40.80% of digital households worldwide have at least one vulnerable device, which can be easily hacked. This puts the whole home network at risk [61].

Key Drivers:

- Lawmakers in Europe implement stricter data privacy laws like GDPR, incentivizing the development and adoption of privacy-enhancing technology [62].
- An increasing number of devices are connected to the IoT, which leads to enormous amounts of data being gathered from everyone's private spaces.
- Since the implementation of GDPR and DPA in May 2018, the data protection awareness of the end-user has raised enormously. The total number of public contacts received by the ICO has increased by almost 70%. The number of data protection complaints has doubled, and the number of personal data breaches has tripled [63].

Challenges:

- Security services can be difficult to implement within a heterogeneous ecosystem which integrates several types of devices [1].
- Many Smart Home-based IoT blockchain protocols create significant overhead traffic, which leads to processing issues due to IoT devices that are limited in bandwidth [64].
- Ensuring secure access to all IoT-connected devices leads to higher prices when building Smart Home living spaces.
- IoT devices often do not have straightforward updates or any other way to inform the end-user about potential security breaches, leading to a huge delay in counteractions.

Impact on the Future of Smart Living:

Home is the place where people's most private moments happen and where everyone feels most vulnerable. Technology has empowered people and made the lives in homes easier and effortless, but at the same time, modern technologies require large amounts of data to provide intelligent services. The interconnectivity of these devices makes them openly exposed to outside attacks. The introduction of technology into living spaces is inevitable. Many opportunities arise for potential market players who can reap its benefits. However, it is essential to responsibly preserve everyone's privacy and keep the atmosphere at home safe in the process.

SOCIETAL & ENVIRONMENTAL TRENDS

INFLUENCING THE FUTURE OF SMART LIVING

Aging in Place
Household Constellations
Physical Health Solutions
Rising Environmental Concern
Rise of the Home Office

SOCIETAL & ENVIRONMENTAL TRENDS

Influencing the Future of Smart Living

Humans are social beings by nature. With society and the environment having a significant impact on decisions and behavior, this is particularly relevant for everyday life. As of early 2021, the COVID-19 pandemic is largely dominating daily life in all societies. The pandemic does not only directly impact how people interact but also shapes society in the future. But are these changes here to stay? When looking at the bigger picture, there are far more trends that influence the way people live. In the following, five trends will be discussed which will significantly shape (smart) living in the near future.

More and more people are worried about the ongoing climate change. They are realizing the impact their behavior has on the environment. This will be reflected in a shift towards a more sustainable lifestyle, focusing on low energy and resource consumption.

Similarly, there is a rising awareness for physical health through implementing a healthy lifestyle. People are willing to accept technology to help them live a healthy life. This does not only include solutions regarding the execution of fitness exercises from home but also specific devices with the

ability to track data and give direct recommendations on diets and changing eating patterns.

During the COVID-19 pandemic, both employers and employees have experienced the potential down and upsides of home office work. Even though there is a gap between people having the ability to work from home and people who do not, it becomes evident that remote working will partially stay. Therefore, the home of the future will either have a special space dedicated for remote working or have adaptable rooms.

When considering society as a whole, two distinct drivers have the most effect on demographics. First, the population in most developed nations is aging. This puts a strain on the housing market as the elderly have their own needs. The implementation of technology in peoples' homes could partially enable aging at home. This will be crucial as there are already not enough caregivers available in most developed countries. Secondly, household constellations are diversifying due to a cultural shift and an increase in migration.

Taking everything into account, there are multiple facets of how society and the environment will change the future of people's homes. The Smart Home of the future will consist of more flexible and customizable spaces as lifestyles are getting more diverse. More people will consider sharing parts of their homes as space in cities is getting increasingly scarce and expensive. This will lead to new ways of designing homes, and living will become more social. As a result, there will be a decrease in large and private homes in city centers. Lastly, people will start to fully embrace technology in their homes as it not only allows them to reduce costs by e.g., saving energy but also staying healthy thanks to personalized health solutions.



AGING IN PLACE

Growing Requirements And Potential In Assisted Living

The human population is aging globally both in terms of absolute and relative numbers: In 2019, the global share of the population older than 65 was 9%. This share is projected to rise to 25% by 2050 in Europe and Northern America [65]. This development can be linked to low fertility and increasing life expectancy. Globally it can be observed that increasingly more 65+ year-olds are living alone or only with a spouse in a domestic environment. This "aging in place" [66] has strengthened the wish for more independence and privacy: barrier-free housing and care assistance in supported accommodations will grow in popularity. New habitation forms like co-living for lower-income pensioners will emerge. In regions where aging is particularly pronounced (namely Europe, northern America, and Japan), the impact on the future of living will be powerful [66]. Although frequently overlooked as technology users, people aged 65 years or older have a relatively positive view of technology. They believe that technology will aid their well-being, health, and security [67]. Considering their substantial purchasing power and the willingness to invest accumulated savings, this age group is becoming more relevant as consumers, particularly in living [68].

Facts:

- The fertility rate has halved from five children on average in 1966 to 2.5 globally (1.6 in Europe) in 2020 [69], [70].
- Global life expectancy has more than doubled since 1900 to 72.6 years in 2019 [70].
- In 2019, the global share of the population aged over 65 years was 9%. Projections show that by 2050, 25% of citizens living in Europe and Northern America could potentially be aged 65 or older [65].
- In 2013, the overall shortfall of health workers in Europe was estimated to be 1.60m, accounting for roughly 22% of the global shortage [71], [72].

- Retirement is related to more significant depressive symptoms among men [127]. Older divorced or widowed women experience a greater sense of freedom [128].

Key Drivers:

- As more women participate in the labor force, the opportunity cost of bearing children increases. This effect is most substantial in western countries [73].
- When today's 50 plus generation retires, they are used to technology in their homes. They have both high expectations and high purchasing power. Particularly in developed countries, the elderly are the only growing consumer group [68], [74].
- Due to a shortage of healthcare workers and caregivers in the EU, technology-assisted care will become necessary to support the growing number of 65+ year-old people [75].

Challenges:

- As the current fertility rate is below the replacement rate in Europe, the population is shrinking in the long run. The implications for society are vast. It mainly leaves the working people with less disposable income to spend on housing because they have to support an increasingly bigger share of the elderly [65], [69].
- One-third or more of senior residents have reported feelings of loneliness and social isolation [66].
- Older people have higher expectations for their homes than young adults. They require individual and special facilities to ensure well-being, such as a barrier-free environment [66], [76].

Impact on the Future of Smart Living:

An aging population puts a strain on the housing markets due to their higher spatial requirements [77]. Advancements in home automation such as cleaning robots can help perform domestic tasks and promote physical independence [78], [79]. A smarter residence that enables safety and mobility can partly ease the need for care assistance [76]. Furthermore, developing these technologies and new forms of co-living can make the elderly feel more connected [80], [81]. This psychological satisfaction can potentially alleviate age loneliness and further facilitate aging-in-place [82].



PHYSICAL HEALTH SOLUTIONS

Embedding Customized Health Solutions In Everyday Life

Scientific studies and social perception outline that nutrition and physical fitness are important components of a healthy life. At the same time, low global nutrition and fitness standards can be observed. One way to solve this global issue is through technological development, empowering citizens to adapt general best practices to their individual needs [100]. Although there are various ways to design these solutions, for maximizing the customer value, they should all have the following in common: customizable by consolidating data from different sources and easy to embed in daily life. These solutions have the power to increase the adoption rate of a healthy diet and fitness level for people in different life stages, e.g., offering meal plans tailored to the individual preferences and fitness exercises suiting the individual skill level and the daily schedule. Implementing these innovations demand connected kitchen devices to offer an optimal customer experience, as well as further home appliance innovations, like smart mirrors, to enable a home gym for everyone. By doing so, an increase in the global health level is possible, as well as reducing symptoms of depression of people in every stage of life [101].

Facts:

- 80% of the global adolescent population are insufficiently active and therefore have an increased risk of death of about 20% to 30% [102].
- Worldwide obesity has tripled since 1975, and an unbalanced diet is one of the leading global risks to health [103], [104].
- There is a 13% rise in mental health conditions globally [105].
- Nutrition and physical activity highly dependent on individual characteristics [102], [103].

- The number of people seeking online health information has doubled since 2005 [106].
- 69% of UK citizens use the internet to seek health advice without the option of receiving personalized recommendations [106].

Key Drivers:

- People are seeking help regarding their eating habits (75%) and their exercise activities (30%). 65% of Europeans would use technological solutions in the nutrition area [107], [108].
- Physical activity improves mental health and quality of life, which is increasingly demanded by the global population [102], [109].
- Elderly people are more willing to maintain their health level than any other age group while being more open towards technological solutions compared to the behavior in the past. Thus, they represent a major target group [110], [111].

Challenges:

- Consumers are concerned about data privacy regarding the data exchange between different products and services, especially in healthcare. This depends on the society and is especially true in the German context [112].
- Global mental health problems caused by stress in the social and work environment are on the rise. The individual confrontation with stress leads to a decrease in physical activity. This effect may increase after the COVID-19 crisis and the associated layoffs [109].

Impact on the Future of Smart Living:

Implementing a balanced diet will impact the population by changing eating habits through solutions like smart plates, which track eating behavior. Those solutions have the power to streamline daily tasks like cooking and writing shopping lists [113]. For implementing a sustainable fitness routine, the focus is on home exercises that smart mirror technologies could support [114]. Tracking the execution of your fitness exercises and your exhaustion level will provide you with tailored exercises. Thus, the home will change by implementing modular concepts, e.g., using the living room as a home gym, and streamlining your kitchen tasks, e.g., automatically updating your shopping list.

HOUSEHOLD CONSTELLATIONS

Customizing Spatial Demands Due To Shrinking Family Size

Across industrialized countries, family structures have undergone a significant change due to several demographic and cultural trends. The average number of children per couple is steadily decreasing. The societal status of marriage has changed: Just a few years ago, marriage was an integral part of everyone's life. Nowadays, it has become an option, often later in life. The average length of a marriage has also decreased, as divorce rates are up [83]. Relationships are more diverse, resulting in new forms of living together: These new models include patchwork families, single-parents, living-apart-together [84]. As a direct consequence, the average size of households is shrinking [85]. Consequently, micro-apartments with a floor area of 20-35 square meters are on the rise. This demand is accelerated in cityscapes, where the housing market is already strained [86]. As other more diverse forms of households are emerging, personal space will be used differently, which leads to a need for more adaptable and multifunctional spaces. It is facilitated by an increase in shared spaces, ranging from simple communal ovens to the possibility of renting a dining room for a few hours.

Facts:

- In Germany, approximately 12% of couples live apart. Among younger couples (16-29), this share is estimated to be 43% [74].
- Graduates work at twice as many different companies in the five years after their graduation compared with 20 years ago [87].
- Between 2010 and 2019, the total number of households in the EU grew by 7%. The average size of households decreased from 2.4 to 2.3 persons [85].
- In Germany, the number of one-room apartments increased by approximately 11% between 2010 and 2018 [88].

Key Drivers:

- In the early 1970s, the average marriage age was 25 years for men and 23 years for women. This has increased to 34 years and 32 years, respectively [89].
- Women's employment rate has increased by 5% from 2008 to 2018 and the number of single households by 18%. In general, there are higher divorce rates, while fertility has decreased [85], [90].
- As more flexible working spaces and individualistic lifestyles are emerging, the demand for temporary micro-apartments is increasing [88].

Challenges:

- The number of single-person households is increasing faster than the pace at which micro-apartments can be built. For example, Frankfurt is undersupplied of micro-apartments by 78% [91].
- One significant difficulty lies in providing more adaptable spaces, particularly for those working from home during COVID-19. As a result, 25% of current home builders are considering additional space that could be used in many different ways, e.g., home office, home gym, and guest room in one based on the current need [92], [93].

Impact on the Future of Smart Living:

The diversification of household constellations will heavily influence how living space will be used. There will be a higher need for more adaptable and modular spaces to cater to households' different conditions [94], [95]. Supported by intelligent and convertible appliances, rooms will need to serve many purposes. An increasing trend of society will likely favor stronger social and communal ties [96], [97]. Sharing amenities will make housing more affordable and might lead to smaller homes overall [98]. With kitchens, gyms, and laundry machines likely to be shared by multiple tenants, amenities, and services will be of higher quality [98]. Co-Habitation is already taking place in many shapes and forms [99]. The design of future homes is largely impacted, as traditionally, homes were designed with a typical family in mind. New spacing concepts will blur the line between private and public space. Shared dining areas and kitchens will be core components of these rising housing concepts [95], [99]. This will make the design and planning of new living spaces more complex.





RISING ENVIRONMENTAL CONCERN

Growing Awareness Of The Climate Crisis And Demand For Sustainable Solutions

While environmental topics have been discussed by scientists, climate activists, and politicians for many years, global awareness of the imminent climate emergency has recently reached a tipping point. In 2019, millions of people across the globe went to the streets to express their frustration for insufficient actions towards limiting irreversible climate change impacts [126]. In 2020, the five most likely global risks according to the WEF all belonged to the environmental category [127]. The number of companies announcing science-based climate targets has reached over 1300 and is growing exponentially since 2019 [128]. Consumers across the globe are becoming more aware of the imminent climate crisis. But it does not end with awareness: a significant and increasing number of consumers believe their actions can have an impact on combating climate change and are beginning to adopt a more sustainable consumer behavior [129], [130]. This starts at home and influences how people live: among the most frequent changes consumers are reporting to have implemented are reductions of water use, waste generation, and energy consumption in their households [131], [132].

Facts:

- The share of global consumers concerned about climate change increased from 71% in 2014 to 77% in 2019 [133].
- Overall, the concern is higher in emerging countries and younger generations [133], [134].
- Globally more people believe their actions have an impact on combating climate change. In the period from 2018 to 2020, the share rose from 65% to 72% in Europe, from 55% to 72% in the USA, and from 69% to 84% in China [129], [130].
- A global study from 2019 showed that 69% of participants have modified their consumer behavior in recent years out of concern about climate change [131].

Key Drivers:

- Until 2021, governments in 34 countries and the European Union declared a climate emergency (from 4 before 2019) [135].
- In previous crises, declarations of emergency have led to increased public attention [136].
- In September 2019 alone, an estimated 6m people participated in a series of global climate protests [126].
- An analysis of search terms suggests that civil disobedience movements are raising public awareness of the climate change emergency [137].
- In a global survey in 2020, 70% of the participants reported that the COVID-19 outbreak made them more aware of how the environment is threatened by human activity [132].

Challenges:

- Following the pandemic, governments, businesses, and individuals might shift their focus to rebuilding shattered economies. As a result, a shortfall of investment in climate action and a loss of both public and political attention regarding environmental topics is possible [138].
- While most consumers are concerned about their carbon footprint, a global survey in 2019 found that only around 50% are willing to pay more for sustainable products. Among the participants not willing to pay more, most would still choose an environmentally friendly product over others, all else being equal. [139], [140].

Impact on the Future of Smart Living:

As consumers are becoming more aware of the climate crisis, they're changing their behavior and are setting an increasing focus on sustainability. The most common factor is reducing household energy consumption [132]. In a US survey in 2020, 44% of consumers reported a wish to see real-time electricity pricing and actual energy consumption by appliance, indicating a desire to better manage energy [134]. Smart Home energy management systems, including heating and lighting control, are expected to reach a household penetration of 17.2% in Europe by 2025, compared to 5.6% in 2021 [141]. Besides energy preservation, residential energy production and storage reduce environmental impact and continuously become more popular [142], [143].

RISE OF THE HOME OFFICE

Working At Home As An Alternative To Office Cubicles

The COVID-19 pandemic has demonstrated how rapidly remote work can be implemented across a large part of the economy. Companies throughout the world accelerated their digital transformation and implemented remote working at scale [115]. Particularly in the service industry of developed countries, the benefits of working from home, such as higher work productivity and less time commuting, are too significant to be ignored [116]. The best examples being jobs in finance and management, where 76% and 68% of the tasks respectively can be done remotely without productivity losses [117]. Most workers cannot work remotely and won't be able to do so in the future, making 20% to 25% of the workforce in advanced economies capable of working from home a privileged minority [118], [119]. The trend towards home office is driven by strong factors: the workers' desire for a hybrid approach, considerable corporate savings, and a better quality of life [120]. However, remote workers will have to make substantial investments to work from home effectively [121]. Regardless of the challenges mentioned above, the home office, whether hybrid or full-time, is here to stay as it offers a long list of benefits and opportunities for workers and corporations alike.

Facts:

- About 20% to 25% of the workforce in advanced economies can work from home between three and five days a week without productivity loss, with up to 22% of increased productivity [53], [122].
- "Home Office", "Remote Working", and "Working From Home", were trending words and reached all-time global search highs in 2020 with Google Trend scores of 90/100, 15/100, and 100/100, respectively. Comparatively, the Google Trend scores for the year 2019 were: "Home Office" 36/100, "Remote Working" 8/100, and "Working From Home" 30/100 [122].
- 76% of office workers globally want weekly work from home days [120].

Key Drivers:

- The COVID-19 pandemic forced companies to rapidly digitalize; an increase in remote working that would normally have taken 454 days pre-pandemic, was completed in 10.5 days in 2020 [115].
- 20% of the workforce in the United States is expected to continue working remotely after the COVID-19 pandemic on a full-time basis [123].
- Employees can save 640 – 6,400 USD per year by working remotely at least 3 days per week. The savings come mainly from reduced costs on gas, and food [124].
- Similarly, firms can save 11,000 USD per half-time remote worker by saving on real estate costs, and reduced absenteeism [125].

Challenges:

- As many as 60% to 75% of jobs in the United States cannot be performed remotely [119]. Some work activities that can be done remotely, such as employee onboarding are more effective in person [118].
- Four out of five workers find it difficult to shut off after work when working from home, which could lead to mental health problems [125].
- A challenge for a 100% remote working approach is the fact that young professionals are still attracted to large cities such as New York and London mainly because of network development, job opportunities, and social circles, which act as strong talent magnets [123].

Impact on the Future of Smart Living:

The home of the future will have a dedicated space for remote working, which will be used a couple of days per week and be paid by the employer [118]. Job opportunities with remote working opportunities will be coveted more than before the pandemic [117]. The home office will impact the Smart Living of the future by bringing the office to people's most intimate place - their home. Households will promptly demand smart appliances, tools, and flexible spaces, not only to live but also to work at home. New solutions will be multipurpose to fulfill the requirements of office work in a home context.



LEGAL & POLITICAL TRENDS

INFLUENCING THE FUTURE OF SMART LIVING



Promoting A Circular Economy
Climate-Neutral Living
Flexible Working
Investments In Digital Transformation
Data Regulation

LEGAL & POLITICAL TRENDS

Influencing The Future Of Smart Living

Governments need to constantly adapt laws and policy frameworks to ensure socio-economic prosperity throughout the dynamics of climate change, digitalization, and demographic change. These regulations profoundly impact the way people live in the future, transcending from the daily routines of individuals to the way industries produce goods and services. This section presents five critical trends of such political and legal actions.

Climate change, induced by a steady increase in GHG emissions, and environmental degradation, caused by extensive resource depletion, pose an existential threat to societies worldwide. Dramatic increases in public awareness about these issues and subsequent voter pressure to take urgent action against them lead to more ambitious environmental policies. Within this domain, two clear trends impacting the future of Smart Living can be derived. First, there is a large regulatory push towards a circular economy, which means that the value of products, materials, and resources in closed loops is maximized. At the same time, waste is reduced to a minimum. Second, carbon taxation and stricter energy efficiency regulations are introduced to achieve a more dras-

tic reduction of CO2 emissions in the Smart Home industry. These political and legal trends will have lasting impacts on Smart Living: requiring new ways of designing and producing home appliances, facilitating new business models, and disrupting cost structures and prices of residential infrastructure, products, and utilities.

Furthermore, driven by changing family models and transformation of the workplace, employees are demanding more flexible ways of working. The opportunities offered by digital technologies and their accelerated adoption due to the COVID-19 pandemic are enabling most employers to offer these flexible working options. Meanwhile, governments are introducing policies to promote and facilitate workers' claims to remote working. In addition, these policies strive to enable families to arrange their work and personal lives according to their individual preferences. This is likely to increase the use of Smart Home systems, which can improve work-life balance by enhancing well-being and reducing stress, and Smart Home devices, which enable data security and compliance with labor laws.

The digital transformation of society and the economy has also reached the home. There is increasing adoption of interconnected Smart Home devices that understand and accommodate the users' routines and habits in their most private environment. As these devices have access to particularly sensitive information, there is a trend towards more sophisticated data privacy regulations based on the GDPR. At the same time, to realize the full potential of these Smart Home technologies, a trend towards more significant public investments in digital infrastructure such as the roll-out of 5G networks is evident.

In the following, legal and policy trends concerning climate change, digitalization, and working activities and their impact on the Smart Living industry will be elaborated further. For each trend, key facts, drivers, and challenges are introduced.



PROMOTING A CIRCULAR ECONOMY

Increased Regulation Of Sustainable Product Life Cycle Management

The transition towards a circular economy is a central contribution to the EU's Green New Deal [144]. By progressively decoupling the consumption of finite resources from economic growth, the EU can reduce its dependence on imported raw materials and vulnerability to resource supply shocks, like those posed by the COVID-19 crisis. Meanwhile, it can create new opportunities for innovative business models [145]. The EU adopted a Circular Economy Action Plan for industries with high circularity potential or a high level of raw materials consumption to drive this transition. These include electronics and ICT, batteries, packaging, plastics, textiles, construction and buildings, and food [144]. All of these can be closely linked to the future of living. For the first time, the plan ensured that between 2016 and 2020, more than 10bn EUR of public funding from EU programs was allocated to fostering a circular economy in the EU. All of the 54 actions of the plan were delivered by 2019 [145]. In 2020, the EU comprehensively revised this action plan to further accelerate the transformational change [146].

Facts:

- Ecodesign regulations for household appliances now include systematic criteria on durability, reparability, recyclability, and recycled material content of products [147].
- A new “right to repair” requires electronics sold in the EU to be repairable for up to 10 years, and manufacturers to supply spare parts for broken devices within 15 working days [144].
- The EU plans to introduce a mandatory score to indicate the reparability of consumer electronics sold in the EU. France already passed a national law for this [148].
- The Construction Product Regulation will be revised, including recycled content requirements for construction products [144].

Key Drivers:

- Humanity would need 2.8 planets if everyone consumed resources at the rate of the EU. Global population growth and a rise in living standards in developing countries no longer allow this disproportion [149].
- By 2030, the circular economy could unlock global economic growth of 4.5tn USD and create around 700,000 new jobs as well as a 0.5% increase in GDP for the EU [150], [151].
- 77% of EU citizens prefer repairing their devices to replacing them. In comparison, 79% think that manufacturers should be legally obliged to facilitate a repair or replacement of individual parts [152].

Challenges:

- A circular economy requires a fundamental transformation of supply chains and production processes involving new forms of collaboration between stakeholders [153].
- Recycled materials often cannot yet compete with virgin materials regarding price and quality. To do so, recycling technologies still need to mature significantly, which requires significant investments [154].
- Recovery and recycling processes within a functioning circular economy are very energy-intensive. To make them viable, a large uptake of renewable energies is required [155].

Impact on the Future of Smart Living:

Increased legislation on the circular economy will make companies more responsible for the performance and sustainability of their products throughout the entire lifecycle. This will significantly transform supply chains and production processes while incentivizing manufacturers to keep ownership of their products and materials. To do so, they may introduce new business models such as product-as-a-service, sharing, or pay-per-use. In the future, this may lead to more extensive adoption of new co-living concepts in urban areas, where home appliances are shared more extensively, or rental apartments are pre-furnished with subscriptions to textiles and home appliances.

CLIMATE-NEUTRAL LIVING

Policies To Enforce Reduction Of Carbon Dioxide Emissions

Climate change caused by GHG emissions results in high costs for society and the economy through damage to property, infrastructure, and health [156]. Increased public awareness and voter pressure brought climate action to the forefront of the political agenda [157]. With the Climate Protection Programme 2030 and the new Climate Change Act, the Federal Government of Germany aims to reduce greenhouse gas emissions by 55% by 2030 compared to 1990 [158]. The EU focuses on EU-wide policies and mandatory national climate change targets [159]. At the end of 2019, the European Commission presented the "Green Deal", which aims to make Europe the first climate-neutral continent by 2050 [160]. This will also impact the Smart Living industry. Through stricter energy efficiency and ecodesign standards for home appliances, targeted policies can influence design and production [161]. Regulations such as the CO2 price introduced in Germany in 2021 can lead to changes in costs and pricing of goods and services with high emissions [159]. However, Smart Homes also represent an opportunity to contribute to climate action through energy efficiency analyses and reduction recommendations [161].

Facts:

- In 2021, fossil fuels suppliers in Germany have to pay 25 EUR per ton of carbon dioxide emitted, rising to 55 EUR in 2025 with a CAGR of 22% [162].
- In October 2019, the European Commission adopted new ecodesign measures for appliances, leading to 167 TWh of energy savings per year by 2030, equalling Denmark's annual energy consumption [147].
- New energy labels for appliances in the EU have been introduced in March 2021 [163].
- The fourth round of negotiations on the first European climate law closed in March 2021 included establishing a

system to monitor progress on climate neutrality and the permission to adopt measures [146].

Key Drivers:

- Climate change causes damage to property, infrastructure, and human health, creating high costs for society and the economy, which is putting pressure on politics [156].
- Climate change is assessed as high risk by a growing majority: In 2021, for the first time, the five most likely long-term risks in the World Economic Forum's Global Risks Report were environmental risks [164].
- Vote shares of Bündnis 90/Die Grünen in the European elections in Germany increased between 1979 and 2019 from 3.20% to 20.50% [157].
- The share of MEPs who belong to the European Green Party rose from 2.50% in 1984 to 11.40% in 2019 [165].

Challenges:

- While the benefits of strict environmental policies are global, the costs have to be carried by each country's population. Therefore, the incentive for a government to pursue ambitious climate regulations alone is low [166].
- Risk of "carbon leakage": companies, e.g., within the EU, relocate their production sites to countries outside of the EU with less strict emission regulations because of the increased costs [167].
- Fossil fuel industrialists spent 30m EUR in 2018 on lobbying efforts to weaken climate action policies in the European Union - 300% more than in 2010 [168].

Impact on the Future of Smart Living:

Stricter energy efficiency and ecodesign standards for appliances directly impact the design and production of Smart Home appliances, which leads to an increase in costs. The CO2 price would cause goods and services that are harmful to the climate to become more expensive and climate-neutral products less expensive if additional charges are passed on to customers [169]. In this way, sustainability can ensure global competitiveness [170]. Smart Homes also constitute an opportunity for climate protection by conveniently recording and analyzing energy consumption and identifying subsequent saving potential [171].





FLEXIBLE WORKING

Regulations Enhancing Flexible Working Possibilities To Accommodate Changing Demands Of The Workforce

The expectations of employees regarding their workplace are changing. In addition, gender roles are becoming more balanced, with parents wanting to participate equally in work and childcare [172]. Furthermore, the work mentality is changing. A growing number of employees are demanding a more individual way of working where they can achieve self-realization and time sovereignty [172], [173]. Digitalization is enabling many employers to offer such flexible working options to their workforce [172], [174]. COVID-19 has forced many employees to work from home and has accelerated companies' efforts to offer flexible working to their employees [175]. As a result of the pandemic, the German government has made it a legal requirement for employers to offer working from home when possible [176]. Moreover, governments have acknowledged the changing needs of workers and are therefore developing legislation to provide a legal basis for flexible working. This strengthens workers' claims to flexible working towards their employer and colleagues [177], [178], [179]. With more employees working from home, demand will increase for Smart Home devices and systems that allow employees to balance home office, caregiving, and housework.

Facts:

- The Federal Ministry of Labour and Social Affairs (BMAS) launched a legislative initiative for a regulatory framework aimed at facilitating mobile working [178].
- Several German parties want to promote opportunities for flexible working. The FDP demands more opportunities for mobile working and working time regulations [177]. Bündnis 90/Die Grünen call for a "flexible full-time" model [180]. The SPD requests more flexible forms of work.
- Flexible working arrangements are on the rise across Europe: Finland passed a new working time law, which fosters flexible working hours. The Prime Minister proposed a 24 hour week [181].

Key Drivers:

- A transformation and digitalization of the working world takes place, referred to as "New Work": a new working mentality driven by changing values, emphasizing the opportunities offered by digitalization [172], [173], [174].
- A reform of the BEEG aims to foster a partnership-based sharing of work and family time between parents [183]. This is further driven by changing family models and gender roles [172], [175].
- The number of employees using mobile work increased from 20% before the pandemic to 36% in July 2020. Employers are obliged to offer a home office option where possible. 87% of employees are satisfied with mobile work, and 63% favor a legal right to it [175].

Challenges:

- Employers are reluctant to offer mobile working: in 2018, only 26% of German companies offered mobile working to their employees. The pronounced culture of presence prevents employees from taking advantage of flexible working opportunities [175].
- Due to a lack of clear boundaries between work and private life, flexible working can increase stress and negatively affect psychosocial health. This is especially challenging for parents who spend more time on work and family tasks in the home office [175].
- Labor law must also apply to mobile working: employers must ensure compliance with occupational health and safety regulations, close existing insurance gaps, and provide employees with the necessary equipment [178], [184].

Impact on the Future of Smart Living:

A legal right to flexible working will significantly increase the number of employees using mobile working, with 55% of German professionals (23m people) seeing their job as at least partially suitable for home office [185]. This will increase the demand for innovative Smart Home technologies that support working at home, create a productive work environment, or support work-life balance by enhancing well-being and reducing stress as well as negative impacts on psychosocial health. In addition, employers may require employees to install specific devices to ensure data security and seamless data transfer or to ensure compliance with labor laws [186].

INVESTMENTS IN DIGITAL TRANSFORMA- TION

Building The Foundation For Smart Living In The 21st Century

Developing a society with high-speed connectivity by 2025 has been an established common goal for all EU member states since 2016 [187]. The trajectory to provide gigabit connectivity to all the main socio-economic drivers involves building high-quality digital infrastructure. The European Commission estimated around 515bn EUR would be required in funds to create a single online market for all of Europe that promotes seamless cross-border trade – also known as the digital single market [188]. However, only a fraction of this amount has been sanctioned in the latest budget, and countries find themselves lagging in their mid-term goals thus far. The COVID-19 pandemic has exacerbated this situation but has brought back the focus on the need for rapid digital transformation. The EU recognizes green and digital transitions as key drivers of economic recovery from the COVID-19 crisis [189]. The investment in developing key technologies like IoT and AI, which are core components of smart devices, is vital to spark innovation in the Smart Living market. Additionally, better connectivity in rural areas could expand the digital market geographically. By enabling Smart Living, digitalization can improve the quality of life in more ways than one.

Facts:

- The EU has adopted the next long-term budget (2021-2027) with significantly higher spending than previous budgets on digital transformation (9.2bn EUR) and digital infrastructure (3bn EUR) [190].
- The Recovery and Resilience Facility (RRP) and InvestEU program earmark around 590bn EUR for recovery from the

COVID-19 pandemic with a minimum of 20% for digital transformation [20], [190].

- The 2018 coalition agreement of the German Federal Government prioritizes the nationwide expansion of gigabit networks by 2025 [191].

Key Drivers:

- The COVID-19 pandemic highlights the need for high-speed connectivity in times of restricted mobility [192].
- Rapid digitalization is required for European countries to stay competitive in the global market in terms of digital economy and innovation [193].
- Europe has a potential of 2.2tn EUR in GDP growth by 2030 through digitalization, a 14.10% increase from 2017 [194].

Challenges:

- Private sector companies utilize public investments to build the required digital infrastructure. When different companies undertake similar digital upgradation projects, they can have conflicting approaches, which could delay the overall progress [195].
- Public institutions depend on the private sector to provide the necessary digital infrastructure and internet services to consumers. The lack of immediate profitability reduces the incentive for companies to take up digital transformation projects in rural areas [195].
- Varying labor laws, taxes, and bureaucratic red tape measures in different EU countries stifles unified progress in developing the digital services sector [196].

Impact on the Future of Smart Living:

The digital transformation in Europe offers many opportunities for the Smart Living industry. Boosted investments over the last year to promote the development of digital technologies like AI and cybersecurity directly impact the future of smart devices [190]. Prioritizing the implementation of 5G connectivity allows companies to realize the full potential of IoT devices, which is the core component of Smart Living technologies [197]. More specifically, 5G would also allow consumers to utilize smart devices from rural areas, thereby expanding the market potential.



DATA REGULATION

Higher Legislative Robustness Against Data Privacy Breaches

Smart Home technology will play an essential role in the future of Smart Living. Every piece of furniture may become a smart device generating data and creates use-cases beyond basic functionality. Machine Learning will enable Smart Home systems to understand the users' routines and habits in their most private environment [198]. At the same time, Smart Homes are vulnerable to a new set of emerging threats - data destruction, illegal physical entry, and privacy violations [199]. The absence of strong monetary incentives for device manufacturers to construct private and secure devices has led to regulators stepping in to ensure data protection [200]. The introduction of GDPR in May 2018 by the EU strives to give users more control of their data [201]. The EU Cybersecurity Act introduced in 2019 aims to provide a European cybersecurity certification framework [202]. The currently awaiting ePrivacy laws intend to strengthen the rights to privacy, confidentiality, and the free movement of data [203]. Data is of strategic relevance to building increasingly sophisticated smart solutions. Therefore, the Smart Living of the future will greatly be affected by future developments of data regulations.

Facts:

- The GDPR requires businesses to disclose any processing of personal data and set up appropriate measures to implement the outlined data protection principles [204].
- Violations against the GDPR are fined up to 20m EUR or 4% of the global revenue of an enterprise, whichever is higher [205]. These fines have increased by 39% in the last 20 months [206].
- The ePrivacy laws aim to strengthen the rights to privacy, confidentiality, and the free movement of data, even for non-personal data [203].
- The EU Cybersecurity Act introduced in 2019 enables manufacturers to certify their ICT-based products for IT security [202].

Key Drivers:

- The number of connected devices will quintuple to 75bn devices by 2025 compared to 2018, leading to an exponential increase of collected data [207].
- The increasing demand for individualized systems requires a constant stream of personal data to truly customize to the user's needs and routines [208].
- There is an increased awareness and demand towards more sophisticated data regulation by the general public due to recent security breaches and data abuse [209].
- Cybersecurity comes into the focus of EU legislators: the EU agrees to invest 1.7bn EUR into cybersecurity coordination and cybersecurity capacities between 2021-2027 [210].

Challenges:

- Data regulation heavily varies in different countries and sectors, with many recent developments requiring global companies to keep up with the respective local data regulations in their markets [211].
- Implementing strict data regulations can be very complicated and costly and may require hiring additional personnel [212].
- Cybersecurity legislation efforts tend to fall behind in context and time. Investigating firms for their compliance is challenging [213].
- Strong lobbying efforts slow down the introduction of even stronger, customer-favored regulation on data protection [214].

Impact on the Future of Smart Living:

The GDPR and further privacy regulations will heavily influence the future of smart living, as the outlined requirements will need to be incorporated into appliance design. Ensuring the safety and consent of processing the user's data shifts from being a feature to becoming a legal requirement. The above-mentioned regulations are just the start: more legislation regarding data is expected. Thus, companies need to ensure keeping up with the latest requirements regarding data. On the other hand, security and data protection can become an excellent differentiation opportunity for companies that gain customer trust through trustworthy IT security certificates.

ECONOMIC TRENDS

INFLUENCING THE FUTURE OF SMART LIVING

1194.38

Vol : 635.25 M

12.00
0.011
-14.00
-26.00

56.45
43.38
21.55
6.57

- More Remote Work
- Faster Green Transition
- Expansion Of The Data Economy
- New Living Concepts
- Increasing Market Maturity

ECONOMIC TRENDS

Influencing The Future Of Smart Living

In recent years, global economies have experienced significant structural changes that influence the way we live. Consumers have become increasingly demanding towards companies to address the ecological challenges in producing and disposing of durable goods. Consumers are now actively engaging in corporations' value creation, and companies are exploring more flexible work concepts enabled by technological infrastructure. The ongoing COVID-19 pandemic has amplified these changes. Restrictive measures to limit the spread of the virus became drivers of digitalization, showed the fragility of global supply chains and highlighted the growing importance of sustainability. Recent developments in technological innovation and infrastructure built the basis for the subsequent momentum to tackle these challenges proactively. There are five trends in this current economic climate that will significantly impact the Smart Home industry over the next five years.

The first development concerns the future of work. Traditional office-centric work models might soon become outdated with more flexible and tech-enabled working models emerging. The "home office" will increase in relevance, reducing

face-time and enabling significant cost savings for both employers and employees. However, this requires a paradigm shift for companies to realize these gains and increase employee productivity.

Sustainable consumption and conscious resource management are not only changing the way we live but have become the subject of growing investors' interest. Incentivized by progressive European regulation and pressure from investors and consumers, companies are faced with the imperative to develop a new generation of intelligent, resource-saving home appliances.

Home appliances of the future will be environmentally friendly and digitally-enabled, creating a smart and personal customer experience via user data integration. The relevance of sourcing, sharing, and evaluating personal data is likely to grow in the next five years. With the increasing adoption of AI-centric product offerings, the "Data Economy" will fuel value creation across industries.

Innovative and flexible concepts are not exclusive to the future of work but influence the way we live. Continuing urbanization, paired with scarce supply for residential real estate in dense cities, accelerates the adoption of new approaches such as Micro- or Co-Living.

Greater emphasis on sustainability and a growing market for personalized data applications serve as a promising foundation for the Smart Home market to thrive. While this certainly holds for the near future, the current state of the Smart Home market is still underdeveloped. Competitors face a fragmented market and a complex supplier infrastructure. Despite predicting an eventual consolidation, the current fragmentation level is expected to prevail over the next five years.

The trends mentioned above might encounter notable challenges. These include consumer concerns (e.g., data privacy), regulatory issues (e.g., zoning regulations), and competitive environments (e.g., need for greater interconnectivity among appliances). Despite the challenges, these trends are expected to sustainably shape the Smart Living industry and advance the way we live.



MORE REMOTE WORK

Benefits For Both Employers And Employees Drive The Adaptation Of Telecommuting

The COVID-19 pandemic strengthens the existent trend towards remote work as it forces employers to enable remote working models [215], [216]. Studies show this leads to happier and healthier employees [217]. Yet, home office proves to have advantages not only for workers but also their employers. Most prominently, it increases productivity and reduces real estate costs. Thus, home office can lead to significant cost savings for companies [218]. Employers increasingly become aware of this fact, and therefore home office will continue to become more important. A hybrid model where workers spend two to three days per week in the office is most likely to become dominant [219]. This enables companies to develop a beneficial corporate culture and employees to maintain personal relationships with colleagues [220]. As more employees work from home, the requirements for their living space change. Optimizing a room for working induces a change in the needs for furniture and appliances. They need to be specifically built to mitigate the challenges of teleworking, e.g., by helping to separate work and private life.

Facts:

- Due to COVID-19, the share of the German workforce working from home for the majority of the time rose from 4% pre-pandemic to 24% in January 2021 [221].
- US companies currently typically save at least 11,000 USD yearly per half-time telecommuter, e.g., by increasing productivity and lowering real estate costs [218].
- In the Netherlands, one day per week remote work results in 3.9bn EUR annual net welfare benefit for employees and companies combined, accounting for 1% of total Dutch payroll costs [222].
- The productivity increase by remote work depends on the function of the worker. Most productivity gains can be achieved through digital work [223].

Key Drivers:

- The COVID-19 pandemic forced companies to offer remote work, but they now realize its benefits, such as increased productivity, efficiency, employee morale, and loyalty [224].
- Employees want to keep working remotely to commute less and be more flexible. The number of German workers commuting to another town for work rose from 14.9m in 2000 to 19.3m in 2018, accounting for 60% of the workforce, raising the demand for remote work [225], [226].
- Reliable broadband internet access becomes increasingly available, and the number of jobs that can be done remotely rises [227].

Challenges:

- It is harder to have a strong corporate culture with employees working decentrally. Team building, connections between colleagues, and benefits like a canteen are more difficult to maintain in a remote setting [228].
- Employees work longer hours in the home office and have trouble separating their work from their private life. Hence, reporting an increased number of burnouts, with 55% of remote workers feeling burned out due to longer working hours [219].
- Workers with high income tend to have roles that can easily be performed remotely, e.g., management, IT, or finance working positions. Thus, this trend may amplify inequality between workers [229].

Impact on the Future of Smart Living:

The number of remote workers will be significantly higher post-COVID than pre-COVID as most employers intend to keep parts of the workforce remote [230]. A hybrid model is most likely to become the primary work model. Employees want to stay in in-person contact with their colleagues and value the increased flexibility of remote work [220]. This location shift enables employees to spend more time at home – both for work and leisure. The increased number of remote workers creates a need for additional work-related furniture and appliances. These will need to address the challenges, such as the increasing difficulty of maintaining a good work-life balance.

FASTER GREEN TRANSITION

Adoption Of Sustainability Measures Demands Product And Business Model Innovation

As concerns about the negative impact of climate change on the environment rise, stakeholders become more aware of shifting to more sustainable economic models. Over the last years, investments and demand for sustainable products have seen a notable increase, partially incentivized by government entities and the use of new technologies. Particularly the home appliance industry has received special attention from politics and regulatory agencies to encourage eco-sustainable innovations. Furthermore, the COVID-19 pandemic accelerated this adoption process and created more awareness about the importance of sustainable development in the future. Therefore, corporations might need to adapt their business models and long-term strategies to embrace the circular economy and adopt sustainable policies. This will have a substantial impact across entire value chains and open new opportunities for economic growth. For example, home device manufacturers will see a rise in demand for eco-friendly appliances and products. And even though this could potentially require increasing sale prices to offset higher production costs, it could still prove to be a successful business model in the future, as sustainability is already perceived as an essential purchasing factor that even competes with price.

Facts:

- The sustainable finance market is booming, with 4x growth in ESG-linked credit volume [231], [232].
- More than 50% of executives in corporations believe that the importance of sustainability for businesses has increased since the start of the pandemic [233].
- Fully sustainable, circular economy approaches are still hardly implemented; however digital technologies such as IoT, Big Data, and Cloud Computing, might prove to be catalysts for transition [234].
- 74% of consumers are willing to pay a price premium for sustainable packaging [235].

Key Drivers:

- Regulatory bodies are putting increasing pressure on adopting sustainable action throughout the entire value chain, which is evidenced both in the 2030 Sustainable Development Agenda of UNESCO and in the latest EU legislation to promote sustainability in the home appliance industry [236], [237].
- There is an ongoing transformation in corporations, as younger generations of professionals are more environmentally aware, and ecological criteria are increasingly gaining importance as revenue drivers for companies [238].
- Sustainable finance has significant momentum, motivated by growing demand from institutional investors and investment managers for more sustainable business operations [232].

Challenges:

- Sustainable production methods and materials are still nascent and not yet financially viable. Considerable investment in R&D and cooperation between different sectors and political and regulatory support is needed to fully develop the potential of green production [239].
- There are persistent psychological barriers – as the climate crisis is not perceived as an immediate threat – and institutional barriers, such as lobbying, opposing sustainable action [240].
- Contradictions within the sustainable development goals of the United Nations, together with local governance (especially in developing countries), pose a significant challenge to the adoption of sustainable economic measures [241].

Impact on the Future of Smart Living:

In the next five years, the development of home appliances with reduced energy and water consumption and the implementation of sustainability measures across the whole value chain will be crucial. Besides, climate change is expected to affect different regions in diverse and individual ways, potentially altering regional needs and demand for home appliances. Furthermore, new emerging business models will be key to further accelerate the transition towards a circular economy. Finally, corporations will have to adapt and modernize manufacturing processes and find fewer polluting alternatives to scarce resources.





EXPANSION OF THE DATA ECONOMY

The Increasing Amount Of Data Becomes A Driver For Growth And Change

Over the last years, the volume of data has increased as companies and consumers use more devices that can generate data [242]. The efficient usage of data transforms many economic sectors and provides them with new opportunities for economic growth. On the one hand, the increasing amount of data contributes to technological advances, including AI, ML, and process automation. This, in turn, leads to a more efficient allocation of resources, reduction of costs in manufacturing, and increasing demand for data professionals [243], [244]. On the other hand, companies accruing data may consolidate a significant amount of market power and become reluctant to share it with other potential stakeholders [245]. From the user perspective, the Data Economy is increasingly associated with personal privacy and security concerns. Data-driven companies, including providers of recommendation-based services, accumulate more and more textual, visual, audio data value generated by users. To address privacy and security concerns, policymakers must define and continuously support relevant data collection rules, storage, processing, and distribution. These measures will ensure the sustainable long-term growth of the Data Economy.

Facts:

- In the post-pandemic scenario, the European Commission (EC) predicts the value of the Data Economy of EU27 at 516bn EUR by 2025, with an increase of almost 59% compared to 325bn EUR in 2019 [243].
- The volume of newly created data per year will increase from 44 ZB in 2020 to 180 ZB by 2025 [242], [246].
- Over the next five years, revenues generated by European data companies are projected to increase by 6.8% annually. This growth is faster than the overall growth of the IT market by 5.2% per year, as data-driven products and services are becoming more widespread [243].

Key Drivers:

- Efficiency gains in Big Data processing and real-time decision-making [247], [248].
- The rapid adoption of AI applications will amount to a 13tn USD global market by 2030, approx. +16%. It will further increase the demand for globally sourced high-quality data [249].
- Until 2027, the EU will invest 2bn EUR to develop energy-efficient and reliable data-sharing infrastructure and related services as part of the Digital Europe Programme and the Connecting Europe Facility 2 [250].
- Modern consumers are participating in value creation processes by sourcing, assessing, and sharing personal data [251].

Challenges:

- The data professionals skill gap will increase by 11.3% CAGR to leave approx. 759,000 unfilled positions in 2025 in the EU27 [243]. This hinders the development of the Data Economy and data-driven innovation.
- The growing demand for data privacy and security challenges companies to create trust without hindering the growth opportunities provided by the Data Economy [252].
- Governments must reduce uncertainty regarding data ownership and establish principles for data privacy and security [253].
- The increase in open data, connectivity, and data processing standards is likely to diminish marginal economic returns for data aggregators and platform owners [254].

Impact on the Future of Smart Living:

The Data Economy may provide the home appliances industry with growth opportunities. Available historical data used for predictive analytics may reduce maintenance and utility costs in manufacturing [243]. Decreasing costs of collecting, consolidating, and processing data facilitate the development of personalized products and services, lowering entry barriers for small and medium-sized companies with alternative solutions [244], [255]. From an economic perspective, these factors will lead to more efficient resource allocation. In the EU, companies with access to scarce data change the competitive landscape and gain market power [256].

NEW LIVING CONCEPTS

Micro-Living And Co-Living As Emerging Markets And Investment Opportunities

New living concepts, such as Co-Living and Micro-Living, are emerging and gaining in attractiveness among different demographic groups, like students and the elderly. Co-Living refers to three or more unrelated people living together, combining personal and shared space. Micro-Living denominates self-contained urban homes with a size typically smaller than 40 square meters [257]. This trend is expected to continue and intensify during the next few years. Due to rapid urbanization and the absence of living space, young people look for more affordable and sustainable habitation options. Furthermore, loneliness and the need for assistance make older people seek Co-Living solutions. Pre-pandemic, investors have already shown interest in these living concepts. Now, the European real estate market downturn caused by COVID-19 opens new long-term opportunities to enter this industry [258]. This will reshape how people interact with their home devices and appliances and will significantly impact the future of Smart Living. In the case of Micro-Living, home appliances may need to adjust their sizes and shapes to fit smaller spaces. On the other hand, features like durability and capacity will gain importance in Co-Living environments.

Facts:

- Investor demand on Micro-Living in Europe rose by 40% annually between 2010 and 2020. This led to an all-time high of 14bn EUR [259].
- The number of single-person households in Europe increased by 18.1% between 2010 and 2019 [260].
- Growing housing costs in cities contributed to global funding of Co-Living models by approximately 210% per year from 2015 to 2019 [261].
- In 2019, 3 out of 10 adults in the EU27 lived in rented dwellings. They are often used for Co-Living, in comparison to owner-occupied homes [260], [262].
- Real estate investment volumes in Europe in 2020 are expected to have been 15-20% lower than the previous year [263].

Key Drivers:

- Micro-Living and Co-Living become a potential solution to less affordable and available housing, especially for the first-time-buyers [264], [265].
- By 2050, the population living in urban areas is projected to increase from 55% to 68%. The Co-Living concept offers affordable and sustainable housing options to tackle problems caused by urbanization, such as demand for accommodation exceeding supply [266], [267].
- New Co-Living options, commonly referred to as Co-Living 2.0, are emerging on the housing market. Co-Living 2.0 targets older demographic groups with preferences over larger shared living spaces and smaller personal areas. This concept is suitable for those who seek community living and thus expands the pool of customers [258].

Challenges:

- Micro-Living raises concerns regarding the lack of privacy, especially for families and communities living together in small apartments and houses [268].
- Co-Living spaces do not correspond to the requirements of the existing zoning regulations and tax categories. Co-Living implies a mix of residential and commercial areas. These hybrid spaces have to be treated and regulated differently [269].
- Less living space may pose health risks, such as psychological problems. The accommodation has to fill various needs such as self-expression and relaxation that are hard to meet in a highly cramped space [270].

Impact on the Future of Smart Living:

Residential real estate is experiencing changes both in terms of living concepts and investments. Currently, Co-Living plays a more significant role as dwellers are moving away from traditional homeownership. The increased demand for communal living spaces increases investments into a Co-Living asset class and more construction of micro and shared living spaces. The transformation of living concepts changes home appliances, which may need to shrink to fit smaller places or be shared within a household. Urban areas will be more densely populated. Depending on the type of space - public or private - customers will prefer different items in terms of capacity and durability.





Economic Trends

INCREASING MARKET MATURITY

Smart Living Markets Will See Short-Term Fragmentation But Long-Term Consolidation

As industries mature, they traverse four distinct phases (Opening, Scale, Focus, and Balance & Alliance), known as the Industry Consolidation Life Cycle [271]. The Smart Living market is still in its infancy and is transitioning from the opening stage to the scaling stage. Major players are slowly emerging and continue to acquire competitors. Recent acquisitions of Smart Living companies by large corporations, such as Alibaba or Google, support this [272]. Yet, a more fragmented Smart Living market will emerge short-term due to the growing adoption and simplified market entry. Especially the increasing number of IoT devices and government subsidies will attract novel players to the Smart Living industry [273]. However, this will be challenged by data and privacy concerns on the consumer side and interconnectivity issues on the manufacturing side. The fragmentation will lead to a complex manufacturer landscape with interoperability and convenience as their unique selling points [264]. In the long run, the Smart Living market will develop along the Consolidation Curve and is expected to enter the final stages (Focus, Balance & Alliance) within the next decade. During these last phases, cooperations focus on growing their core business and forming alliances with their competitors.

Facts:

- The European smart home market reached a volume of 20.1bn USD in 2020, with smart appliances being the largest segment with 6.7bn USD [273].
- The traditional appliance market continues to be more fragmented compared to previous years [274]. The Smart Living market appears to be more volatile, with fragmentation starting now [275].
- Recent IoT investments and acquisitions by big tech companies such as Amazon's takeover of Ring for over 1bn

USD continue to drive consolidation [276].

- The ongoing COVID-19 pandemic will affect market growth only in the short term [277].

Key Drivers:

- The number of IoT devices is expected to grow from 22bn in 2018 to 50bn in 2030, increasing adoption and acceptance among users [278].
- Increasing support from regulatory bodies through subsidies on a national and international level simplifies market access for novel stakeholders [279], [280].
- Open standards and platform solutions will ease market entry for new entities and increase adoption [281], [282]. Initiatives like "Connected Home over IP" attempt to unify incumbent market players such as Amazon, Apple, Google, and the Zigbee Alliance using an open-source Smart Home platform [283].

Challenges:

- Interconnection and interoperability across different vendors are becoming a tough challenge for consumers, slowing down the global adoption of Smart Living technology [284].
- Especially in Germany, many users still have strong sentiments regarding data security and privacy, influencing market penetration [285]. Successful vendors will have to tackle these issues in a meaningful way to win over consumers.

Impact on the Future of Smart Living:

The ongoing market fragmentation will present consumers with a broad range of possible Smart Living solutions. To stay attractive, manufacturers will need to offer a maximum amount of interoperability and interconnectivity. The abundance of choice will be accompanied by a reduction of costs, driving market penetration. Companies will face additional competitors and lower margins. Furthermore, the adoption will be an impetus for incumbents to double down on Smart Home devices, further increasing fragmentation. However, as the industry matures, the market will consolidate, leaving only a few key players. In line with the average consolidation curve lifetime of 25 years, this is expected to occur within the next five to ten years.

BUSINESS MODEL TRENDS

INFLUENCING THE FUTURE OF SMART LIVING

Increased Sharing

The Rise Of Prosumers

Data-Driven Personalization

The Surge Of Hyper-Convenience

Building Ecosystems

BUSINESS MODEL TRENDS

Influencing The Future Of Smart Living

According to the St. Gallen Business Model Navigator, a fundamental business model (BM) consists of four dimensions: Who is the client? What does the business deliver to its clients? How is the offering created? Why is it financially viable? If companies iterate upon at least two answers to the four questions, they innovate upon their current BM [286]. Why should organizations think about transformation? BM innovation is a more significant source of value creation than only product or process innovation. It hence results in a lasting competitive advantage [287], [288], [289]. In other words, “how companies do business will often be as or more important than what they do” [290]. The following five trends highlight promising BM patterns that will significantly shape the future of smart living and its industry landscape [291].

First, consumers care more about sustainable consumption in their daily lives to protect the environment. Circular consumption patterns are also encouraged by the Sustainable Development Goals (SDG) to reduce waste. Moreover, economic benefits motivate people to participate in the sharing economy. In addition, different ways of sharing or renting household objects from corporations or other households

are emerging.

Additionally, users show interest in participating in the creation of the product. There is an ongoing rise of “Prosumer” BMs driven by a variety of factors. On the one hand, there are significant advancements in digital manufacturing and home fabrication. On the other hand, there is a societal and political perspective shift towards more sustainable consumption and production patterns in line with the UN SDGs. The term “Prosumers” refers to consumers who integrate into the value chain by contributing to the production of products and services. One result is a potentially highly personalized product or service with great value for its consumers.

Furthermore, customers also increasingly feel like they have less time than generations before them and value solutions that save them time. Combined with the consumers’ expectations of immediate answers to their problems, they expect businesses to provide more flexible and convenient services. This flexibility can be implemented well using the Subscription or the Pay-per-use model. They provide flexibility for the customer by lowering the upfront costs.

Moreover, consumers find themselves surrounded by an increasing amount of information. Their attention is becoming more relevant as a commodity. Users are also looking for help in dealing with the information overload of the current digital age. They are therefore more interested in personalized services that relieve the stress of deciding. Additionally, data-based technology is on the rise. For these reasons, businesses are increasingly leveraging customer data to make personalized offers to the customer.

Lastly, consumers increasingly prefer a thoroughly connected smart home to single high-quality appliances. Single, non-integrated smart software or hardware products as main business offerings are increasingly easy to reproduce and thus very replaceable. Instead, companies now provide more holistic solutions by participating in consumer data-driven ecosystems to differentiate their USP.



INCREASED SHARING

Offering Access To Products And Services - Rather Than Ownership

The sharing economy is booming from \$15 billion in 2014 to \$335 billion in 2025 [292]. Millennials drive most of its growth since they value accessibility to experience more than ownership [293], [294]. The following BM patterns respond to the shift in business-to-consumer (B2C) markets, including the Smart Living space: First, “Fractional Ownership” enables sharing assets amongst a group of (co-)owners on an occasional basis. Most assets are capital intensive and used on an occasional basis, for example, laundry machines [291]. Second, for longer utilization periods, the customer rents the product referred to as “Rent Instead of Buy” [291]. Thirdly, “Peer-to-Peer” offers an online meeting point for individuals who rent personal belongings [291]. These platforms also connect people and can stimulate social cohesion in neighborhoods [295]. The shift from ownership to shared resources is linked to more service-oriented BMs. Overall, successful forerunners are, e.g., Airbnb and Uber. Collaborative usage patterns also emerge in retail and consumer goods sectors: firms offer services to share household tools, kitchen appliances, sports equipment, food, clothes, and gardens [292].

Facts:

- Shared resources foster access to underutilized assets, potentially reduce net consumption, and lower the environmental impact [292], [296], [297]. That also relates to the car- and ride-sharing uptake.
- Users neither have to invest in expensive goods nor pay for repair and maintenance. Benefits are reduced personal burden and cost [292], [297]. Consumers increasingly value holistic experiences.
- Asset sharing through two-sided online marketplaces correlates with a higher chance of success at BM transformation [287]. More and more firms achieve success through shared resources, like Appear Here or Zopa.

Key Drivers:

- A key concern among Millennials and Generation Z is climate change and protecting the environment [298]. Thus, consumers share assets to act more sustainably [299], [292].
- The SDGs and the EU support circular consumption patterns by implementing sharing BMs [300], [301]. A second driver is hence more regulations. These can take shape as economic benefits, saving time and money in the short term and motivating people to participate in the sharing economy. Additionally, members can earn an extra income within peer-to-peer communities with unused belongings [292], [302]

Challenges:

- Shared resources are not sustainable by default, considering the indirect and long-term social, environmental, and economic impact. Businesses need to design and implement BMs with an improved sustainability performance [296], [303].
- Sharing platforms often face a critical mass constraint that significantly influences the profitability of the company. Businesses need to understand how to strengthen their network effects to scale the number of active customers [299], [304].
- Further, a high-quality perceived overall experience is crucial to retain price-sensitive switching customers [294]. Hence, a seamless customer journey can be a sustainable competitive advantage.

Impact on the Future of Smart Living:

“Fractional Ownership”, “Rent instead of Buy” and “Peer to Peer” BM patterns disrupt the way everyone lives at home. Younger generations flexibly rent daily used technologies at Grover [305]. Market places, like Vinted, make used clothes the first choice [306]. Platforms like Taskrabbit match freelancers with customers that look for help with daily tasks, including cleaning, moving, and handyman work [307]. Consumers will perceive joint consumption as crucial to pursue environmental sustainability. Future users further prefer paying a service fee over ownership. Sharing is caring with a great potential to create a more sustainable future.

THE RISE OF PROSUMERS

Increasing Integration Of Consumers As Producers Into The Value Chain

“Prosumer” BMs blend consumers into value chains as (partial) producers [291]. The idea is not new: in 1980, Alvin Toffler explicitly introduced this concept in his view on the post-industrial era, which is characterized by overcoming the substantial division of production and consumption [308]. In a related comment, Philip Kotler already emphasized new technologies' relevance in enabling customers' value chain participation [309]. Today, prominent examples profoundly rely on this concept while already being deeply integrated into daily life, e.g., social media platforms or open-source software development communities [310], [311]. Yet, recent technological progress, its applications, and sustainability thoughts further promote and accelerate the rise of “Prosumer” BMs with considerable impact on the Smart Living space. They arise in various verticals related to Smart Living with individual properties and include, e.g., intelligent urban or home farming, smart energy grids, and 3D printing at home [312], [313], [314], [315]. This trend enables higher personalization levels and incorporates rising societal efforts to act sustainably, in line with the motto: think globally, act locally [316], [317].

Facts:

- About 90% of active internet users globally and more than 4.2bn people in total are active social media users stressing their deep integration into digital value chains [318].
- Since October 2020, there are more than 2m solar electricity prosumers in Germany. In 2020 alone, more than 180,000 solar power units were installed, showing the significant traction that the energy vertical generates [319], [320].
- The global 3D printing products and services market is projected to grow at around 26% CAGR between 2020 and 2024. Thus, it is expected to reach 40bn USD by then [321].

Key Drivers:

- Significant advancements in digital production and home fabrication enable customer integration into future value chains. This is, i.a., driven by software and hardware breakthroughs related to 3D printing [309], [322].
- Rising demand for personalization facilitates prosumerism while already being daily practice at scale in multiple verticals [323], [324].
- Growing global awareness on a political and societal level is highlighted by the UN's twelfth SDG (“Ensure sustainable consumption and production patterns” [325]). It supports stated technologies embedded into “Prosumer” BMs to streamline supply chains and use resources sustainably.

Challenges:

- A challenge for “Prosumer” BMs could be their dependence on reaching critical scale to function correctly. Reasons may vary: technology investments challenge hardware verticals, while beneficial network effects challenge digital platforms [326], [327].
- Regulatory barriers challenge decentralized “Prosumer” verticals while being exceptionally high for the energy sector as an example. They arise due to the complex, regulated energy production and distribution market [328], [329].
- Additive manufacturing adoption and inherent growth potential realization have been averted by intense competition instead of ecosystem creation with shared standards among industry players [330].

Impact on the Future of Smart Living:

“Prosumer” BMs already shape the way people live and interact today [310], [316]. The stated technologies will continue to foster prosumerism as advanced manufacturing and information technologies promote ways for firms to integrate consumers into value chains at scale. Multiple Smart Living verticals are affected. Examples include individual energy production via solar panels and infrastructure connection (e.g., Enpal), home entertainment and digital social interaction via digital content creation (e.g., Clubhouse), or individual commerce via 3D printing (e.g., HP) [331], [332], [333]. Thus, the accelerated rise of “Prosumer” BMs will continue.





DATA-DRIVEN PERSONALIZATION

From Standardized To Highly Individual Products And Services

Individuals are increasingly looking for support to handle the information overflow they face as consumers [334], [335]. As the number of digital services continuously rises, customers increasingly turn to brands that create the feeling that they listen to them, understand them, and pay attention to their specific needs. As the 2018 Accenture Digital Consumer Survey states, consumers are more likely to shop with brands that treat them personally [336]. Meeting these expectations is a crucial responsibility for marketers. Where humans were previously needed, now businesses can integrate “Leverage Customer Data” as a BM and create new value [291]. Data-driven personalization is the ability to make customer experiences as relevant as possible, regardless of the channel [337]. Adopting this personalization has a significant impact on the Smart Living space. Customers are growingly looking for new brands and products that help reduce stress and especially engage and listen to them at home. At the same time, firms are increasingly looking for data to be extracted from smart home devices [338].

Facts:

- Personalization at scale has the potential to create \$1.7tn to \$3tn in new value globally. Corporations can capture this value via more valued products and services, revenue growth, cost savings, or consumer surplus [339].
- Personalization has significant positive effects. After a consumer has a personalized shopping experience, 44% are likely to become a repeat buyer, and 39% are likely to retell [340].
- Customers are willing to spend more money when brands deliver targeted recommendations [339]. Personalization is even expected; on average, 71% of consumers express some level of frustration when their experience is impersonal [340].

Key Drivers:

- Increasingly available customer data and the advent of data-based technology enable developing experiences or products specifically tailored to each customer [256], [337].
- Attention has become a precious commodity in the digital age as consumers are swarmed with information [341]. As customers pay more attention to information tailored to them, it is increasingly important to identify meaningful ways to help customers [342], [343].
- Consumers want engagement. 91% of consumers are more likely to shop with brands who recognize, remember, and provide them with relevant offers and recommendations [336].

Challenges:

- Data gathering faces augmenting privacy barriers. Customers are increasingly concerned about their privacy and are willing to leave due to privacy concerns [344]. Governments around the world are also trending to enforce data protection laws [345].
- Companies face a high array of organizational barriers to extract value from data, like incorporating data-driven insights into day-to-day business processes or attracting and retaining the right talent [256].
- The quality of data is a considerable obstacle to providing a sustainable personalized experience. Consumer data is often spread out in different silos of customer engagement, one of the leading causes of customer disengagement [346].

Impact on the Future of Smart Living:

An intelligent home collects data about habits that offer firms a window into everyone's domestic space [347]. Big tech companies, like Google and Amazon, are already big players, and more firms can be expected to enter this space looking to profit from collected data. Consumers will further appreciate devices that eliminate energy-draining tasks from their daily basis and help them deal with the high degree of information available, making the consumer feel listened to and involved. A rise in personalized and engaging services or products can save the user time, energy, and money by automating many decisions and tasks.

THE SURGE OF HYPER-CONVENIENCE

Instead Of Long-Term Commitment, Customers Look For On-Demand Services

Over a third of surveyed people in the United States (US) feel like they have less time than five years ago [348]. Consumers are increasingly prepared to pay a premium for convenience that saves them time when it comes to daily activities such as shopping for groceries [348]. One way to provide comfort for the customer is the “Subscription” BM. In this model, the consumer pays a fee on a monthly or annual basis to gain access to a product or a service [291]. Some examples of subscriptions related to the home are food box deliveries, subscriptions to self-care products, and security systems. This model also benefits companies, as it provides them a steadier income stream [291]. On-demand services, such as grocery and food delivery, can also be provided to customers using the Pay-per-use model. In this model, the actual use of a service or product is metered. The customer pays only what he or she effectively consumes [291]. This results in increased flexibility and more fair pricing for the user [291].

Facts:

- 83% of retail shoppers in the US in early 2020 said that convenience when shopping is more important today than five years ago [348].
- The market for smart home subscriptions is projected to grow to 10.78bn USD in 2022 worldwide with a CAGR of 25% between 2019 and 2022 [349].
- Consumers have adopted subscriptions and are open to new ones. In the US, 69% of people have multiple subscriptions, and 28% have at least four. It is followed by Canada (50%), Germany (49%), and the UK (47%) [350]. Additionally, 27% of people say that they would increase their number of subscriptions [350].

Key Drivers:

- People expect their products and services to be delivered faster than ever. A UK survey discovered that 61% of people are unwilling to wait for more than 45 minutes for food deliveries to arrive [351].
- Companies are moving toward subscription BMs because they provide a more steady and predictable revenue stream [291].
- People have less perceived free time, which causes them to look for new ways to save time. Over a third of US consumers feel like they have less free time today than five years ago. [348].

Challenges:

- High churn rates and low customer loyalty plague the subscription model. A survey of thousands of US shoppers in 2018 showed that one-third of consumers who sign up for a subscription service cancel in less than three months, and over half cancel within six months [352]. This means that companies need to differentiate themselves and maintain a sustained stream of new users.
- Subscription fatigue is a new problem caused by this trend. Managing an increasing number of subscriptions is a pain for users. 47% of interviewed customers of online streaming platforms say that managing subscriptions is frustrating [353].

Impact on the Future of Smart Living:

As our daily life accelerates with the development of technologies, people are increasingly starting to value the convenience and flexibility that on-demand services bring to them. Consumers expect services and products delivered almost instantaneously. A recent example of this is the success of Gorillas. This on-demand grocery delivery service promises delivery in ten minutes in German cities. Additionally, subscriptions will become more accepted by people. They will increasingly replace regular grocery runs with predictable monthly packages. The combination of devices with subscriptions, e.g., an oven with a food subscription, will also be on the rise.





BUILDING ECOSYSTEMS

Companies Transition To Being Solution Providers As Part Of A Data-Driven Ecosystem

Companies shift from selling multiple, separate products and services to becoming holistic solution providers [291]. At the same time, they form ecosystems. These consist of different inter-operable smart devices which the customer controls from a single-entry point, e.g., a smart speaker [354]. There is a synergetic relationship between companies broadening their value proposition (platform participants) and companies cooperating with others to provide an overarching solution (platform hosts). As the number of smart devices increases [355], companies start to focus on solving a broader problem instead of building a device for a single function, e.g., solve “cooking” instead of just providing a single oven [356]. For companies to provide an overarching solution, they have to make multiple partnerships. Different types of companies take different approaches in building their solutions. Leading internet consumer companies and larger traditional hardware manufacturers aim at locking consumers in their ecosystems. Examples for this are Amazon Alexa [354] and BSH Home Connect [356]. Platform participants mainly aim at increasing their initial reach (CommScope - B2B2C [357], [358], [359], Sonos - B2C [360]). Both pursue an “Open Business Model” [291] and focus on using collected consumer data as part of their USP.

Facts:

- In 2018, 12bn USD were invested in smart-home solutions [361], and until 2025, the number of IoT smart devices will more than double [355]. The smart-home market is set to grow by 317% in 2020-26 to 317bn USD [362].
- A few main ecosystems keep on growing (e.g., Amazon Alexa supports 28k different devices across 4,500 brands [363]), but presumably, no market leader will establish itself as the main platform provider in the medium-term [361].
- All-in-one solution offerings as part of the “Solution Provider” [361] BM are increasingly popular among Smart Device Manufacturers [364].

Key Drivers:

- Increasing competition and exponential technological progress force companies to adapt continuously and innovate on their USP [355]. A mere single, smart product is increasingly replaceable - customer data and a data-driven network of services are unique [365].
- A new value perception of data, together with rapidly advancing data processing and analytics capabilities, such as Machine Learning, drive the potential business value of consumer data [366].
- Consumers value the range and interoperability, which results in ease-of-use, of a smart home system over the quality of the single components [361].

Challenges:

- Collaboration between companies is not standardized in terms of communication protocols and public data exchanges, i.e., data marketplaces. No standardized policies for ethical guidelines and best practices in data sharing or data analytics, e.g., AI, are enforced or widely adopted.
- Competition between platform hosts and platform participants could lead to a winner-takes-it-all scenario where a few leading companies provide the consumer touchpoints, such as smart assistants, to control the platform. This monopoly would lead them to own most user behavioral data and thus facilitate market domination. A recent example for this is Facebook [367].

Impact on the Future of Smart Living:

A growing competition amongst smart device manufacturers and new value perception of data drive the creation of solution ecosystems. Companies need to be agile and adapt to the vast array of ecosystems. These will further grow and most likely co-exist, with no single market leader claiming the entire domain for itself [361]. Platform providers such as Amazon with Amazon Alexa [354] or BSH with Home Connect [356] facilitate and incentivize the usage of their central point of control by other companies both financially, such as the Alexa Fund and through technical support, such as SDKs for Alexa [368].

SCENARIOS

The following chapter describes four scenarios of different futures. The chosen scenarios are relevant and of consequence for the user's decision. They are challenging, internally consistent, and recognizable from the signals of the present and the near future. All four scenarios described below are equally plausible. They describe extreme visions of how the future of smart living might shape our lives in the year 2041 with regards to two key drivers. Stories of personas experiencing a day in 2041 are used to envision the scenarios. Signposts, often described as signals, that indicate a development towards each scenario are identified to describe a possible path from the present to each of the four extreme futures.

SCENARIO OVERVIEW

DRIVER & SCENARIO MATRIX 51

SCENARIO 1
ON-DEMAND CONVENIENCE 55

SCENARIO 3
SMART HOME ISLANDS 61

SCENARIO 2
GARDEN OF EDEN 58

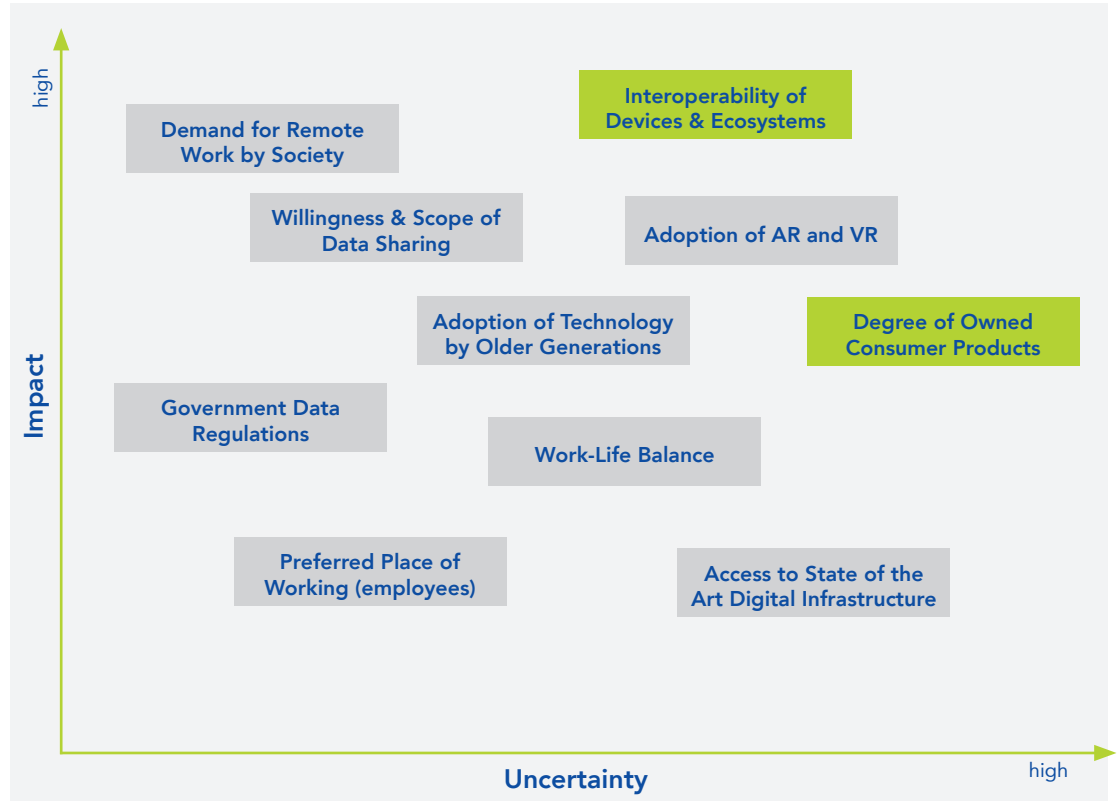
SCENARIO 4
MY HOME-OS 64

DRIVER MATRIX

Building upon the findings of the Basic Phase, key drivers and their resulting challenges for the future of Smart Living were identified. From over 100 identified drivers, we focussed on the 10 drivers that have a high exogenous impact on individual stakeholders of the future of Smart Living. As the outcomes of the drivers are highly uncertain, they are modelled with plausible bipolar extreme outcomes.

The adjoining matrix displays the ranking of the identified drivers according to their individual impact and uncertainty of outcome. Based on the ranking, we decided on the two drivers "Degree of Owned Consumer Products" and "Interoperability of Devices & Ecosystems", marked green in the matrix, to build the base for our future scenarios.

In the following, the two identified key drivers will be described in detail. Also, the derived scenarios will be elaborated on and ranked in the scenario matrix.



KEY DRIVERS

Low Degree of Ownership

In this extreme outcome, people will rent, subscribe, or share most of their products at home instead of fully owning them. The subscription business models imply that customers pay a fixed fee either monthly or annually instead of paying the entire purchasing price upfront. This allows the consumer to flexibly use products privately with the feeling to still “own” them. Another alternative is sharing products with other people on a Pay-per-use basis. This is especially applicable for household products that are not used that often and thus do not need to be continuously paid for or owned. Overall, this scenario facilitates the transition towards a circular economy much more, as ownership of the products is retained by the providers, who ensure that products are kept in a closed loop by following regulations.

Isolated Ecosystems

In this extreme outcome, companies will either be restricted by law or refuse to share common standards that could assist third parties to collaborate with them in building smart living technologies. In such a case, companies would work independently to expand their product portfolio in order to provide comprehensive solutions for consumers. On the other hand, smaller companies would find it harder to compete with their counterparts by failing to offer comprehensive solutions due to insufficient resources. This would enable a lock-in effect where consumers would not be able to own products from different ecosystems if they prefer personalized solutions from connected devices. Additionally, large corporations would have the opportunity to dominate the market by erecting entry barriers.

Degree of Owned Consumer Product

Will people in 2041 continue to own most of the products they use in their daily lives, or will they prefer to rent or share them flexibly? The share of privately held consumer products by individuals depends on many factors such as the cultural values of a society and existing business models on the market. While the “high ownership” scenario represents the status quo to a large extent, the “low ownership” scenario is an emerging and thus a more complex one. Low ownership not only implies sharing products but can also entail using products via a subscription model, depending on the type of product, the use-case, or the frequency of usage. Finally, both scenarios have very different implications for the sustainable production and consumption of consumer products.

High Degree of Ownership

In this extreme outcome, people will own all of their products used at home. Customers purchase products at a “full price” and acquire full ownership rights. This outcome is especially relevant for durable goods as subscribing to such products results in a higher overall price in the long run. However, owning tangible products means that owners are also responsible for the disposal of a product they no longer need. In contrast, today, possessing a product challenges the circular economy, as it does not guarantee that individuals dispose used products properly.

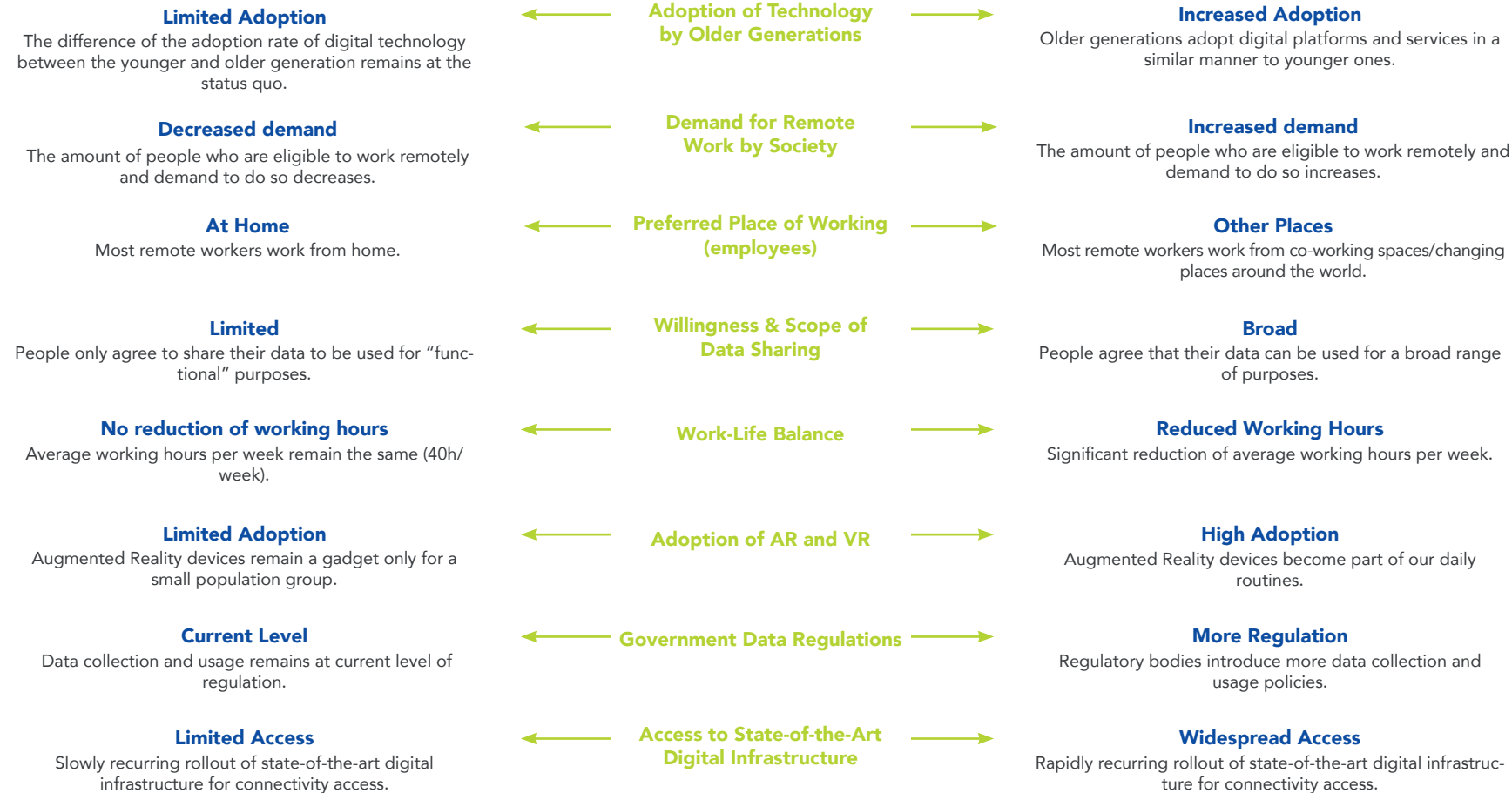
Interoperability of Devices and Ecosystems

Interoperability between ecosystems refers to the connectivity of devices from different brands that interact with each other using shared resources and interfaces. Regardless of the regulations concerning data exchange between organizations, a company’s choice to share its data, and access to its platform is the basic requirement to connect ecosystems from different providers. This could have a big impact on the Smart Living Industry as the core functionality of Smart Living is for various devices to be connected and provide personalized assistance. Since connectivity plays such a significant role, the extent of interoperability would affect the research and development of smart living technologies. More extensive interoperability will widen the scope for development, whereas limited interoperability could dampen the speed of development.

Interoperable Ecosystems

In this extreme outcome, companies will be able to build products that seamlessly interact with each other based on shared standards. New companies will improve on existing technologies and make devices that complement the services provided by other companies. This way, technologies become more nuanced, and large companies do not need to create their product in every domain. By having a common platform to work on, smaller companies can tackle niche problems in the industry and accelerate the overall growth of these technologies. With no limit to interoperability, the scenario suggests a collaborative effort between various organizations to improve the Smart Living Industry.

OTHER IMPORTANT DRIVERS



SCENARIO MATRIX

The scenario matrix consists of the two key drivers and their corresponding bipolar outcomes. Each key driver represents one of the axes of the matrix. Each of the four built scenarios results from the intersection of two of the drivers' extreme outcomes (one per matrix quadrant). All scenarios are plausible and internally consistent.

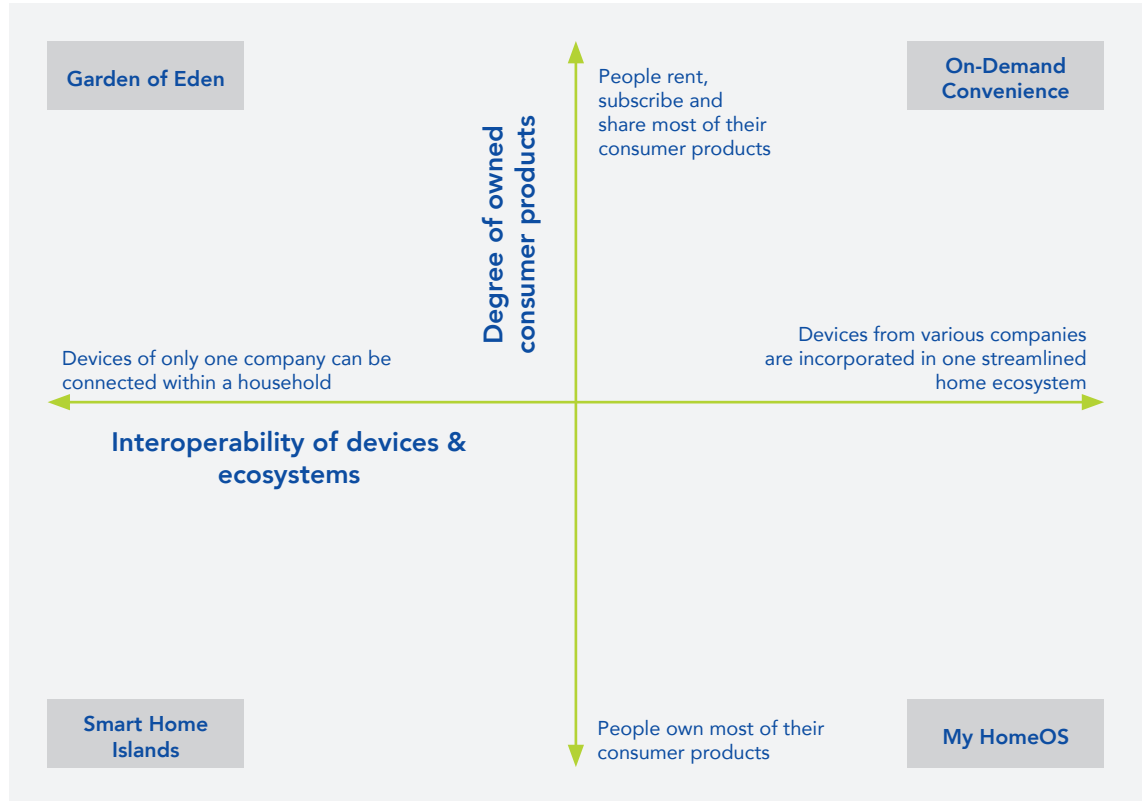
"Garden of Eden":

Most consumer products are not owned anymore, they are rather exchanged through sharing platforms or subscribed to as a Product-as-a-service. Device manufacturers put high emphasis upon perfect integration within their own ecosystem, but do not facilitate any interoperability with third party devices.

"On-Demand Convenience": Widespread adoption of technology standards enable interoperability of devices from competitors. To increase utilization, current legislation has enabled sharing and subscription as the predominant form of device usage.

"My HomeOS": Sharing models have not become a widespread success: people value individuality and ownership of their consumer products. As a result of open standards, these devices from various manufacturers are able to communicate with each other in one streamlined ecosystem.

"Smart Home Islands": The widespread adoption of privately owned IoT devices with a lack of a common standards leads to a fragmented IoT environment at home while device manufacturers focus on the interoperability within their own ecosystem instead of facilitating the integration of other firms.



ON-DEMAND CONVENIENCE

Interconnected devices and sharing of goods substantially improve living standards

It is 06:30 AM on a Friday. Claire sleeps peacefully in her perfectly adjusted new bed. She recently rented it for the week, but it already fits her body shape and has the perfect temperature for her. In 30 minutes, she will finish her deep sleep cycle. TARS, her smart personal assistant, already starts adjusting the bathroom temperature, heating the coffee machine, and giving instructions to the cooking kit to prepare breakfast. Today, Claire needs an additional cup of strong coffee due to her tight schedule.

At 07:00 AM, Claire slowly opens her eyes to her favorite Beethoven sonata's gentle sound and the subtle, increasing brightness. She thinks to herself: "I feel so refreshed, and TARS always manages to align with my mood." Ever since using her assistant bracelet, her sleep quality has dramatically improved. Thanks to continuous sleep tracking, she always wakes up at the perfect stage of her sleep cycle. Energized and excited for the new day, Claire walks to the bathroom. The water temperature was already perfectly adjusted to a comfortable 31°C for her morning shower.

After finishing her morning routine, Claire stops in front of her wardrobe, which she shares with the inhabitants of C2F4, the community her family recently joined. Excited, she does not hesitate to open it to see which look TARS chose for her today - her wardrobe changes every week. "I have chosen a business casual outfit consisting of Jennie's fashionable shirt and Emma's black jeans and blazer. I know you have an important meeting with your boss at 11:00 AM," TARS explains to her. All dressed up, Claire enters the kitchen where she smells the freshly brewed Arabica coffee, already served together with her breakfast at the table. "Uhh, porridge with nuts and a green smoothie. I would have loved to have some pancakes," she says to herself. "You have been overeating sugar in the last few days, Claire. Your body starts lacking proteins, and your bracelet measures an increase in your blood pressure," TARS justifies the breakfast choice



with a deep, caring voice. Enjoying the fantastic taste of her coffee, Claire thinks to herself: "I wish I could have this kind of coffee every day, and not only once a month." Unfortunately, her access to the coffee machine is limited since she shares it across her company. She can only rent it once a month, and today it has to be transferred to a colleague who has an important partner visiting.

Afterwards, Claire reaches for her AR glasses to get her personalized morning briefing and an update to her daily schedule displayed on it. Suddenly, breaking news announces that the government has introduced stricter regulations to make all IoT ecosystems compatible and controllable with a

single point of control for the end consumer. Claire realizes again how thankful she is to use all her favorite devices by giving orders only to her smart bracelet now. "Hmm, Sarah already has the newest model of these glasses and loves them. It is probably time to upgrade my subscription model and try them out as well!" "TARS, could you please subscribe me to the new AR glasses?"

New message: "Package arriving in three minutes. Please keep your window open." "Hmm, I did not expect anything today. What could that be?", Claire thinks to herself. Just some minutes later, a drone flies in delivering a big box on the kitchen table. "Ah, just the missing groceries for our

On-Demand Convenience

dinner. I am so happy with our new fridge. It never forgets to keep all of the needed ingredients in stock, and it seems like it knows my taste better than I do!

Ready to conquer the day, Claire moves to her workroom. A short notification reminds her of the upcoming wedding of her sister. "Oh, I still have not chosen a dress," she remembers. Her dress will be rented and delivered just a day before the wedding. But she does not have to worry about the dress size because TARS keeps track of her body size. Finally, she sits down at her work desk and starts her first meeting of the day.

After having a short lunch break, Claire completely loses herself in the afternoon tasks and forgets about the time. After some time, she hears a gentle sound reminding her of the next event in her schedule. It is already 04:00 PM, and she needs to pick up her children from school. Despite a shift to remote work for Claire, children are still educated offline. Leading psychologists are certain that social interaction is an integral part of a child's development. Today is her father's birthday, so Claire tells TARS to send a car to pick up the children and drive them to their grandparents' house. The autonomous driving service acknowledges the request, and the nearest car is sent to their location. Claire leaves the house five minutes later. Even though the family has a premium subscription for shared cars, allowing 24h priority access to the nearest cars available, she chooses to walk. It is only 15 minutes, and she has not enjoyed a walk outside for a long time. Maybe it is also her father's birthday that makes her nostalgic. Still, she seems to enjoy the inconvenience of walking in the pressing heat and arrives slightly sweaty at her parents' house.

The kids are just arriving. The car is pulling into the driveway, and the gate automatically opens, already expecting them. Shortly after, her husband arrives. He has been working from a beach house for the week to concentrate on an important contract his marketing agency is trying to close. Luckily, the family living plan allows for 14 days of short-term stays in any of the 500,000 available homes in the C2F4 community. For the weekend, the whole family is coming together again. The home management system finishes the last tasks for the visit: building up the slip-and-slide for the children in the backyard, assembling some snacks, and letting the grandparents know that their family has now arrived. Grandpa Rick is full of joy to see his grandchildren again. While sitting together and eating

the snacks prepared for them, he starts talking about the old times without automation, where people still owned the products they used and machines were not interacting with each other. He goes on to talk about that one time when a global pandemic nearly brought human civilization to a standstill and eventually marked the starting point to the digitized world we know today. The children are well familiar with his stories but politely listen even though they cannot imagine how such a life must have been.

At 06:00 PM, the family leaves the house and orders a ride back to their home. Rob's personal assistant informs him that a car of the new sports roadster type, he has seen in his morning briefing, is nearby and would be available for a test drive. Claire sighs: "Are you really thinking about that

subscription upgrade? Next thing you are going to tell me is that you want to drive it manually as well." Rob replies defensively: "Nobody said anything about upgrading our subscription. It is simply a free test drive." On their way home in a comfortable minivan, Rob cannot stop thinking about the sports roadster. "I wonder if I could still drive a car manually", but he quickly rejects his thoughts as manual driving now requires a complicated process that is certainly not worth the effort.

When they arrive at home, dinner has already been prepared. Usually, the dinner table is a non-tech zone, but today Claire's son favorite football team is in the world cup final. Sponsored by the five big subscription firms, the tournament is held on the moon colony for the first



On-Demand Convenience

time. Claire quickly checks Luke's academic and behavioral performance of last week and concludes that he deserves this treat. Luke has already put on his AR glasses and has shifted his focus to the game.

After dinner, everybody relaxes in their own way while the home appliances clean up the kitchen and living space. Claire and Rob decide to watch a movie. Once Rob gives the command to the assistant, their moods across the day are analyzed by accessing their fitness trackers, work output, and social interactions. The streaming platform then offers them three suitable movies to choose from - they settle on a classic from 2020. Two hours later, the movie ends, and Claire looks around the room: everything has been cleaned

by the team of smart robots, orchestrated by their home management system. Claire and her family have been living in this apartment for almost five months now. "It is time to move to another home, and I heard some excellent things about the Paris communities," she thinks to herself and falls asleep.



Signposts

- Half of the consumer goods in Europe are not fully owned by the user
- New studies show strong growth of sharing communities based on common interests
- 85% of household chores are automated by smart assistants in Europe
- Climate change averted: decentralized renewable energy production makes fossil fuels obsolete
- New European legislation enforces new standards concerning IoT ecosystem compatibility
- Smart Home devices automatically trigger on average 80% of recurring household purchases
- Greenhouse gas emissions are reduced by 30% compared to 2021 due to advancements in energy management and production
- New appliance utilization rate regulation drives sharing of consumer goods
- Environmental taxes make single-use products 20% more expensive
- New European regulation authorizes automated digital payments among IoT devices

GARDEN OF EDEN

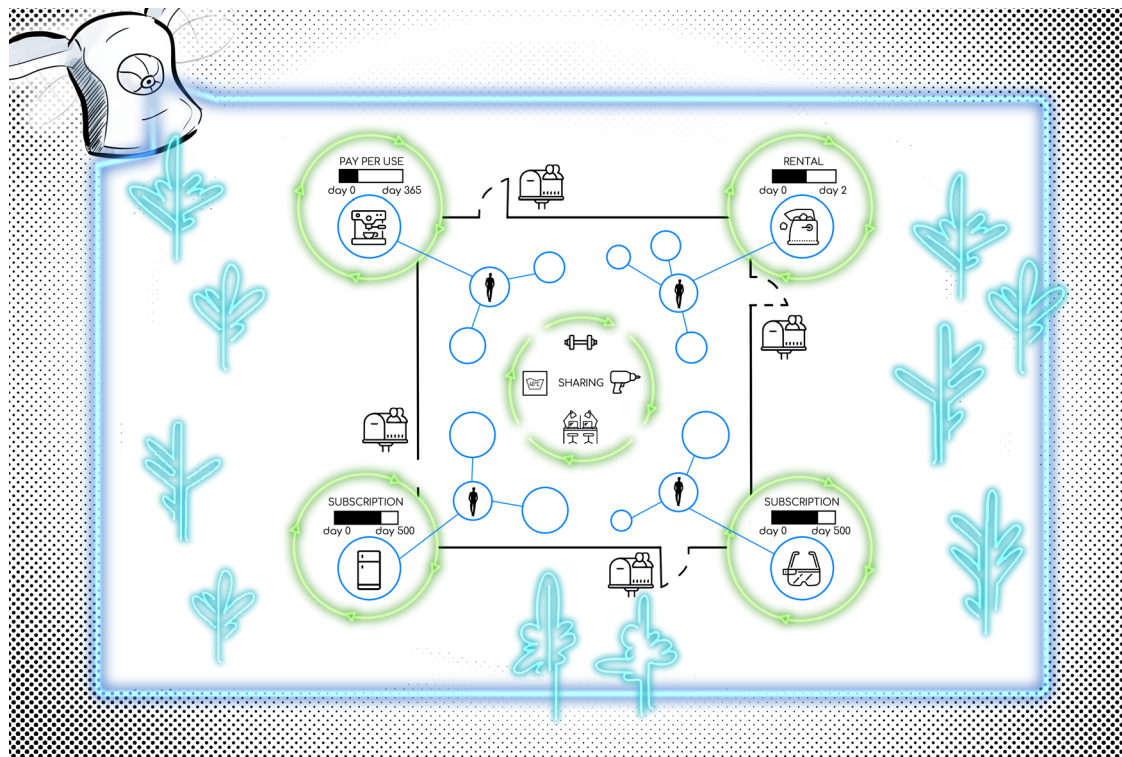
A life in an ecosystem without ownership

“Good morning, Eve. Are you ready for a wonderful day? You have now perfectly rested.” Sapa, Eve’s voice assistant, softly wakes her up while increasing the intensity of the bedroom light. After sleeping for exactly 07:54 hours, Eve is well recovered from the past day and is feeling energized.

As Eve takes a shower, Sapa prepares the morning coffee. Sapa is made by Serpent, one of the few major brands in the home industry. A few years ago, Serpent made a large number of acquisitions, so Eve got most of her devices from them, which makes them interact perfectly with each other. Her coffee machine is a special model capable of producing the drink to a personalized intensity, which is quite expensive. Eve still wanted to try it and thus opted for a Pay-per-use model. The machine itself was free, but Eve had to agree to buy beans for at least 30 coffees per month. It is an older model called Gaggia Classic, which has been recycled and updated with modern features. That is quite common due to the European Union’s (EU) circular economy policies. The beans are her favorites, sourced from a local vertical farm.

After her shower, Eve puts on her Serpent Augmented Reality (AR) glasses and makes her way to the kitchen to enjoy the drink. “Could you please fetch the new bag of coffee beans I ordered, which were just delivered?”, Sapa asks. The devices in the home are truly smart nowadays, yet some things still have to be done by humans. Eve quickly opens the window of her city apartment and empties the drone delivery box that is attached to the window board. “At least I do not have to go downstairs to get my packages as my parents used to,” she thinks.

After spending some leisure time reading, Eve wants to burn off calories doing a workout. For this purpose, she recently subscribed to a workout package, including a smart mirror. Eve prefers using the mirror instead of wearing her glasses during a workout. In this mirror, she can see both, herself and the animated instructor. Eve is not particularly athletic and did an exhausting run yesterday, so the instructor proceeds



more slowly today. To have this degree of personalization, she agreed that her fitness tracker could use the data for this purpose. This is common these days as the government strictly regulates data sharing. But Eve usually accepts everything because the services make everyday life so much more convenient. She saves a ton of time.

Exhausted, Eve looks forward to her lunch. “Sapa, show me the available dishes for today,” she instructs Sapa and views the dishes on her Serpent AR glasses. She is subscribed to a convenient lunch service by the company “Foody” that has an exclusive partnership with Serpent. Every day, Eve has five

alternative dishes to choose from. These dishes are chosen such that they use ingredients that grocery stores would otherwise throw away. Ten minutes after choosing her lunch, a drone arrives and delivers the ingredients. While she could also order pre-cooked meals, she still enjoys spicing the dishes with herbs from the community garden and working with the fresh and healthy ingredients once a day. She quickly cooks them in the Serpent oven that Sapa already preheated and finally enjoys the meal.

A notification pops up in Eve’s field of view: “Daily Standup with Team at 01:00 PM.” Eve quickly goes over to her

Garden of Eden

ultrasonic dishwasher, a cube-shaped cutout in her kitchen countertop, and puts her dishes into it. "I can't imagine how people had these huge dishwashers back in the days, having to place all of their dishes neatly into it. And what a waste of space!", she thinks to herself. Her ultrasonic dishwasher works without water and barely uses any electricity. A timer and a small icon hover over the closed dishwasher, now flush with the rest of her countertop, indicating the time left for the dishes to finish. She knows, she's still within her calorie limit for the day, and the numbers in her Serpent health profile have been great this past couple of months. Eve grabs a piece of chocolate from her "treats drawer", willfully ignoring the calories that her glasses show for it as she snacks on it.

She makes her way to her working room, a small, mostly empty room with a desk, and a chair facing the window. Her employer had provided for both, the desk and the chair, which is made of 100% recycled materials. There is barely

anything except for a couple of pictures and notes scribbled with ineligible work-related things on her desk. Eve sits down on her chair and puts on the VR headset and accompanying bracelets, all provided by her employer. The bracelets are capable of measuring her finger movements down to every detail. They provide air resistance to simulate haptic feedback for the actions she takes in VR. This meant, she didn't have to own a physical keyboard, instead only a virtual one. Eve used to work at a place using equipment from "Genesis", Serpent's main competitor. Still, while she liked the job, it was too much of a hassle to have the work devices incompatible with her private Serpent ones. Sometimes, she is missing the good old days, where people would still gather in the office and have a laugh over a cup of coffee.

As she puts on her headset, she immediately finds herself on a wide, open field. She sits on a tree stump in a round grove surrounded by gigantic, lush trees. Around her are her

team members, Cain, Able, and Lilith. "Hey Eve! How are you doing? Have you tried the new forest environment in Serpent Work?", Lilith asks her, sitting on the stump opposite of hers. Serpent Work is a service provided to companies that models digital offices: every employee can choose their environment. While Eve sees the forest, Cain is sitting in a spaceship control room, surrounded by his coworkers. "I've got it activated today!", she responds. Eve had asked Sapa to download it this morning. After her standup, Eve wraps up some of the tasks she wanted to get done for today.

By 05:00 PM, she is done with all her tasks. As she puts her AR glasses back on, she checks her notification board by making a throwing gesture to the wall. There are a bunch of messages. Adam, her boyfriend, is coming over soon, and she still needs to get her laundry done. Eve loads her laundry into the box, Serpent provided for it and hands it over to the house robot. Which will bring it back in 30 minutes, all clean and dried. But the robot refuses to take the box as it is too heavy by 100g. After taking one shirt out of the box, the robot carries the laundry to the shared laundry room with her neighbors, where the content of the boxes are cleaned and dried, using Serpent's newest washing and drying technologies.

A sharp, ringing sound comes up. It seems like Adam arrived, as Eve can see on her glasses. Her doorbell has recognized Adam on the door. "Sapa, let him in," she says, signaling her home to open the door so that Adam can enter. "Hey Eve! You mind if I order food already? I am starving!", he yells as he enters her living room. "Sure, go ahead. I am just finishing up the laundry." "Sapa, can you get me a Pad Thai and Eve a Lemongrass Curry?" "Sure, Adam. I ordered it. Estimated delivery is in 10 minutes." Sapa knows their dietary profiles and the food they like to order, so all of that context is enough for her to order the right dishes from their favorite restaurant. If they wanted it differently, they would specify so. "You do not happen to have a Genesis charger, right?", Adam asks. "No, I just have the ones provided with my place." "Did you book the trip to the Alps already, Adam?", Eve asks him. "Yeah. I guess we can work from there now that it is getting warmer. Our satellite subscription covers 7G in the whole EU anyways, so it should not be a problem."

As the night approaches, the lights in Eve's home by themselves dial down their blue light all the way to zero. Just from the home temperature drop, she knows it's time to sleep. "Eve, would you like to start your meditation?",



Garden of Eden

Sapa asks with her soothing voice. "Sure, let us get started." Eve sits down, and Sapa guides her through today's evening meditation. Eve had a pretty relaxing day, so the meditation adapts to that circumstance, guiding her to reflect on the day and face the future with a calm mind. With all of these recommendations and intelligent devices, she sometimes questions if she's really the one making the choices. Ready for sleep, Eve goes to bed to recover from her day with a whole night's sleep.

Signposts

- Tesla diversifies production portfolio - from cars to coffee machines
- EU releases new data protection law: business-to-business data sharing and re-use now more restricted
- Amazon closes Alexa interfaces for third parties
- AR glasses now released for the public mass market replacing conventional smartphones and computers
- Google starts first managed settlement, Apple follows with first Apple village
- New EU circular economy law forces adaptations of business models, product design and supply chains
- New International Telecommunication Union report: 5G access available to 95% of earth's population
- Preferred business model of tech players shifting from ownership to Pay-per-use and subscription models
- Study reveals that 50% of people in the EU work remotely at home or in coworking spaces
- The biggest five tech players have now a market share of 90% of the Smart Living Industry



SMART HOME ISLANDS

Living in a world of full ownership and limited interconnectivity

Wednesday, 2041-05-16 - As the bedroom curtains slide open, the first rays of sunlight tickle Jane Lebowski's nose. At the same time, her morning playlist starts playing. Jane snoozes the alarm for another five minutes and turns around, trying to get as much rest from those five minutes as possible. As the third song fades out, Jane finally decides to get up to take a shower. She then dresses up in the clothes suggested by Emma based on the weather and walks into the kitchen.

The family values having breakfast together. Chris, Jane's Husband, is already at the table waiting for the rest of the family. Harrison and Zoe, the Lebowski's children, are the last to join. As it is Wednesday, there is not much time in the morning. For that reason, each Lebowski takes Emma's recommended breakfast. The meal is automatically prepared, and the smart kitchen personalizes the ratio of the ingredients individually based on each family member's health status and preferences. Their service robot makes fresh orange juice and serves the family at the kitchen table. After breakfast, they put their dirty dishes back in the cabinet, where they are cleaned automatically.

Before leaving for work, Jane has to change her AR contact lenses into ones compatible with the augmented screens at the office. She still has to get used to this annoying inconvenience as she only recently switched her job. With her former employer, who was equipped with the same connected office system as the Lebrowskis have in their house, she did not have to do this.

The Lebowskis live in the suburbs of Munich. Jane has a full-time job in the city, and her husband, Chris, works part-time and fully remote. Jane used to commute using CopterPool, which allowed Jane to share a Lilium air taxi with people from her neighborhood to get into the city quickly. Unfortunately, CopterPool went bankrupt some years ago. Jane, therefore, commutes by car. This commute takes over an hour



because the traffic jam is inevitable. It was about 20 years ago when the city of Munich introduced automated driving on highways. Automated driving was perceived as very comfortable and very popular as the passengers efficiently spent their transportation time. This led to an unbearable increase in car traffic. Even though the regional trains were significantly faster, most people preferred their slower but private cars.

In 2041, rail-based trains are only used for the transportation of goods. Jane dreams about the possibility of reopening trains for human commute when she sees a freight train overtaking her in a traffic jam.

While Jane is still stuck in traffic, her son Harrison prepares for his school day. On two days per week, he can decide between going to school or attending class remotely. Of course, he prefers the remote days, as he can sleep an hour longer. Yesterday he had been up late, playing Augmented Fortnight with his school friends running across the entire house.

Homeschooling has become easy. Sitting in his room, Harrison simply puts his AR contact lenses on and turns his AR Prism on, a device that projects himself in his usual desk spot in the classroom. Today even his teacher stayed at home. Mr. Snyder's Hologram is already waving at the class

Smart Home Islands

and waiting for the last of them to come in.

Only Kim and Steven are physically in school today and sitting in the first row. Harrison has always wondered why they never stay home. Steven has told him he prefers to study and meet other kids in person, but somehow Harrison doesn't believe him. He has never seen Steve online in the holographic Fortnight sessions, and he also never participates in the AR sports games in school. Harrison has wondered whether Steve can't join because his Mate devices are not working with the Google ones the school requires. But then Harrison's best friend, Boris, appears in a dramatic fireball hologram on the left, and all the thoughts about Steve are forgotten.

Mr. Snyder rolls his eyes and, with a snap of his fingers, turns the fireball into a regular Boris. "All right class, today you learn about data structures!". Although data structures are not his favorite topic, Harrison tries to pay attention and solves his quizzes 15 minutes before the session ends. That means he can rush downstairs to drink some Cocoa with his grandma Olivia.

Harrison finds Olivia in the garden. He has always wondered why someone enjoys working with plants. He does not like the manual work that his grandma enjoys. "Today, everything is solved with a machine that does things for you, sweetie. When I was young, we weren't so useless," says Olivia, putting the gardening equipment on the floor and walking to the kitchen to grab the Cocoa. Harrison loves hearing grandma's stories about a recent past that feels like such a different life.

After a long hour, Jane finally arrives at work. As there are not many meetings today, she can focus on the presentation she will hold on Friday in front of the company's board. Around 03:00 pm, Jane usually feels the need for coffee. The smart office system at work has already recognized this behavior, and when she enters the kitchen, she smells the aroma of freshly brewed Colombian coffee.

Jane's colleague Monica is also enjoying a coffee break. They met two weeks ago at a digital golf session. After finding out that they use the same intelligent home system, they talked about doing coached morning fitness sessions together.

Now they finally get to discuss this further. Monica is already excited: "I am so looking forward to this! Doing sport together really motivates me. It will be so much easier to get out of bed early in the morning." "I know exactly what you



are talking about!", Jane responds with a smile. "I am also really excited to try out your pilates exercises!"

The two agree to start with their new joint routine the following Monday. Delighted by this thought, they return to their smart desks. Jane briefly reads two articles about the latest current affairs in her customized digital news journal before continuing to work on her presentation.

Even though Jane recently joined her new company, she quickly found a connection to her co-workers. Recently her closest friends from work started a weekly cooking meetup. This week, Jane is hosting the group. As they arrive at the Lebowskis' home, they're greeted by Emma, who lets them enter automatically, as they've been set on the whitelist for tonight.

The days in 2041 are busy, always connected, and characterized by a strive for maximum efficiency. To help the group unwind, Jane asks Emma to activate the Bubble. This feature automatically turns all devices in the house to silent mode and only allows notifications in emergencies. Some of Jane's friends use a different smart home system, though, and therefore have to put their devices into silent mode manually.

Most of the meals in the Lebowskis home are prepared automatically. But during these weekly cooking meetups, the group makes a point of preparing the meals by hand. Before starting this tradition, it had been many months since Jane had last prepared a meal by hand. She almost forgot how good it felt and how she used to cook to relieve stress when she was younger.

Smart Home Islands

At some point, the group realizes that one of the main ingredients is missing. This is no cause for worry, in any case. In recent years, Gorillas had extended their on-demand drone delivery network to cover all of Germany. Jane asks Emma to order the missing ingredient, and a few minutes later, it is dropped on the Lebowski's doorstep.

After Dinner, the group decides to play a round of augmented reality minigolf. They move to the living room, where the sofa can be folded into the wall to create a spacious gaming area. The guests without a compatible pair of AR contact lenses are equipped with spare AR glasses, which the Lebowskis keep for occasions like this.

After the guests have left, Jane asks Emma to start the winding down routine. Over the next hour, Emma gradually dims the lighting to simulate sunset and adjusts the room scents to create the right mood for sleeping.

Jane and Chris brush their teeth using their newest gadget: a fully automated toothbrush. The device is placed in the mouth and cleans the teeth without human interaction within 30 seconds. Jane was skeptical at first but now could not imagine using a hand-toothbrush anymore.

For tonight, the Lebowski's select the wilderness sleeping ambiance. As Emma simulates crickets chirping and stars are twinkling in the night sky, the Lebowskis fall asleep, happy about the day that just passed.

Signposts

- A study reveals that 9 out of 10 European citizens prefer owning consumer products to renting or sharing them
- In the EU, ownership of Smart Home devices reaches a record high
- Google, Apple, Amazon, Microsoft, and Facebook close open APIs and announce their app marketplaces
- The EU reconsiders data protection laws and reduces data regulations. Large tech corporations gain even more power
- The demand for Product-as-a-service models decreases dramatically. The last company offering subscription models for home consumer goods declares bankruptcy due to high operational costs and strongly diminished revenues
- Major tech companies offer significant discounts if customers turn in devices from competitors
- EU report: increasing interconnectivity of Smart Home appliances reduces time spent on decision-making at home by 57%
- Quantum technologies enable new standards of security for interconnected home appliances
- Mother sues school for declining her son because of "incompatible tech ecosystem"
- The EU bold plan on the circular economy: mandatory share of recycled materials in home appliances raised to 90%



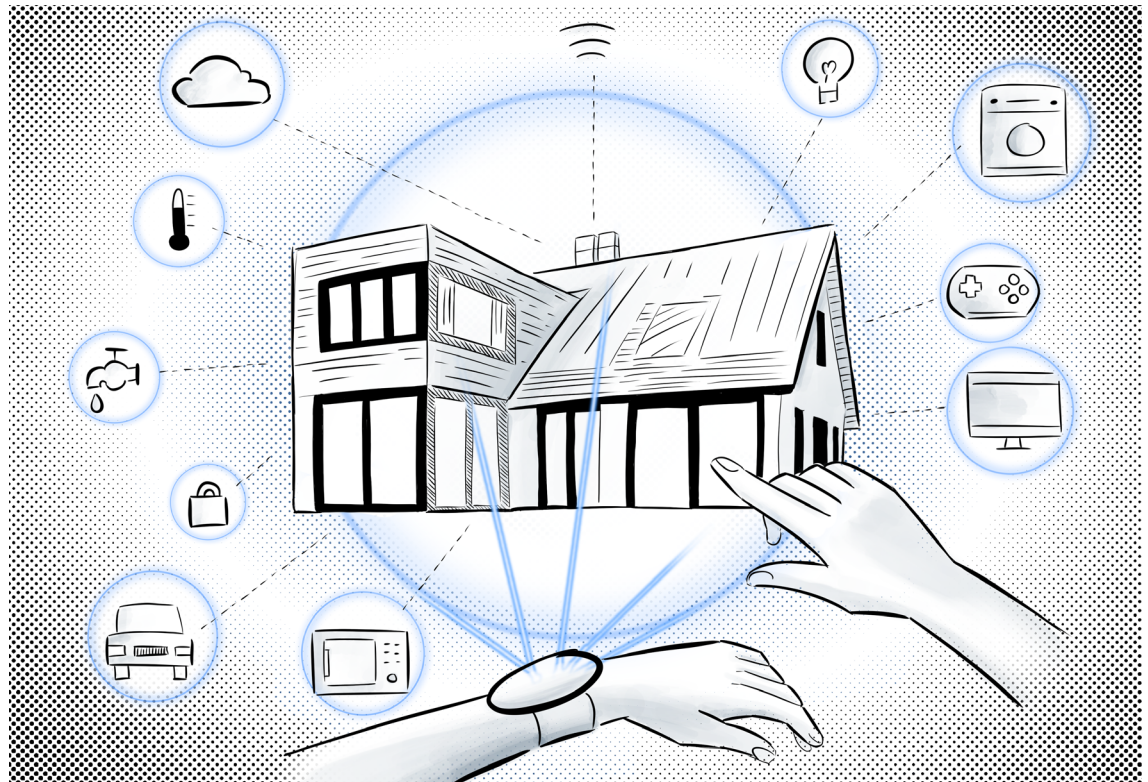
MY HOME-OS

People prefer to own different smart devices joined by a single system

It is a gorgeous morning in 2041. Ben Gardenspring, who is just in between two sleep cycles, is gently awoken by Iris. Iris is the voice of HomeOS, the Gardensprings' home operating system. Iris connects smart devices from different companies and manages the energy consumption of the home. It runs on a dedicated computer called SmartCore. SmartCore is a powerful hardware device that provides the necessary computing power and interfaces to run a smart home.

As the family wakes up, Iris pulls up the blinds automatically and switches the lighting from night mode to morning mode. While Ben showers with his preferred temperature already set by Iris, he listens to news and messages of the day. The family consists of Ben, his 16 year old daughter Mia and his father Phil, who moved back in because of early-stage dementia. As usual, family Gardenspring gathers in the kitchen to eat breakfast together. The kitchen appliances have already prepared the oatmeal with blueberries and coffee according to the Gardensprings' preferences. Afterward, the smart cleaning robot takes care of the dishes. While Mia finishes her breakfast, she gets a notification from her smartwatch: "It's time to leave now because heavy traffic is to be expected!"

Along the way, Mia picks up her friend Lena with the family's autonomous car. "Thank you so much for picking me up!", Lena tells Mia with an embarrassed smile. Mia knows that Lena's dad recently lost his job. He worked at one of the major furniture sharing companies that went bankrupt. "You are always welcome to drive with me," Mia replies. "I am excited because the latest SmartCore for our HomeOS will arrive today. It is the most innovative smart home core computer on the market and runs super fast! It even supports DanceParty - a new AR video game!" Immediately after saying this, Mia regrets bringing it up, knowing that her friend's family is currently struggling financially. Lena, seemingly impressed, replies: "Wow, the latest SmartCore from CoreSeller? That is amazing. We recently got a refurbished SmartCore from SmartHousing24." She hesitantly adds, "I mean, in the kitchen, everything is connected, but it is too slow and does not support DanceParty."



Meanwhile, back at home Ben gets ready for work, "Iris, switch to office atmosphere!" Ben is a quality assurance manager at a car manufacturer and uses AR glasses to work remotely. At 02:00 PM, he has his last meeting of the day. His colleague Nina asks: "So, what are your plans for the afternoon?" Ben replies: "My smartwatch recommends a workout based on my activity of the last days. I think I will try that. Do you want to join?" "That sounds like a great plan," Nina answers enthusiastically. "I am glad that the European Union limited the workweek to 30 hours." Ben nods and adds: "Yes, it allows us to spend more time with our families."

Phil's day looks a little different. Phil has been diagnosed with early dementia and is therefore in close contact with a doctor who offers an online therapy program. It consists of regular online check-ins as well as cognitive training, which is based on his vital signs and activities. The growing number of elderly citizens exerts severe pressure on the healthcare system. Most therapies are held remotely with the help of online services and smart devices. Many cannot afford these because the automation of jobs has exacerbated poverty among the elderly. Thus, Phil is privileged to obtain this service. Today, he has another online appointment with his doctor via a telemedicine service. Phil's smartwatch already uploaded his vital signs and activities to the electronic

My Home-OS

medical record. They discuss Phil's condition and the focus of his therapy for the next week. The doctor is very content with his progress, "The transmitted vital signs show that you have exercised three times in the last week. Well done, keep up the good work!". After the session, the doctor sends therapy activities and prescriptions to Phil's HomeOS system. Iris orders the required medication accordingly and puts together a set of recommended brain exercises, which he can do on the family's smart entertainment system.

Phil appreciates spending time in the garden during the afternoon. In particular, he loves the peace and tranquility of his very own space. Also, growing his vegetables makes him feel independent. His gardening skills are supported by a set of interconnected devices that record the plants' moisture and condition. Based on this data, Iris has come up with some gardening tips for Phil: "Hey Phil, I sense that the soil around your tomatoes is a bit dry. I think they could use some water! Do you want me to turn on the sprinkler?"

After Mia gets back from school, she enjoys spending her free time playing with her new X557, the latest version of home

entertainment systems. The X557 combines elements of a game console, a TV, and a Hi-Fi system. Although a different manufacturer produces the system, it connects seamlessly with HomeOS to use the home's speakers and sensors. Mia's favorite game is DanceParty. The game allows her to dive into a virtual club with her friends and practice certain dances. The AR technology, together with the HomeOS sensors and the SmartCore, create a truly immersive experience. This way, Mia can meet all her friends without having to leave the home. Unfortunately, her friend Lena cannot participate because her SmartCore is not advanced enough to support the game.

HomeOS also plays a crucial role in taking over a large share of the household chores. Further, it ensures that those activities are conducted in an energy-efficient manner. Since the government adopted strict regulations on energy consumption and CO2 production, wasteful resource utilization comes at a high financial price. An energy management system that is linked to HomeOS enables the family to minimize utility costs and easily comply with

sustainability regulations. Solar panels produce the family's energy, which is then saved in internal energy storage. Today's sunny weather has fully charged the Gardenspring's home battery and even generated a surplus. Iris asks Ben whether it can reschedule the washing cycle to an earlier time to utilize the excess energy most efficiently.

In the kitchen, the family is also supported by HomeOS. The smart fridge detects that the bell peppers are about to spoil, and Iris makes the following suggestion: "Hey Ben, why do you not use the bell peppers to make some enchiladas tonight?". Ben thinks it is a great idea, "That sounds amazing Iris, I am really in the mood for Mexican tonight. Can you order the missing groceries?" "Sure, no problem, I will send a shopping list to the supermarket. The groceries will be delivered in ten minutes."

In the evening, the Gardensprings decide to cook together. While preparing the main dish, Iris sets the oven to the right temperature, starts to play Mexican music, and dims the lights to create a cozy atmosphere.

After dinner, the family listens to the news: "With the recent bankruptcy of FurnitShare, the number of workers who have lost their jobs due to the insolvencies of subscription-based companies rises to 100,000. After the surge of subscription services in the 2020s, the subscription and sharing model have not proven to be economically sustainable as most companies have failed to become profitable." Mia is very upset by the news: "Wow, it is really crazy how the sharing economy took a nosedive. Lena also told me that her father is affected by this. Dad, is your job safe?", Ben reassures her, "Do not worry, Mia, it will be fine. I am more worried about the increasing inequality in our country."

At the end of the day, the Gardensprings decide to watch a movie together recommended by HomeOS. Afterward, the family gets ready to sleep upstairs. To help the family fall asleep, Iris dims the lights and plays some relaxing music. While the family enjoys their rest, the cleaning robot downstairs is still wide awake. It cleans the floor, dust and loads the dishwasher so that everything is tidy for tomorrow. Laying in her bed, Mia reflects, "We should be grateful for all the luxuries we own."



Signposts

- People buy smart devices to impress their friends and family
- The Sharing Economy bubble is about to burst as investors worry about sustainability
- Out of fear of getting broken up, big tech companies establish a consortium for open standards in the smart home market
- The new law is passed in the EU: all new smart home appliances need to adopt an open standard
- Large manufacturers agree to use the open-source software HomeOS to power their devices
- Study shows that people living in a Smart Home save an extra hour of free time per day
- Refurbished smart devices and appliances are increasingly sold on second-hand markets
- Over 70% of the elderly are now using smart home technology and can stay independent longer
- Researchers agree smart homes are more energy-efficient than regular homes



IDEATION

The following chapter describes five novel business models in the field of smart living. Each of the business models is described using the Osterwalder Business Model Canvas. Both eco-social costs and benefits will additionally be elaborated on.

TEAM 1
MOKI68

TEAM 4
COOKLINGS89

TEAM 2
SPYNE75

TEAM 5
HELPING HAND96

TEAM 3
TRASHLY.AI82

MOKI

Simply the Kitchen You Desire

On average, people spend 2.8 hours a day in their kitchen [369]. That is why it is essential to transform it into a place where everyone can feel comfortable and happy. However, planning a kitchen is very time-intensive and requires large monetary investment upfront to ensure that everything looks exactly how customers like it. Especially for landlords, providing a kitchen for their tenants can be tedious. Today it is challenging for landlords to ensure that their next tenant will be satisfied with all their personal preferences regarding design and appliances. Furthermore, once a kitchen is purchased, it becomes hard to find affordable and reliable maintenance and service providers who will ensure a fast and uncomplicated reparation.

MOKI offers an innovative solution to all of these pain points. It is an affordable kitchen-as-a-service with a clean and stylish design, fully modularised to be easily adjusted to the needs of

any user. The plug-and-play system makes it easy to assemble and change modules. With no commitment required, MOKI can be flexibly rented via a subscription at any time. The MOKI package comes together with a best-in-class customer service that includes a fully digitalized configuration and ordering process through a simply accessible online platform that ensures excellent customer satisfaction. Furthermore, MOKI provides express deliveries and continuous free-of-charge, on-demand repair and maintenance. In the process, MOKI aims to fulfill three core value propositions. Planning and getting a kitchen will become simpler and more convenient, giving the unique opportunity to avoid today's complicated and tedious processes, from designing its look to customizing and adjusting all included appliances. Landlords and tenants will have maximum flexibility, accommodating their individual preferences regarding the kitchen's functionality, design, and usage period. Furthermore, even premium quality kitchens



MOKI
SIMPLY THE KITCHEN YOU DESIRE

will become accessible and affordable for everyone. Due to its circular business model, MOKI aims to be a sustainable brand that ensures proper recycling of the used materials and reduces environmental damage.



Key Partners

- Manufacturers of appliances and kitchen furniture
- Companies for repair and maintenance of the modules
- Expert kitchen designers
- Logistics companies for transport and first installation of the modules



Key Resources

- Financial resources
- Kitchen design experts with interior know-how
- Technical appliance knowledge
- Online kitchen configuration
- Efficient logistics network with own hubs and operational



Key Activities

- Development and production of modular kitchens
- Transport of modules
- Refurbishment and storage of exchanged modules
- Development and maintenance of an online platform
- Sales and marketing configuration



Value Proposition

- Simplicity: less time for kitchen planning, repair, maintenance
- Flexibility: on-demand subscription to the desired kitchen regarding design and appliances with individual rental periods
- Accessibility: no initial investment, attraction of new tenant groups with the landlord having a customizable kitchen solution



Customer Segments

- Urban professionals
- Landlords of one- to two-person household urban apartments
- Future segments: young families and students



Channels

Online

- Online website, including online kitchen configurator
- Social media, e.g. Instagram

Offline

- Lifestyle magazines
- Kitchen ambassadors
- Pop-up stores and showrooms
- Cooperation with cafés



Customer Relationships

Tenants

- Fast communication loop via smart online assistant
- Upselling of newer modules and designs
- Repair and maintenance of kitchen
- Short- to medium-term contracts
- Customer support for

Landlords

- Single touch-point at subscription start
- Long-term contracts



Cost Structure

Initial Investment Costs

- R&D of modular kitchen prototypes
- Setting up a first production line
- Development of software for customer service

Fixed Costs

- Human resources & overhead

- Marketing expenses
- Warehouses and logistical hubs

Variable Costs

- Manufacturing costs
- Refurbishment, repair & maintenance
- Logistics



Revenue Streams

- Landlord subscription to a basic kitchen
- Tenant subscription to add-on modules



Eco-Social Costs

- Increased air pollution due to frequent transportation of modules
- Possibly shorter kitchen life cycle in comparison to owning it



Eco-Social Benefits

- Circular business model
- Ensured recycling of unused modules
- Accessibility to high-quality kitchens



Value Proposition

MOKI fulfills three main value propositions.

Simplicity: For both landlords and tenants getting the right kitchen is a hassle. It usually takes several months from the initial idea of the kitchen to the final product [370]. People usually spend a lot of time in their kitchen and invest a lot of time and energy to make it perfect. However, once a kitchen is delivered and set up, it is usually difficult and expensive to make adjustments. MOKI drastically simplifies this process by offering an intuitive online experience and a smart assistant that helps customers find the right modules for their kitchen. Since MOKI is a kitchen-as-a-service, there is no pressure to get the kitchen right the first time. It is always possible to exchange modules afterward. Lastly, MOKI takes care of repairs and maintenance.

Flexibility: Once a conventional kitchen is bought and set up, it usually stays unchanged for the rest of its life since making changes is very cumbersome. This stays in strong contrast to MOKI's modular kitchen-as-a-service. MOKI aims to offer both tenants and landlords the maximum flexibility, accommodating their individual preferences regarding functionality, design, and usage period of the kitchen. This is enabled by a modular, plug-and-play design that makes it easy to add, remove or change entire modules.

Accessibility: Since MOKI offers a subscription model to landlords and tenants, it has two main advantages over a traditional sales model. First, it removes the barrier of a high upfront cost allowing everyone to experience a high-quality kitchen. Secondly, even for short-term stays, tenants get access to a fully personalized kitchen, which may not be possible otherwise. Lastly, it removes the fear of having to sell the used kitchen at a potential loss.



Customer Segments

Due to the high share of rental living in Germany, MOKI prioritizes two customer segments that are closely linked: urban professionals as the end-users of the MOKI kitchen and the landlords who often rent out apartments together with a kitchen.

Urban professionals: Professionals who live in large German

cities in single or two-person households and have a net income of over 38 thousand Euros are the main end-user customer segment. As they are a very mobile demographic group, they value flexibility and convenience. Moreover, they are likely to connect to a lifestyle brand like MOKI. Although they have a higher disposable income, they often avoid making a large investment into a high-quality kitchen as they do not know how long they will live at a certain place. With MOKI, they now gain access to high-quality kitchens that meet their personal preferences, already for short-term stays. Other population groups who live in smaller households, such as young families or students, could be potential customer segments in the future.

Landlords of urban apartments for one or two people: for around 75% of rental apartments in large German cities, landlords provide a built-in kitchen as part of the apartment [371]. Therefore, they are an important customer segment to capture. MOKI tries to target those landlords who experience a high fluctuation in tenants and want to offer more attractive rental packages with a customizable kitchen. Moreover, urban professionals, who are the main end-user target group, usually live in single or two-person households. As the apartment size for these households is also slightly smaller, they are the ideal use case for the modular kitchen designs that can be flexibly adjusted to the specific room dimensions.



Customer Relationships

MOKI serves various stakeholders and maintains different relationships with them. With tenants, MOKI aims to keep a close relationship throughout the entire subscription period. The goal is to keep the customer in the loop and engaged, which is key to offer fast and seamless maintenance and repair services. In addition, MOKI informs the tenant about new or upgraded modules and offers inspiration how the current kitchen could be improved. Even after the subscription period has ended, MOKI tries to stay in tenants' minds to influence future kitchen purchases by advertising the latest and most sophisticated kitchen modules.

In contrast to the tenant, most communication with the landlord takes place before the subscription starts. This includes educating the landlord about the benefits of a modular kitchen-as-a-service and showing example calculations of how it compares to buying a kitchen upfront.

This is also the opportunity to upsell the landlord to choose a larger kitchen as it might make the apartment look more attractive. After the initial sales contact, MOKI tries to minimize the communication with the landlord as the main goal is to provide a hassle and worry-free experience. Most of the further communication takes place between MOKI and the tenant. The landlord will only be informed about repairs and maintenance and potential new MOKI offers



Channels

Online Channels: There are three main online channels that MOKI leverages to reach its customers. The latest designs and modules are showcased on social media platforms such as Instagram, YouTube, and popular online lifestyle magazines. This leads customers to the website and the configurator. The website further highlights the design and the innovative plug-and-play system of the modules. In combination with the smart assistant, the configurator proposes new module combinations to the customers taking into account customer preferences, space requirements, and what modules the customer might already have. Lastly, MOKI targets already existing customers via emails and push-notification to advertise special module deals or introduce newly developed modules.

Offline Channels: Since many people want to get an idea of how a kitchen might look and feel in the real world, MOKI targets several offline channels. First, there is the ambassador program. Customers can choose to become MOKI ambassadors and invite potential customers to their homes to showcase their kitchen and provide additional information. In return, they will receive additional modules for free or benefit from a reduced subscription fee. Secondly, MOKI will cooperate with and sponsor bars and cafes to further establish its lifestyle brand. Lastly, various MOKI kitchens will be presented and showcased in pop-up stores in large cities to give customers the option to experience it directly.



Key Activities

Kitchen Design: Kitchens today are already standardized but not fully modularized. MOKI will focus on designing stylish but simple and easily interchangeable modules based on an easy plug-and-play principle and do not need special

MOKI

installation techniques. Furthermore, appliances have to be adjusted to fit smoothly into the modules.

Organizing refurbishment, storage, and transportation: MOKI provides the customer with a simple modular kitchen and full service around it. Transportation and refurbishment of the modules will be organized if the tenant decides to upgrade his kitchen and exchange a module from the basic landlord version.

Development and maintenance of the online platform: The first contact of the customers with MOKI takes place on an online platform. There they gain their first impressions of the brand. Therefore, an appealing website and simple online kitchen configurator must be developed and maintained so that tenants and landlords can rapidly access all functionalities and get in touch immediately when they need something. Convenience and accessibility are one of MOKI's core values. That is why an excellent customer journey, including a fully digitalized kitchen configuration and ordering process, fast deliveries, and continuous on-demand maintenance services, will be provided

Customer acquisition and marketing: People are overloaded with information about furniture companies and face a hard choice which is the right one. That is why MOKI will work towards cross-channel marketing and effective customer acquisition to gain traction and ensure business success.



Key Resources

MOKI is the first fully modular kitchen of its kind. However, to establish this solution, various resources to build the hardware of the appliances and the software for a digital configuration tool will be required. To achieve that, a strong interdisciplinary team will work on developing an attractive and convenient MOKI service for its users.

Technical appliances knowledge: On the hardware side, talented engineers focusing on the hardware development of kitchen appliances are a key player to enable a finely engineered and perfectly styled modular model. To find new ways to grow profitably and disrupt the existing market, unconventional ideas for innovative gadgets will be crucial.

Online kitchen configurator: To enable smooth planning and flexible customization for the customers, an intuitive user

interface where everyone will be the designer of their modular kitchen needs to be developed. For this purpose, landlords and tenants will be offered an online platform, visualizing all kitchen modules and the possibility to report any required appliance repair or upgrade. Kitchen experts will prepare pre-built design templates to facilitate the planning for the users and review the finished configurations before the final order. This will support inexperienced customers to arrange their dream kitchen without any layout mistakes easily.

Sales and Marketing: A big sales and branding network of kitchen and furniture suppliers and knowledge about online marketing will be of great importance. In this way, access to MOKI's main customer groups - urban professionals and landlords - can be ensured. MOKI will represent an appealing brand that customers can trust.



Key Partners

Production partners: MOKI will partner up with suppliers and kitchen appliance manufacturers who will produce its special modules. There will be constant two-way communication to ensure quality and fast production of all parts delivered to the end customer. A core value for MOKI is that the supplier is perfectly aligned with the plans and specifications of the entire production process.

Repair and maintenance: To offer seemingly new kitchen appliances at all times, special repair and maintenance subcontractors will be hired. They will smoothen and accelerate the process of adequate kitchen equipment maintenance that is usually very time intensive.

Kitchen expert designers: Expert kitchen designers will guarantee a modern but simple look for MOKI. The support of professional interior designers will make sure that the suitable materials and appliances are chosen and all pieces fit together in the framed structure and can be easily exchanged.

Logistics: Logistics companies are one of the key elements in the supply chain. They will handle the transport of the modules from the manufacturer via the storage room to the apartment of the end-user. At delivery, a trained team of subcontractors will install the modules into the frame and connect the plug with a standardized interface. However, the tenants can also easily change modules themselves.



Revenue Streams

A key differentiation to competitors in the market is that MOKI offers its kitchen via a subscription rather than selling it. That way, MOKI will generate recurring revenues over a long period.

Basic subscription for core kitchen modules: The main share of revenues will come from the basic MOKI subscription fee of approximately 100 EUR per month. This fee is paid by landlords who want to provide a kitchen as part of their rented-out apartments. If the landlord does not want to provide a kitchen, the tenant can also directly subscribe to a basic MOKI kitchen. The basic MOKI subscription includes a fridge, an oven, a stove, a sink as standard modules to offer core functionality, and cupboards and worktops in default designs. There will also be the possibility to pay the subscription fees on a semi-annual or annual basis.

Add-on subscription for personal customization: The basic MOKI can then be further customized and upgraded by the tenant according to her preferences for an additional subscription fee. This can include adding further functional modules such as a waste collector, food processor, or coffee machine and customizations in the design by exchanging worktops or front colors. The amount of the subscription fee depends on the selected upgrades and the duration. To ensure the coverage of the operational costs associated with this offering, the minimum subscription is 20 EUR per month. Like the basic subscription, the fee can also be paid monthly, semi-annual, or annually.



Cost Structure

Initial Investment Costs: MOKI will require a substantial initial investment. The major part of this will go into the research and development of modular kitchen prototypes. This includes the modular kitchen designs with the plug-and-play system for easy assembly and manufacturing of the first prototypes. The testing of the prototypes, including iterations over the designs and re-manufacturing, will be the main drivers of these costs. Once there is a validated prototype, another major part of the initial investment will flow into the industrialized production of the first MOKI kitchen line to enter the market. A comparatively small cost will be the development of the software powering the

MOKI

digital customer service.

Fixed costs: There will be important human resources needed to get MOKI started and keep it running, including kitchen designers and engineers, software engineers, and the management team. Another large part of the fixed costs is marketing expenses to establish awareness and

recognisability of MOKI as a lifestyle brand for high-quality kitchens. Lastly, a small office will be needed to conduct the business operations. In the future, warehouses and logistical hubs will add another large fixed cost factor.

Variable costs: The manufacturing costs of the different kitchen modules will vary depending on the demand of

MOKI kitchens. Nevertheless, as MOKI strives to be a fully circular business model, the manufacturing costs will be much higher at the beginning and then likely be lower compared to refurbishment and repair costs. Due to the flexible subscription model, MOKI modules may switch users between tenants or even landlords several times. The modules hence will have to be continuously repaired and refurbished throughout their life cycle. Therefore, refurbishment and repair costs will be a very large variable cost factor, depending on how intensively the kitchen modules have been used. A third variable cost factor are operational costs around logistics, such as deliveries or pick-ups of modules for repair or refurbishments.



💰 Eco-Social Costs

The possibility to frequently exchange modules and upgrade kitchen parts will inevitably lead to more frequent transportations. In this way, MOKI's logistics structure could produce increased amounts of packing materials, GHG emissions and contribute to air pollution. As our customers will always have accessibility to the newest kitchen appliances on the market, the need for constant exchange of the older ones might accelerate the demand for recycling and decrease the kitchens' lifetime compared to owning them. Furthermore, the recycling of some materials still uses loads of resources and can harm the environment. With current technologies, it is not yet possible to recycle 100% of the materials.

🌱 Eco-Social Benefits

MOKI aims to establish a circular business model with a closed kitchen life cycle. In the design phase and production, there will be a strong focus on using durable and renewable materials. In that way, the MOKI modules can be re-used as long as possible. That means, if tenants move out, we take back their modules. Then, we maintain and refurbish the furniture and appliances to maximize their lifetime. Since the kitchen is fully modular, it is possible only to replace parts of the modules. If the material cannot be repaired, MOKI aims to fully recycle them in the future by establishing strong partnerships with forerunners in that space. Since all kitchen modules are re-used and finally recycled, MOKI significantly reduces resource consumption and thereby reduces environmental costs, i.e. regarding

MOKI

carbon emissions or waste. Furthermore, no high initial investment is required to get the MOKI kitchen. Instead, MOKI offers subscriptions for all modules. The monthly fee is relatively small compared to the price of the kitchen. Thus, MOKI enables more people to access high-quality modules such as appliances with the lowest energy consumption standards.

Scenario Fit

Garden of Eden: In this scenario, we have, on the one hand, a low degree of ownership and, on the other hand, low interoperability between devices of different producers. This means that the renting business model is likely to succeed as people are used to renting everything. The low interoperability makes a market entrance harder and introduces more risk of not being widely adopted. On the other hand, it offers MOKI the opportunity to stand out with a perfectly integrated kitchen with a set of appliances that work perfectly with each other. MOKI aims to become one of the most widely adapted kitchen ecosystems to offer this additional benefit to customers and be seen as one of the trendiest kitchen brands in the market.

On-demand Convenience: In this scenario, we have a shift from ownership towards renting. Because people value the added flexibility and convenience, it will be easier to attract customers and scale the business. On-demand convenience, which is the name of this scenario, is exactly one of MOKI's core value propositions. MOKI is therefore ideally positioned to thrive in this case. With kitchen rental starting to become mainstream in the coming years, MOKI should aim for a high market share in this business from the beginning. The high interoperability makes it possible to have devices from various producers working together. This can be leveraged by partnering with multiple different companies to offer their modules as part of the MOKI kitchen while still providing a holistic kitchen solution where every module fits perfectly.

Smart Home Islands: If the Smart Home Islands scenario comes true, people in 2041 will prefer ownership over renting. The renting business model with kitchen-as-a-service is therefore difficult to realize. Thus, the business model should be changed fundamentally into selling kitchen modules. While the focus cannot be on the on-demand flexibility aspect anymore, the convenient effortless selection of a new kitchen, the modern lifestyle and strong brand, and a sustainable circular recycling strategy could serve as

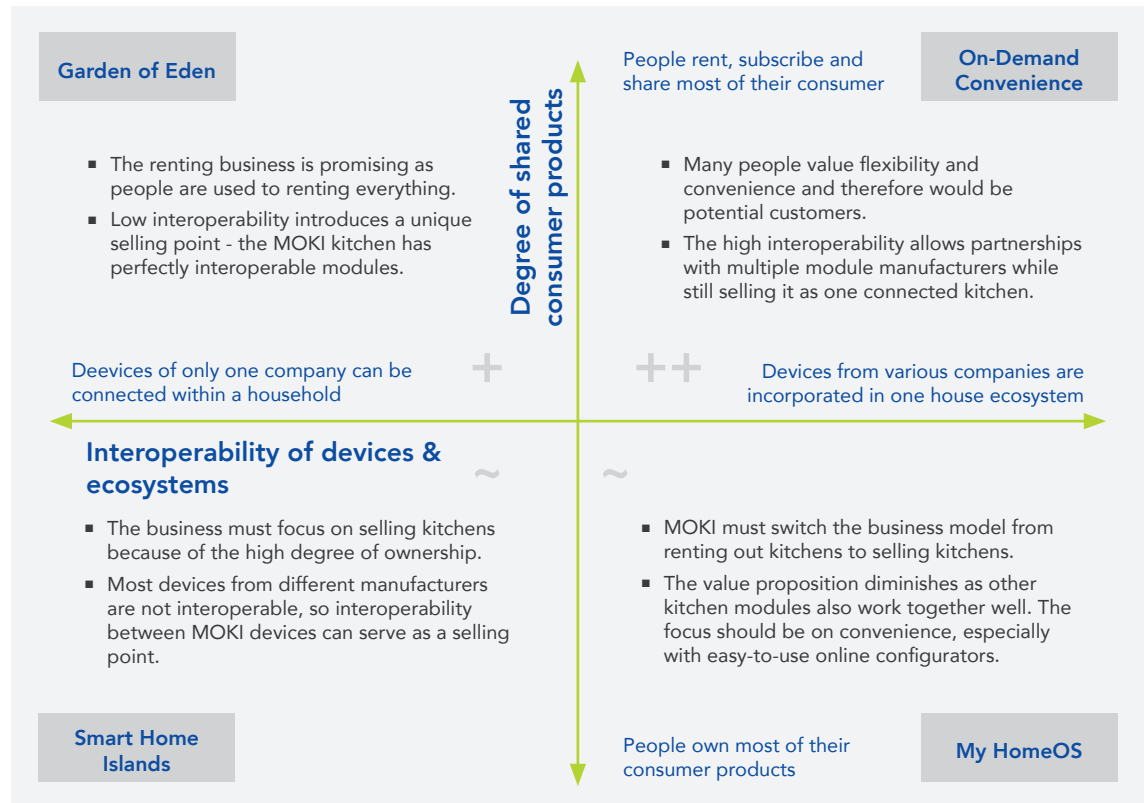
unique selling points. Especially as appliances from different producers are not interoperable, MOKI could become the go-to solution for people who want a kitchen where devices work together smoothly.

MyHomeOS: The high degree of ownership in the MyHomeOS scenario makes the rental business model less attractive to customers. Therefore it is necessary to change the core business model and focus on selling kitchens. On the other hand, this scenario comes with high interoperability. If this interoperability also extends to more hardware modularity of various appliances in the market, it will be harder to find clear value propositions of the business model. The main focus

should then be on a streamlined purchasing experience with providing an easy-to-use online configurator. MOKI should stand for known quality without the need to pick appliances from various vendors separately.

Challenges

- Before launching the product, extensive research and development work are needed to create a fully modular kitchen. This requires expertise and financial resources.
- The subscription model introduces high initial investments for the production of the kitchens. It will take several years until the subscription fees first cover the production cost.



MOKI

- The key step is attracting landlords to subscribe to the Basic MOKI. As landlords have the goal to make money, the subscription price has to be competitive given the additional convenience benefits. Getting this price right with both being attractive and covering the costs is crucial.
- The logistics of delivery and set-up of the kitchen have to be taken care of in a cost-effective manner while still achieving high customer satisfaction.
- An important aspect of the business model is the refurbishing to hand out modules that look like they were new. The willingness-to-pay of customers will be significantly lower if the refurbishment quality is not excellent.

Outlook

The first step in proceeding with this business idea is to validate the feasibility of the business model. Interviews with potential customers, landlords, and tenants, are needed to figure out how much they would be interested in renting their kitchen and willing to pay for it. This information leads to the first prototype, which will be the basis for further development and market research. Strong strategic partners are necessary for the prototype development to profit from experience in designing and building kitchens and appliances.

Continuing with these partners, MOKI should aim to build the first product line and integrate appliances from partners specifically fitted to meet the MOKI kitchen module dimensions and connection interfaces. This way, the first customers can be acquired in 2022.

MOKI should build up the first logistical hubs in the largest German cities, where not only the furniture and devices are stored but also refurbished. Nevertheless, MOKI initially needs additional partners for delivery and refurbishment. Finally, with a higher adoption in big German cities, there would be possibilities to scale the business. On the one hand, more and more different modules could be offered to provide a holistic kitchen solution. On the other hand, other European markets offer attractive expansion opportunities.



SPYNE

SPYNE

The Smart Chair That Takes Care of Your Back

The spine is one of the most complex parts of the human body. It is what has enabled us to walk upright. It has been paramount in our evolution into the intelligent species we are today. Modern humans, however, lead very different lives to their hunter-gatherer ancestors. Our ancestors moved a lot during the day, burning more than 3,000 calories daily. They were constantly training and strengthening their bodies, especially their backs and spines. Nowadays, for many people, working out has replaced the constant physical strains of the past. But simply working out and strengthening back muscles is often not enough to alleviate all issues raised by modern lifestyles.

With the advancement of technology, humans started to live a more sedentary life. Especially with the invention of computers and other technologies, most of our working days are spent sitting down at a desk, in uncomfortable positions for

more than 8 hours a day. This leads to many people complaining about back pain and other spine-related health issues, even at a young age. Many applications and therapies promise to fight the symptoms of poor posture, alleviating the back pain caused by constant sitting. However, none of them try to fight the actual cause: excessive static sitting for prolonged times without proper ergonomic support.

Spyne's mission is to protect and care for its user's back. Spyne is a chair fitted with an extensive array of sensors, delivering the most accurate picture of a person's posture and spinal movement that has ever been produced. The chair itself is built with humans in mind, is perfectly ergonomic and customizable to the user's body and needs. Through vibrations, it reminds the user to correct and care for their posture. Accompanying this chair is an application with access to the data gathered by the chair's sensors. That is how the users

can see their movement patterns and weaknesses in posture, spinal alignment, and back muscles. An additional subscription called Spyne Pro allows users to act on this information by recommending personalized therapy and giving tips on alleviating their back problems during their day-to-day lives.

Business Model

 Key Partners

- Chair manufacturers
- Sensor manufacturers
- Ergonomics researchers and experts
- Smart home ecosystem providers

 Key Resources

- Patents for posture recognition and analysis
- Sensor expertise for accurate detection
- Relationships with (chair) manufacturers
- Ergonomics knowledge for designing the chair

 Value Proposition

- Individually adjustable ergonomic chair
- Posture tracking using sensors in the chair
- Nudging to sit correctly via vibrations
- Accompanying app to give personalized feedback on posture and work behavior
- Individualized workout routines and tips to improve your posture via the app
- Integration into Smart Home

 Customer Segments

- Middle to upper-class workers that are eligible to work from home
- Businesses that allow remote working
- People that already face heavy back pain

 Customer Relationships

- Entertainment of customer through posture challenges and streaks in the app
- Automated recommendation of workouts and tips to improve posture
- Personal support for businesses
- Online support for end customers
- Flagship stores/co-working spaces

 Key Activities

- Production of the chair with its sensors
- Ergonomics research for chair design and sensor functionality
- Marketing for B2B and B2C channels
- Development and maintenance of the app, accompanying the chair

 Revenue Streams

- One-time sale of a chair
- Additional subscription service
- Leasing model for customers unable to pay a large up-front sum
- Partnerships with health insurance companies

 Channels

- B2C business model
- B2B business model
- Health insurance companies

 Cost Structure

Initial Investment Costs

- Setting up a manufacturing unit through partnerships
- Consultancy fees for orthopedists and experts in ergonomics
- Arranging a stable supply of raw materials
- Sensors, chair, and app prototyping

- Establishing partnerships with leasing and co-working spaces providers

Fixed Costs

- Research and development
- Operations and IT infrastructure maintenance
- Offices and warehouses for rent
- Salaries for employees

Variable Costs

- Marketing and sales
- Manufacturing
- Direct materials that go into a chair production
- Logistics

 Eco-Social Costs

- Chair materials
- GHG emissions during manufacturing and operations
- Logistics and delivery
- Old chair disposal

 Eco-Social Benefits

- Improved health and less strain on the healthcare system
- High-quality chairs have a longer lifetime

Value Proposition

Spyne is an ergonomic sensor-fitted chair that takes care of your back by tracking your posture and nudging you with gentle vibrations to sit correctly. Furthermore, it provides personalized guidance on posture and back strengthening workouts in the accompanying app.

Individually adjustable ergonomic chair: At the core, Spyne is a high-quality office chair that perfectly adapts to the individual back of every customer. Based on the latest research, Spyne provides over 20 possibilities to fully customize the chair to your needs. The chair alone can already considerably improve the posture of the customer.

Posture tracking using sensors in the chair: Fabric-based sensors embedded in the chair track every movement. Through machine learning, the sitting position can be detected with 98% accuracy. Furthermore, current stress levels and nervousness can be identified.

Nudging to sit correctly via vibrations: If Spyne detects that you are not sitting correctly, it can give you feedback with a gentle vibration to correct your posture. 11 vibration motors spread across the chair draw awareness to areas where posture could be improved. This short feedback loop teaches you to always sit in the healthiest way. In the long term, this learning experience will help sitting straight even if the user is not sitting on a Spyne.

Accompanying app: The accompanying app shows you insights into your posture and sitting behavior. It shows you all the data collected by the sensors and the current trends regarding your sitting behavior. Furthermore, it can provide you with tips to configure Spyne correctly for your body, as well as provide personalized workout routines to further strengthen your back.

Integration into a smart home: With Spyne being integrated into the major smart home ecosystems, scenarios can be triggered based on the sensor data of the chair. This can involve lights, heating, or any other accessory already existing in the relevant ecosystem.

Customer Segments

Spyne's targeted customer segment is middle- to upper-class office workers that regularly work from home. They value working from home as a very flexible way of working. Often their work environment at home is not fully optimized for the individual ergonomic needs of workers. Even if these workers buy expensive ergonomic chairs, adjusting all the settings on the chair correctly requires a significant amount of trial and error and knowledge in ergonomics. Yearly training by occupational safety and health advisors has proven to be ineffective. Workers remain largely unaware of their sitting habits. As working from home is becoming more widespread through the pandemic, yet here to stay post-covid, this becomes a more pressing issue.

The second targeted customer segment is businesses that want to alleviate their employees' back pains by providing them with Spyne. Herniated disks have become a widespread disease, leading to a loss in productivity and long-term absence of employees. They are interested in the wellbeing of their employees, in their office as well as when they work

from home. These businesses have working-from-home as a firm principle in their working policies or do not even have office space at all. Spyne is an excellent addition to existing wellbeing solutions and is easy to incorporate in the office and home environment.

Lastly, Spyne targets customers that already fight extensive back pain. In the long term, Spyne wants to become an accredited health solution that is subsidized by health insurance. Lowering the price through these subsidies will enable Spyne to cater low-income customer segments that already experience severe back pain since the barrier of entry will be reduced through a lower price.

Customer Relationships

Interaction with users: Customers share their height in the buying process to get a perfect fitting version of Spyne for their body size. In the future, Spyne plans to build a video-based tool that will help to even further tailor the chair to the person.



SPYNE

The customers' body measures can be accurately detected through AI technology and the chair settings appropriately adapted. These measures are forwarded to and securely stored in the Spyne Companion App. When the customer buys a new Spyne chair, set-up instructions based on the individual customer measures are provided.

Automated services: Via the accompanying app, customers benefit from receiving personalized tips regarding their posture. This service is based on the sensor data of the chair and state-of-the-art AI technology that generates the appropriate recommendations. These include the perfect set-up of the chair, appropriate stretching, and meditation exercises, as well as the automated suggestion of breaks. Customers are motivated through posture challenges and streaks in the app. Lastly, Spyne provides online support for all customers that are heavily based on chatbots and ML.

Personal assistance: Spyne provides B2B customers with a personal sales representative that serves as a direct contact for all their concerns and questions. B2B customers of Spyne require more personal attention as they buy Spyne in bulk. The sales representative will understand the client's situation and provide a custom-tailored offer for each client. Furthermore, direct interaction with the customer is facilitated via Spyne's flagship stores. Customers can try out Spyne and talk to Spyne representatives. Here they can get their back analyzed and their Spyne chairs set up to their individual needs.



Channels

B2B model: In a B2B business model, we aim to establish trustworthy partnerships with co-working spaces, leasing providers, and companies owning their furniture in the offices. The B2B model requires a fact-based and data-driven marketing strategy that directly indicates the additional value of the Spyne chair. The Spyne Pro subscription model focused on long-term health benefits and increases productivity for users. This will be especially interesting for companies where employees spend most of their time seated. For these companies, most value can be created.

B2C model: In a B2C business model, our objective is to target consumers that primarily work in the office and care about their level of physical activity, long-term health, and productivity. B2C marketing strategies mainly focus on strong brand relationships with customers. For this purpose, the Spyne marketing campaign focuses on user experience

and fact-based storytelling, thus turning our product from a want-to-have into a must-have. To reach the target group, we are promoting Spyne via online channels such as social media advertisements, blogs for professionals, and online magazines. Another promising channel for establishing a reliable brand reputation is building flagship stores. Such stores provide potential customers with a co-working space for a day, where they can try different models in action. Although co-working testing day does not provide customers with an immediate improvement of their health, such a day helps them understand how suitable Spyne features are for them and how it improves their office work experience.

Health insurance companies: Health insurance companies can become a partner of Spyne and provide our services subsidized to their customers. This will reduce their long-term costs of treating expensive back pain problems.



Key Activities

Production of the chair with its sensors: As mentioned above, Spyne is an ergonomic chair fitted with custom sensors to detect a user's posture and spinal movement. To achieve this, the chair is equipped with pressure and movement detecting sensors on the bottom and backrest of the chair. That allows complete tracking of the user's movements and posture while he or she is sitting.

Ergonomics research for chair design and sensor functionality: Blindly building a chair and fitting it with sensors does not work. It is important to do research in cooperation with experts in ergonomics to get knowledge on how best to design a comfortable and ergonomically sound chair that can fit the large number of sensors needed for accurate tracking. Research is also needed to determine the kind of sensors that should be built into the chair and their optimal positioning. Further analysis is required to find out how to gain meaningful insights from the acquired sensor data.

Marketing for B2B and B2C: The chair's main target group are people that spend most of their working day sitting at a desk. These are employees working in the classic office setting or currently in the home office. Thus, the chair is marketed both to businesses looking to maximize their employees' health and productivity and well-being and to consumers looking to stay healthy while spending the majority of their day sitting in front of a screen.

Development of the app accompanying the chair: The chair and its sensors are only one part of the solution. To act on the data gathered by the sensors, Spyne offers an application that displays posture and spine health information and recommends personalized therapies and workouts based on the individuals' sitting habits.



Key Resources

Patents for posture recognition and analysis: Recognizing posture and analyzing that data to the degree of accuracy Spyne does, is only possible with state-of-the-art sensor technology combined with a unique chair design. Protecting from competitors profiting from the research and development of this novel technology requires patenting it.

Sensor expertise for accurate detection: Talents that are experts in working with sensor creation and sensor data are needed to produce the custom textile sensors and design them in a way that allows meaningful, accurate posture and spine tracking. Knowledge to make the low power circuitry in order to reduce charging time and energy consumption is also paramount in the chair's design process.

Relationships with manufacturers: The novel construction of a chair with sensors requires close cooperation with sensor, textile, and chair manufacturers to execute Spyne's vision. Fitting the chair with the batteries needed for its smart functionality is another aspect that requires cooperation to assure safety and functionality.

Ergonomics knowledge for designing the chair: Even without its sensors and the accompanying application, Spyne is ahead of its competitors in terms of the ergonomic design of the chair. This requires deep knowledge of ergonomics, human biology, and design principles, which makes it a key resource in the development of Spyne.

Partnerships with smart home companies: Connecting a chair to the smart home has never been done before. Thus, partnerships with smart home companies are needed to assess use cases and cooperate on building the best integrations in a manner that is as seamless as possible. Furthermore, new devices could be built once Spyne enables insight into a user's spinal health, like workout devices or more ergonomic, intelligent mattresses.



Key Partners

Chair and sensor manufacturers: To build sensor-fitted chairs, partnerships with manufacturers for chairs and sensors are necessary. The chairs are designed to achieve perfect ergonomics for the human spine. Thus, it is essential to coordinate its construction from end-to-end: from the materials used to their seamless assembly. As the chairs are unprecedented, sensor-fitted models, the sophisticated sensor designs need to be fabricated in cooperation with expert manufacturers. This partnership enables the electronic textile sensors to fit perfectly into the chair design and makes them invisible to the user. The chair's manufacturing cycle needs to be perfectly coordinated to avoid incompatibilities and allow a smooth process.

Ergonomics researchers and experts: Adequately addressing customer's back pains and suggesting therapy options requires detailed scientific knowledge of ergonomics and the human body. Partnering with ergonomics researchers and experts enables Spyne to design chairs that are built like an extension of the body: invisible in use, perfect in comfort. What distinguishes Spyne from existing ergonomic chairs is its connection to the user. Researchers and experts help in designing sensors that accurately detect 11 different sitting postures and derive recommendations and insights on posture and back health. A thorough analysis of the user's posture allows personalized therapy.

Smart Home Ecosystems: Spyne is connected to existing smart home ecosystems and their devices. That is how Spyne gets a more holistic view of its user's health and activity patterns and enables interactions that fit their work pattern. Sitting down could set up focused lighting and music, standing could open windows. If users are continuously stuck in one postural pattern, Spyne reminds them to train their back using intelligent workout devices. Intelligent mattresses connecting to Spyne allow insights into sleeping posture and a holistic view of an individual's spinal health.



Revenue Streams

Spyne offers a hybrid business model which combines the one-time purchase of a chair and Spyne Pro subscription services with additional features provided by the well-trained recommendation system.

One-time sales: Purchasing at a relatively small fixed price enables customers to enjoy high-quality ergonomic chairs without paying a large up-front sum for all the available features, instead covering additional features in a subscription. In addition to a chair, customers have access to the application with basic posture analytics, which tracks daily activity and sitting habits through sensors embedded in a chair. From the operational perspective, the one-time sales model benefits Spyne at keeping higher production levels in partners' manufacturing units due to affordable prices and consequently higher demand on the market niche.

Subscription service: Spyne Pro is a subscription model for customers who want to extend the app's basic features and get individual workout plans. The subscription complements a standard one-time purchase solution with a personalized recommendation system that analyzes both static and dynamic posture over time. Based on the sitting habits of its customers, Spyne Pro detects how poor sitting habits disproportionately affect muscle groups and recommends personalized exercises for targeting weak or overly active areas. Spyne Pro can help enhance the benefit of physical therapy for workers who struggle with poor body awareness by enabling them to break out of unhealthy postural patterns.



Cost Structure

Initial investments: Setting up Spyne requires an initial expense to develop a chair prototype and build the software. To reduce risk and costs associated with production at the initial stage, we will partner up with an existing chair manufacturer who is already experienced in cost-efficient procurement of raw materials. Since the principal added value of a chair is posture tracking and analysis, Spyne involves experts in ergonomics and sensor technology to create a prototype and a final product. Therefore, especially in the beginning, a dedicated research budget will be required to differentiate Spyne from existing ergonomic chairs on the market. A part of the initial budget is allocated to establishing partnerships with leasing and coworking space providers to facilitate first-time sales.

Fixed costs: Spyne bears costs that occur regularly and do not depend on the level of production. Fixed costs include research and development for improving Spyne's ergonomics and recommendation system. Continuous durability testing is a further fixed cost to consider. Another share of fixed costs comes from the remuneration of employees, including administration, marketing, and sales employees, user

support, and engineers. Additional expenses are arising from operational activities, maintenance of the IT infrastructure, renting warehouses and offices.

Variable costs: Spyne bears costs that are dependent on time and the level of activities. These costs are related to the manufacturing process, including raw materials for the production of chairs and sensors. Another fraction of costs is associated with marketing and sales activities for promoting Spyne chairs on the market, impact lead, and revenue generation. Lastly, financial costs are arising when it comes to delivering chairs to the end customer.



Eco-Social Costs

Chair materials: The polymers used in conventional chairs can have a negative impact on the environment, and textiles are often sourced from animal farming and produced under poor working conditions. Spyne guarantees the use of 100% recycled polymers and sustainable, vegan materials made under fair working conditions.

GHG emissions during manufacturing and operations: Manufacturing processes commonly produce GHG emissions in plants and by transportations of materials to and from them. Spyne cooperates with carbon-neutral manufacturing businesses where possible. If it is not possible Spyne offsets the emissions to be carbon neutral.

Logistics and delivery: As mentioned above, Spyne tries to work with carbon-neutral partners where possible and offsets all other emissions.

Old chair disposal: After a chair has been used, it needs to be disposed of, creating plastic, electronics, and fabric waste that cannot immediately decompose.



Eco-Social Benefits

Improved health and less strain on the healthcare system: Poor posture during prolonged sitting times leads to various back, spine, and cardiovascular-related health problems later in an individual's life. With the increasing pace of automation, more and more jobs are sedentary and require sitting for prolonged times. With its science-based approach, Spyne effectively improves an individual's posture and cares for their back and spine health. That is how Spyne reduces the impact

SPYNE

on their health and the healthcare system as a whole.

High-quality chairs have a longer lifetime: spyne chairs have a longer lifetime than the average office chairs, given by the exceptional manufacturing quality. Once a chair is not usable anymore, Spyne offers to recycle it and gives a discount for future purchases. Discounts incentivize customers to give back their chairs for recycling instead of just disposing them.

Scenario Fit

On-demand convenience: In this scenario, Spyne does not provide the one-time sale business model anymore. Instead, households and businesses have the opportunity to rent the chair and pay for using it on a per-month basis. There are at least two absolute advantages of this model. First of all, Spyne provides its customers with care service, thus preventing chairs from a high level of depreciation. Besides, the rental model reduces large upfront costs for individuals and companies, therefore increases the total addressable market for Spyne. In this scenario, the Spyne chair is also connected to the ecosystem of interconnected home appliances produced by different brands. This will enable other appliances to leverage the data collected data including stress levels and daily activity.

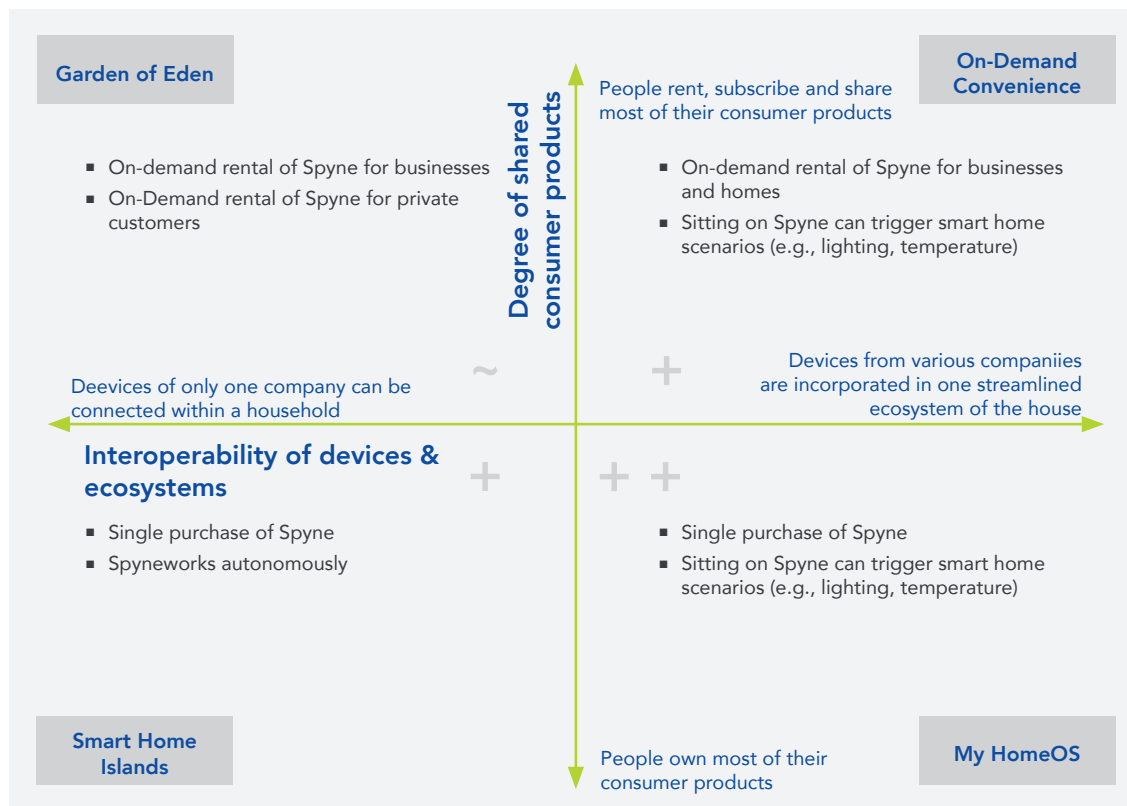
Garden of Eden: In this scenario, Spyne also provides customers with renting or sharing opportunities. Depending on the type of space, private or public, individuals decide on whether they rent a Spyne chair for their personal use, or they share it in a co-working space with others. This scenario also implies the connectivity of devices within one brand. Spyne works on developing new products that will be synchronized with a chair. This includes a smart armchair, a sofa, and a bed that would allow a customer to continuously improve his or her posture, reduce stress levels, and increase activity even more. Spyne Pro options will be extended as well. Now that the data collected from other furniture items, a subscription plan has more information to leverage and provide its users with higher accuracy and advanced recommendations regarding their posture and health improvement.

Smart home islands: In this scenario, Spyne is a standalone research-powered solution that is not connected to the smart home items produced by other brands. This implies fewer features related to the overall well-being environment at home, yet a more precise focus on poor posture improvement and subsequent benefits for health. Spyne makes it possible with the help of advanced sensors that collect data and software that

analyses such data to provide haptic feedback and, in a Spyne Pro version, data-driven exercise recommendations. This scenario restricts Spyne revenue streams to one-time sales only. In such a case, there are two Spyne purchase options: a basic model with a chair, an app and the Spyne Pro model with lifelong access to exercises from leading experts in physiotherapy. Spyne also sells its sensor solutions to other furniture manufacturers. This allows them to modify and improve other items Spyne does not focus on, including armchairs and sofas.

My homeOS: In this scenario, Spyne gained a strong brand reputation and became an attractive option for owning it for long-term exploitation. This is due to the high quality

of materials resistant to depreciation and a well-known personalized recommendation system for exercises called Spyne Pro. When purchasing Spyne, customers think about 7 to 10 years. That means whenever they decide to move to another residence, they take the chair with them. One striking feature of the Spyne chair is that it connects to other smart home items. Spyne seamlessly synchronizes data with sensors and switches responsible for temperature, light, and noise cancellation. Together with other devices, Spyne not only helps customers to improve a poor posture but also creates a productive and creative environment. Spyne Pro version takes care of exercises requiring additional items, including foam rollers, balls, timers, and walls.



Challenges

- In this market niche, there are high entry barriers due to the substantial cost of initial research & development and the need for competent experts in ergonomics, health-care, and technology.
- For outsourced production, partnering up with existing manufacturers can be challenging.
- The problem of a cold start is to collect data for the recommendation system Spyne Pro and to create a collection of exercises to alleviate back pain.
- Customer retention for the Spyne Pro subscription can be a problem due to posture improvement in the long run.
- Posture improvements and therefore benefits for overall health as a result of exercises are difficult to prove to customers

Outlook

The Spyne office chair is just the start of a great line-up of smart chair technology. After successfully entering the market, Spyne plans to extend its product line-up to include all kinds of seating furniture equipped with smart sensor technology. In the long term, Spyne will integrate sensors into all of its fabric-based products, including mattresses for advanced sleep tracking, sofas, and lounge chairs.

With the growing amount of tracked data, Spyne will understand human posture profoundly and design the next generation of smart chairs. Spyne's vision is that wherever customers sit, it can help them to sit healthier and more comfortably.

Furthermore, Spyne plans to expand the functionalities of our Spyne companion app. Spyne wants to become the trusted assistant for all questions regarding back health, stress management, and meditation. Spyne plans to build partnerships with leading workout course providers to improve back health sustainably.

Lastly, with furniture becoming more interconnected, Spyne wants to focus on building meaningful use cases in interaction with Spyne in the context of a smart home. This may include automatic adjustments to the customers' environment, like setting their smart table to the right height or adjusting lights, temperature, or airflow.



TRASHLY.AI

We Empower You to Your Way to Sustainability!

Environmental pollution is one of the biggest problems on this planet. In the EU, only 32% [372] of trash is currently recycled. Waste that could be recycled is dumped in landfills, and resources that could potentially be re-used are thus wasted. Additionally, this waste often ends up in the ecosystem, affecting wildlife and plants and negatively impacts many people's lives. At the same time, trash separation is often confusing and inconvenient and one of the reasons why much trash is not being disposed of correctly.

Trashly.ai offers a solution to these problems. Trashly is an intelligent trash bin that sorts the waste automatically. Thus, the user does not have to worry about the correct disposal. In addition, the trash is compressed regularly so that the garbage bag has to be replaced less frequently. Sensors detect the garbage volume of the trash bin, and Trashly seals the

trash bag automatically once it is full so that the user can easily carry it out. Trashly is also connected with an app that helps the user become more aware of their environmental footprint. Users can connect with their friends over the app and collaborate to produce as little trash as possible. Another option shows charting trends that help the user to keep track of their current garbage volume and compares it to the optimal one. Premium users enjoy the advantage of getting even more individualized recommendations on how to contribute to waste reduction and additional perks such as an automatic trash bag subscription.

Trashly enables everyone to separate waste properly and thus increases the percentage of recyclable waste. Less waste will therefore end up in landfills, a big step towards protecting the environment. Through personal tips, trash separation

and reduction are no longer a matter of confusion but enable effortless trash separation and empower you on your way to sustainability.





Key Partners

- BSH as a key partner to gain industry expertise and capital
- Chip manufacturers and database providers for technological development
- Public administration to foster sustainable waste management along the trash life-cycle
- Sustainability focused companies and climate influencers for marketing and app content



Key Resources

- Training data for ML model
- Data science and engineering team
- Engaged customer base



Key Activities

- Development of hardware and software
- Establishing partnerships with home appliance, marketing, and sales companies
- Analyzing customer interactions and further development of the product



Value Proposition

- Making trash separation convenient and easy
- Motivating the user to lower trash production
- Increasing the amount of trash separated
- Raising awareness concerning trash in the household



Customer Relationships

- Cohesive native app, supporting customer service and communication activities
- Call center in the EU for smooth customer interaction



Customer Segments

- High willingness to pay for smart trash cans and individual sustainability services
- Three sub-target groups:
 - Middle-aged career people focusing on convenience
 - Young professionals focusing on making their lifestyle more sustainable
 - Parents looking for sustainability assistance and convenience



Channels

Online

- Social media platforms
- E-Commerce platforms

Offline

- High and mid-quality furniture retailers and builders
- Advertising partnerships with environmental organizations and movements
- Referral programs



Cost Structure

Initial Investment Costs

- Patents
- Production infrastructure
- Technical infrastructure

Fixed Costs

- Talent
- Production
- Research & development

Variable Costs

- Material costs
- Customer acquisition
- Cloud infrastructure



Revenue Streams

- Trash bin and basic app functionality is directly sold for 199 EUR
- Additional features are offered under a premium plan for 30 EUR a year



Eco-Social Costs

- Transportation of trash bin
- Use of trash bin requires extra resources such as electricity
- Effects of working conditions on workers
- Data processing poses potential security risk
- Potential stress increases due to more screen time



Eco-Social Benefits

- Proper trash disposal results in less non-recycled trash
- Increased awareness of produced trash leads to less trash disposal overall
- Incentive through app to contribute as a community to waste pollution

Value Proposition

Effortless trash separation: The world now produces more than a billion tons of garbage a year [373]. To avoid a future earth full of trash, the share of recycled garbage must increase. The key to enabling this is trash separation. Nevertheless, separating waste is confusing and inconvenient for many people, which in turn leads to many failing to do so correctly. By automatically sorting garbage, Trashly.ai makes waste separation convenient and easy, decreasing the amount of personal trash that lands in a landfill or gets burned. With convenience as the main focus, Trashly.ai introduces two additional features. First, garbage is automatically compressed after reaching a certain threshold, reducing the frequency of taking the garbage out. After reaching a provided weight threshold, the garbage bag is automatically sealed, and a notification is sent to the customer. This way, Trashly.ai reduces the effort around separating trash and taking it out considerably, enabling every user to reduce the final amount of unrecycled waste.

Sustainability empowerment: Pictures of beaches full of plastic or turtles suffocating with bags are familiar to everyone. Leaving a clean planet to our children is an important focus of society. Trashly.ai empowers its users on their way to sustainability by providing profound insights into the amount of trash that the household produces. With the Trashly.ai app, users can see their garbage production divided into plastic, paper, and residual waste and set goals for the month, aiming to produce less waste. This motivates the reduction of trash and provides awareness on trash creation, enabling the user to make informed decisions about the personal impact of trash. Trashly.ai also offers personalized recommendations to lower the trash footprint of the household. Thanks to this, Trashly.ai empowers every user to be the sustainable person they want to be.

Customer Segments

Trashly's primary target group is sustainability-conscious adults with high disposable incomes. This target group is expected to have an increased willingness to pay for Trashly, as

their annual spending on smart appliances, such as intelligent trash cans and individual sustainability services, is high and still growing. Therefore, there is enormous market potential in addressing this group. The target group consists of three sub-customer segments:

Middle-aged, high-income professionals: This target group is aware of environmental issues and would therefore like to live more sustainably but has difficulties incorporating sustainable actions such as waste separation into their daily lives. This target group is very busy at work and wants to enjoy a high and comfortable standard of living, so they look for sustainable solutions that are convenient and effortless. For this customer segment, the convenient way of separating waste through Trashly is the key value proposition that is emphasized when addressing this group through advertising.

Climate- and environmentally-conscious young professionals: For this group of high-earning young professionals, a sustainable lifestyle is very important. They are already actively integrating sustainable practices into their lives. But not only are they looking for more ways to live more sustainably, but they also want to be able to track their environmental footprint and receive active guidance on how to reduce it. Our tracking app is therefore highly relevant for this target group.

Environmentally responsible parents: This group strives for an environmentally friendly lifestyle and has a good income. They have already integrated some sustainable practices into their lives, such as shopping locally, separating waste, and using sustainable mobility services. However, since this group is very busy with daily tasks such as work and raising children, they look for a more convenient way to pursue these sustainable practices. They would also like to receive support on what they could improve. Therefore, all of Trashly's features are equally well suited for this target group. Additionally, Trashly can assist them in raising their children to be environmentally conscious.

Customer Relationships

Automated services: Streamlining the waste separation process and providing personal recommendations are key values that Trashly.ai provides. To achieve this, ML algorithms that are dependent on user data are needed. Regarding the waste separation automation, cameras capture the trash and process the image via the recognition algorithm to sort it



in the respective bin. To provide the best personal recommendations possible, the active participation of the user is required. This means setting up a user profile and thereby giving consent to accessing the individual data. This allows to visualize the user's waste footprint, generate individualized recommendations, and keep the user via push notifications up to date.

Customer service: For Trashly to be perceived as a premium product, a sophisticated customer service relationship must be established. To do so, the customer can contact the Trashly.ai team in two different ways: for small requests, there is the option of accessing a user-friendly website. It is designed to describe the product, possible problems and also offers a demo version of the app to explain it to everyone in an understandable way. Trashly also provides phone service, complementing the website to ensure optimal customer service. The call center is operated from the EU and offers help for hardware and software-specific problems. In case of more complex issues with the product, a local service partner of Trashly.ai is referred, or a new shipment of the product is arranged.



Channels

Online channels: Based on the digital nature of the product as well as the young and technology affine target group, online channels are the focus of Trashly.ai. A mixture of webshop placement and social media advertising is used to communicate the product. Regarding the former, Trashly.ai relies on our key partners, who have been carefully selected in advance. E-commerce retailers in the household sector and online furniture stores are of particular interest.

Offline channels: To reach out and explain the product to senior customers, offline channels are used. For this purpose, product placements are made in high and medium-quality distributors in the furnishing and kitchen sector. Since one of Trashly's core values is to improve the individual waste footprint, cooperation and promotions with environmental organizations are also being pursued to draw attention to this advantage specifically. Besides, existing customers are also used as a channel and monetarily intensified via referral programs to recommend the product to their friends and relatives.



Key Activities

Trashly.ai sets itself apart from competitors by using innovative hardware and software components, enabling use cases that provide the central value-add for the customer. The goal is to provide a user-friendly system with an excellent customer experience and a smooth service offering.

Hardware and software development: The main focus is on embedding IoT components in conventional trash bin design. Therefore, it is essential to integrate sensors and cameras, which converge in the central computational unit. The sensors are necessary for sealing the bag-sealing and compressing the trash. The cameras are essential to recognize the trash type and sort it accordingly. To provide a nearly error-free result, the development of the algorithm, which enables the sorting process, mainly depends on the quality and quantity of the training and test data. Therefore, the development of the algorithm as well as obtaining the data is a crucial activity.

Formation of strategic partnerships: Trashly is priced as a high-quality product, emphasizing the importance of partners that are perceived in the same way. Therefore, a key activity is to find partners in the home appliance production and sales market that meet our requirements regarding a high-quality brand and a fair and sustainable working environment. Trashly also engages in intensive dialogue with local authorities to optimize the entire trash value chain in terms of recycling efficiency.

Data Analytics: Since innovation and consumer-friendliness are at the core of Trashly.ai, constant product development is another crucial activity to stay competitive. The Team is always looking to improve the product, from a hardware and software perspective, especially regarding use cases and improving existing algorithms.



Key Resources

Training data for machine learning model: One primary function of the Trashly smart garbage can is the trash recognition and sorting algorithm, which is facilitated via an integrated visual scanner. The optical scanner takes a picture of the trash item and identifies the respective material. The underlying ML model is trained based on a comprehensive

trash image database. The access to high-quality and extensive quantity training data might become a relevant entry barrier for potential competitors in the future and is thus a crucial resource. Once Trashly has initiated its market rollout, the recognition model continues to learn from the trash pictures generated by the intelligent trash cans in circulation.

Data science & engineering team: High-quality training data is not the only key component of a successful AI model. Image recognition endeavors in adjacent applications such as the detection of food in smart fridges have shown the importance of a strong team of data scientists. Trashly.ai uses a proprietary trash can structure to accommodate the sorting and compression features, which is novel compared to existing solutions. This innovative design relies on the expertise of an engineering team with vast experience.

Engaged customer base: While most companies appreciate satisfied and engaging consumers, it is the value-driven business model of Trashly.ai, that further increases the relevance of active customers. The Trashly smart can is the first of its kind, offering functionalities that are not comparable to existing "smart trash can" solutions. Thus, convincing innovators and early adopters of the value Trashly.ai delivers is key to ensure fast and effective market adoption. To support this process, Trashly's customer success team ensures a frictionless customer experience.



Key Partners

The formation of strategic partnerships is an integral part of Trashly.ai's development and product placement strategy.

Since product development requires specific technical expertise and could become fairly capital intensive, a strategic development partner is critical. Trashly.ai plans to collaborate with BSH or a comparable industry leader in the smart home appliance industry to gain access to the intellectual and financial resources necessary to develop the product successfully. Once the product is launched, this partnership will be extended to a distribution channel collaboration.

Trashly.ai aspires to be a premium product. To fulfill its desired purpose, the trash can needs to be equipped with advanced sensors and cameras, and the sorting AI algorithm needs to be trained extensively. To offer this high technological quality, partners and suppliers in the field of comput-

er science and IoT development are central. Key partners in this category can supply the needed resources and support Trashly.ai in hardware development, especially regarding the sorting functionalities and developing the AI algorithm.

Trashly.ai's mission is to reduce residual waste and increase the amount of recycled waste. To achieve this, it is not enough to recycle at home, but waste must be separated throughout its life cycle. Therefore, it is important to work with public administrations to promote the continuous separation of waste after collection from households.

Finally, Trashly.ai aims to partner with sustainability-oriented companies and climate influencers to conduct joint marketing campaigns and develop content for the Trashly app. For example, a partnership with a climate offsetting provider is planned to embed a carbon offsetting feature in the app and to develop joint content on how to live more sustainably, which will be used in both the Trashly app and several marketing channels.

Revenue Streams

Direct selling: This revenue stream follows the standard in the industry, selling the intelligent trash can and basic functionality of the app for 199 EUR. This price derives from comparing the average smart trash bin price in the industry and considering the increased value compared to the competition. The sorting functionality combined with the statistics provided by the app is state-of-the-art technology that no other competitor offers. These characteristics build up the premium price that the basic bundle is sold for. Using online channels also lowers the selling price per piece, enabling a margin bigger than the average one in the industry.

Yearly subscription fee: Trashly.ai offers additional features on top of the basic bundle that can be accessed by 30 EUR a year. Personalized recommendations to reduce waste disposal and access to knowledge about garbage pollution and how to avoid it best are the two main features of the premium offering. This premium offering allows Trashly.ai to connect with the customers for an extended period of time after buying the intelligent trash bin, ensuring that customers stay with Trashly.ai as the standard home waste management device. This customer loyalty is the main benefit of the yearly subscription fee, explaining the lower potential price.

Cost Structure

Initial investment costs: Due to the combined hardware and software offering of Trashly, significant initial capital is necessary to allow for the market entry of the smart trash can. Trashly's component and feature constellation are novel in the market of smart garbage cans. Therefore, it is crucial to set up a scalable production and supply chain infrastructure early on. This entails building relationships with reliable providers of micro-controller chips and raw materials, setting up frictionless logistics solutions, as well as constructing suitable facilities for product assembly. The feasibility of Trashly's scanning and analytics features depends on a sound technical infrastructure. This ranges from an initial core engineering team to investments for third-party services needed for product development and delivery.

Fixed costs: Human capital is an essential part of Trashly's success. This is especially true for developing and implementing its innovative hardware and software features. However, a strong team is also necessary to facilitate customer acquisition, retention, and to build up strategic partnerships with relevant stakeholders, such as local public administration. Furthermore, as Trashly.ai is looking to expand into new markets in Europe and beyond, additional investments into production infrastructure will be necessary. As the product offering of Trashly.ai aspires to be at the forefront of innovation, continuing investments in research and development capabilities ensure that it stays ahead of the curve.

Variable costs: While economies of scale are reachable for Trashly's software solutions, its hardware components entail stagnant variable costs for materials and assembly. A self-sorting smart trash can pose a completely new offering in the home appliance market. Multi-channel customer acquisition will be crucial for the success of Trashly.ai. These costs are expected to develop linearly in the first five years of market entry until Trashly.ai has been established as a household name.

Eco-Social Costs

Costs of manufacturing: Compared to an ordinary trash bin, Trashly is equipped with more advanced technology such as cameras and sensors. The production effort of these high-tech products relies on rare resources whose mining and

processing are often harmful not only to humans but also to nature. After production, Trashly needs to be transported to the resellers with transport contributes to further GHG emissions in addition to manufacturing. Once, Trashly is in use, constant power consumption is necessary. Additionally, Trashly's ML algorithm receives its data from a data center using electricity and therefore adding to GHG emissions.

Impact on society: As Trashly is connected with an app, much personal data is collected. This poses the risk of potential security vulnerabilities as well as data leaks. The app's interconnectivity and features make a digital detox more difficult for the user, which could lead to an increased stress level. Furthermore, if Trashly is manufactured abroad, labor and environmental regulations might be lacking.

Eco-Social Benefits

Benefits for the environment and society: One of the most significant advantages that Trashly offers is the automatic sorting of trash. This contributes to a higher percentage of recyclable waste and a lower portion that ends up in landfills. As a result, more resources can be efficiently reused, and a longer life cycle of a package also saves GHG emissions. A higher share in recyclable trash will also ensure that less waste is disposed of in nature. Another great advantage is that Trashly will bring the issue of waste into focus. Combined with Trashly's app, the user's awareness of problematic effects of incorrect waste disposal will increase. The app incentivizes a more sustainable lifestyle by providing individualized recommendations on how to produce less trash. For instance, the app allows you to connect with your friends and collaborate to produce as little trash as possible. Trashly is an excellent opportunity to do something against the waste pollution.

Scenario Fit

Garden of Eden: As products are not owned anymore, the revenue stream would have to be adapted to a subscription-only model. The subscription contains the trash bin and all app features for a fixed yearly price. If the customer does not want the trash bin anymore, they can cancel the subscription. The trash bin is immediately picked up, which after maintenance would be ready to be reused by the next customer that buys a subscription, enabling this way a circular economy. Regarding interoperability, not many changes are necessary to Trashly.ai, as it already has its own system, which fits this scenario perfectly. As interoperability with other brands is not the standard, it does not need to be changed. Trashly.ai strives therefore to become the main app for tracking trash in the market, trying to incorporate as many features as possible.

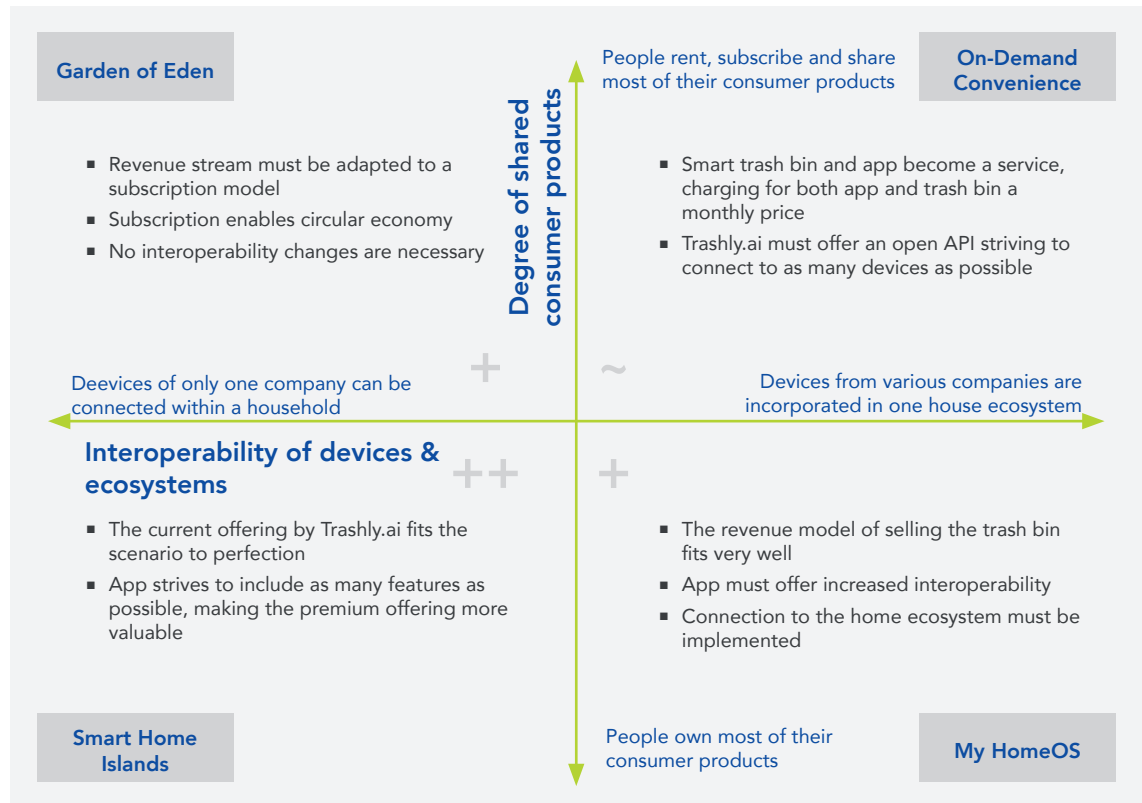
On-Demand Convenience: Trashly.ai makes trash separation convenient, leading to its service being highly appreciated in this scenario. As consumers are looking for on-demand services and experiences, Trashly.ai would need to change the revenue model to only offer the subscription service. This subscription contains the trash bin and all app features for a fixed yearly price. Therefore, the smart trash strives to become a service, renting the usage of the smart trash bin and the insights in the app for a fixed monthly price. The consumer is able to cancel the subscription when the demand is not there anymore. The trash is then picked up, checked for problems, and then sent to the next interested customer. As interoperability is expected, Trashly.ai must ensure maximum integration capability with other apps. Striving to connect to as many different services as possible, Trashly.ai offers an open API, enabling other garbage tracking-related services to connect to the app and provide insights to the user.

Smart Home Islands: The current offering by Trashly.ai fits this scenario very well. The Trashly smart trash bin for private end-users is suitable, as most consumer goods are bought. The trash bin is therefore privately owned by the end-user and used directly in their home. No change to the revenue model is therefore necessary. The system offered by Trashly.ai would not be necessary to be adapted either as interoperability with other brands is not the standard. Trashly.ai would strive to become the leading app for tracking trash in the market, incorporating as many features as possible. The increase of features makes the premium offering increasingly

more valuable to the user, making it likely to increase its price with time.

My HomeOS: The revenue model of selling the trash bin fits this scenario very well, as most consumer goods are sold to the user at a fixed price. Society enjoys owning goods, and adding an intelligent trash bin to the list of things owned is highly appreciated by the user. The app would, on the other hand, require a series of changes. Interoperability must be increased, as consumers are looking for it. First, offering an open API to anyone looking to connect to the service provided by Trashly.ai is a must. Several manufacturers want to use the app to show stats about their own services, making

the app, and with it the premium model, more popular. In this scenario, a holistic home system supports the user in day-to-day tasks. Therefore, connecting to this home system is a must for Trashly.ai to fully empower the user to lower their trash footprint.



Challenges

- Sourcing a comprehensive database of training data, as well as developing an effective AI model for Trashly.ai incorporates several challenges and takes considerable time.
- Incorporating compressions and sealing technologies into the Trashly design means re-engineering the components to reduce their size while maintaining effectiveness.
- Trash cans are still seen as a low-cost utility tool. Trashly.ai aspires to create an entire ecosystem and introduce transparency into the garbage disposal journey. This value needs to be communicated, and a comparatively high price could hamper initial adoption.
- Visually sorting trash items currently only works for a limited number of categories. Trashly differentiates between plastic, paper, and residual waste. Expanding the sorting features for additional categories of trash might require a supplementary sorting mechanism.

Outlook

Trashly.ai rethinks trash separation by making waste sorting effortless and empowering everyone on their path to sustainability. To achieve this, product development will take place in 2021. To ensure a strong product-market fit, great emphasis will be placed on involving potential customers in development by conducting intensive user research and testing.

The product will be launched in the German market in early 2022. During this phase, Trashly.ai will focus on building strong partnerships in marketing and sales, but also public administrations to ensure that trash is not only separated at home with Trashly, but throughout the entire waste life-cycle. After the successful market entry in Germany, Trashly.ai will expand to other European countries with a high awareness of sustainability and high technology adoption, such as Sweden or Norway, to tap into the full European market potential.

However, Trashly.ai is not only a viable product for private households. Companies, schools, and public spaces also generate large quantities of waste that are not properly recycled, representing significant market potential in the B2B sector. Therefore, Trashly.ai plans to launch a product tailored to B2B customers subsequently. This will enable Trashly.ai to promote the recycling of waste in private households and drive waste separation in public spaces, which strongly supports the goal of significantly reducing waste globally.





COOKLINGS

Combining an Engaged Culinary Community with a Simple Voice-Based Recipe Creator

Documenting recipes takes time and effort. As a result, great recipes are often only passed on by conversation and are not written down. Hobby chefs often like interacting with other people about their culinary experience but do not find the time to create recipes and share them online. Sometimes, traditional family recipes can be forgotten due to the lack of documentation. Given that food and dining is an essential part of people's social life, it seems clear that easy recipe creation and recipe sharing may facilitate human relationships with regards to their culinary journey. Cooklings values the importance of sharing recipes and creating meaningful connections through food. While there are various sources for recipes on the internet, they only provide vertical interaction.

Cooklings fills this void by combining easy recipe creation with an engaging community of like-minded people who share a passion for cooking. One can like, comment, and

share recipes from other users on the platform and effectively learn from each other. The community platform serves as a specialized space for all passionate chefs to share their culinary experiences and engage with the world. Furthermore, by being able to explore content from celebrities and other professional content providers, the community incentivizes users to contribute similar quality content. Additionally, restaurants and catering agencies have the opportunity to tap into the community and engage with their customers.

The core competency of Cooklings is a voice-based interface that allows users to easily narrate a recipe they would like to document. Users then instantly receive a well-illustrated recipe card that they can easily share. People can narrate recipes in various different ways: some may list the ingredient first, and some may describe it along with the process. To standardize this unstructured input, Cooklings leverages NLP

and AI to create a structured recipe based on understanding each user's unique style. Cooklings empowers hobby chefs to take their culinary passion one step further towards being a professional with ease.

 **Key Partners**

- Culinary celebrities
- Grocery suppliers
- Travel agencies
- Event organizers

 **Key Resources**

- Intellectual property
- Technical infrastructure

 **Value Proposition**

- Empowering customers to tell their stories
- Seamless, easy, and hassle-free way of creating and documenting recipes
- Formatting and structuring content with little effort (with the option to add augmented pictures)
- Easy integrations to share recipes with friends for meaningful connections
- Natural communication and interface
- Creating recipes in real-time while cooking
- Building a community for recognition and authenticity

 **Customer Segments**

- Hobby chefs
- Fine dining restaurants
- Elderly

 **Customer Relationships**

- B2C Customer Relationships**
- Focus on self-service within the platform
 - Co-creation within the community
 - Focus on self-service for advertisers using the platform
 - Personalized assistance available via key account management

 **Key Activities**

- Product
- Marketing
- Community engagement

 **Revenue Streams**

- Advertising and product placement
- Cooperation with grocery suppliers
- Gamification
- Content monetization
- Premium subscription
- Trend identification

 **Channels**

- Online**
- SEO and targeted advertisement
 - Social media and online marketing
 - Bloggers and influencers
 - App stores (editor's choice)
- Offline**
- Print cooking magazines
 - Event management organizations
 - Restaurants and caterers

 **Cost Structure**

Initial Investment Costs

- Platform development
- Technical equipment

Fixed Costs

- Set-up and maintenance of operational and IT-infrastructure
- Cloud service fees
- Personnel and financing costs
- R&D costs

Variable Costs

- Marketing (online and offline)
- Technology development (maintenance and updates)

 **Eco-Social Costs**

- Energy demand
- Digital dependency
- Organizational use of resources

 **Eco-Social Costs**

- Human connection
- Healthy lifestyle

Cooklings

Value Proposition

Cooklings is the most seamless, easy, and hassle-free way to create and document recipes. Thereby, Cooklings empowers all customers to tell their own stories. To do this, Cooklings employs the most convenient form of communication: speech. Cooklings uses state-of-the-art NLP technology. All one has to do is to record the recipe as if one would talk to friends or family. It also allows users to record the instructions while cooking, so there is no need to sit down and put the recipe into writing afterward. This is especially useful to individualize recipes for one's dietary preferences. Cooklings' smart algorithm will format and structure the recipe automatically. No more jumping textboxes, no more missing ingredients, no more unclear handwriting.

Convenient integrations provided by Cooklings allow recipe creators to easily share their favorite recipes. This fosters meaningful connections as amateur cooks and hobby chefs can interact on the community platform and recreate each other's recipes. Furthermore, premium customers can view a detailed nutrition breakdown, both of macro and micro-nutrients to improve their physical well-being. Moreover, Cooklings will partner with local grocery shops, which will deliver the ingredients right to the doorstep, saving both time and effort spent on grocery shopping. This reduces stress and thus enables Cooklings' users to spend more time on what they enjoy most: being creative in the kitchen.

Customer Segments

Cooklings' content is very specific, but the platform aims for a diverse customer group. Advertisers can reach a highly relevant target group with very little effort.

Hobby chefs: Hobby chefs value quality food and love the full culinary journey - from preparing a dish to enjoying the last bite. They enjoy cooking for themselves as well as for others. A hobby chef likes to invite friends for a dinner party to present the newest creation and spend a fun evening together. It is guaranteed that the guests will ask for the recipe. With Cooklings, the user can easily create recipes that look amazing. The live recording feature ensures an accurate recipe and the opportunity to repeat the culinary adventure. When pursuing cooking as a hobby, being part of a community with like-minded people is fun and inspiring. They ad-

ditionally act as heavy users and accelerate the community growth in their immediate network if they share their recipes via the platform. This supports the long-term vision where everyone who is cooking is addressed with Cooklings.

Fine Dining restaurants: Restaurants will use the platform to engage with the culinary community as well as to promote their creations. Currently, restaurants mainly use social media channels such as Facebook or Instagram to promote themselves. In Cooklings, they find an audience that appreciates quality food content that might turn into paying customers. Restaurants may hide recipe details and add a new revenue stream by selling recipes. Additionally, Cooklings' user activity is a reliable source to identify culinary trends. These insights are especially valuable for restaurant chains and can be provided on a subscription basis.

Elderly: This target group has lifelong cooking experience

and accumulated countless self-created recipes in their memory. Furthermore, they love sharing their culinary expertise and want to preserve the culinary aspect of family traditions. However, many elderly are late adopters of digital technologies. The typical cookbook by grandma or grandpa is written on paper. Now, Cooklings appeals to the elderly by offering an intuitive and easy user interface.

Customer Relationships

B2C: Cooklings' users value that the product enables them to create, share, and seamlessly consume culinary content. A key enabler for this is an intuitive user experience incorporating standardized workflows that users are accustomed to from other applications in the market. To have relevant content for individual users, Cooklings relies on its users to provide engaging content. Trust in the Cooklings product,



Cooklings

and a positive impact of product usage are the basis for an engaged community which is additionally enhanced by elements of gamification. With increasing content and user data, the user experience can be further personalized through improving adjustments with regards to the displayed content and product features.

B2B: Cooklings' partners value a highly engaged community sharing a common passion for culinary topics. An intuitive, scalable self-service web-shop is the basis for customer relationships with B2B partners. This set-up additionally provides automated services with regards to measurement and analytics capabilities of advertising campaigns to allow for strategic steering and optimization. This provides significant value to B2B partners. Major partners exceeding a set amount in advertising spent will furthermore benefit from individual key account managers who support and drive their activities through personalized assistance. Partners below the mentioned threshold in advertising spending will have an option to contact a shared pool of account managers in case assistance is needed.

Channels

Online: To reach customers, Cooklings utilizes both online and offline channels. The efforts for online marketing are focused on traditional marketing strategies such as SEO and targeted advertisement on social media networks. Through SEO, the Cooklings platform will gain traction by appearing at the top of specific web searches (e.g., recipes or culinary communities). Furthermore, Cooklings seeks out key opinion leaders like influencers and popular blogs to spread the message about its product and review it. The third pillar of Cooklings' online marketing activities relates to app stores. Through a superior user experience and innovative app design, Cooklings aims to be featured in the curated section of app stores. Once customers are on board, newsletters will keep them up to date with relevant information. The community itself offers an additional touchpoint and fosters active user engagement.

Offline: Offline, Cooklings is present in printed cooking magazines to appeal to a different demographic. It is also present at cooking conferences and meet-ups to present the platform to relevant stakeholders in the culinary industry. A referral system incentives word of mouth and referring novel customers to Cooklings. For restaurants and event organiz-

ers, Cooklings offers an innovative way to engage with customers in a meaningful way and provide them with additional information. Caterers present the cross-section of the aforementioned and also benefit from the reach and connections on the Cooklings platform.

Key Activities

B2C platform that aims to attract consumers through its free basic plan and provides exclusive features for premium users. Initially, Cooklings needs to gain popularity and reach a critical mass of active users. To do so, Cooklings will implement both online and offline marketing strategies.

Product: Cooklings values the culinary experience of each user as they navigate through the application. To reflect this, Cooklings focuses on building a high-quality product. The speech-to-recipe technology utilizes state-of-the-art NLP. Using speech as the most convenient form of communication to create and document recipes is the competitive advantage of Cooklings over existing cooking platforms. A robust implementation of this technology builds the foundation of the community platform that Cooklings offers.

Community engagement: In addition to providing an easy tool to create recipes, Cooklings values the importance of sharing recipes with the entire Cooklings community. An editorial team is set up to keep up the core values of Cooklings to enable a safe space for everyone to share freely. This team is in charge of the curation of content, providing customer support, and removing all malicious content from the community. To strengthen the bond within the community, Cooklings also plans to offer interested users scheduled meet-ups where they can share their common interests and passion for cooking.

Key Resources

Human resources: The core pillar of Cooklings is the user base which brings it to life by creating, documenting, and sharing within the app. Without the community, there would not be a product. As a result, taking care of the people who enable the business is at the very center of what Cooklings does. Cooklings loves its users and empowers them to tell their own stories. Furthermore, Cooklings encourages users



Cooklings

to upload and share recipes that have an emotional value to them.

Serving the customers is facilitated by the interdisciplinary team behind the product. The developers, the sales team, the user experience designers, and many more work tirelessly to create the best product possible.

Intellectual property: A key element of the platform is an intuitive voice interface, which enables users to easily create structured recipes from an unstructured dialogue. This interface plays a crucial role in the user experience, mainly bringing new users onto the platform. This is why Cooklings is in need of professionals in the field of NLP. To provide a valuable digital assistant in the kitchen, which goes beyond a simple dictation feature, Cooklings must utilize the latest ML technology. Within the domain of information retrieval and speech recognition, experts must be leveraged to scale the business successfully.

Technical infrastructure: From a technical standpoint, reliable and secure cloud infrastructure is needed to host the Cooklings platform. Data aggregation with privacy at its center must be realized to win the trust of consumers. This data forms the foundation to power the speech-to-recipe algorithm.



Key Partners

Culinary celebrities: Culinary celebrities such as famous chefs and food bloggers act as brand ambassadors for Cooklings. They attract large audiences, which are potential users for Cooklings. During the launch of Cooklings, partnerships with culinary celebrities are used for marketing the novel platform and onboarding users. In later stages, Cooklings aims to be the standard platform for bloggers to entertain a wide audience with original ideas.

Grocery suppliers: Cooklings offers its users to place a recipe's ingredients list directly into a grocery supplier's virtual shopping cart. The grocery order can be completed within the Cooklings app. Users benefit from a seamless shopping experience as well as recommended grocery items. Cooklings aims for partnerships with grocery suppliers where Cooklings receives a commission for every completed order.

Travel agencies: Cooklings partners with travel agencies for

the culinary travel feature. Within this feature, users discover international recipes from every country in the world. Users can travel virtually by cooking a local dish and marking the visited country on a map. Travel agencies can leverage the platform's content to create a virtual experience of traveling in pandemic times. Furthermore, travel agencies may place advertisements for offline traveling.

Event organizer: Event organizers and catering agencies can tap into the Cooklings community to engage with the event attendees. Often people enjoy a certain dish at an event but are unable to learn more about it because of the lack of communication between them and the organizers. The community platform on Cooklings fills this void and allows conversations around food to continue beyond the event itself.



Revenue Streams

Premium subscription: Cooklings is a B2C platform that works under a freemium model. To this end, Cooklings provides high-quality services for free to build a customer base. The basic subscription plan is free to all users with unlimited access to the speech-to-recipe technology and the community but limits the number of recipes that can be saved. A key source of revenue in the basic plan is advertising through product placement and strategic partnerships with grocery suppliers. A premium subscription plan generates additional revenue by providing exclusive features for the users.

Advertising and product placement: Cooklings has a user base with a specific interest: cooking and food. Strategic partners from the culinary world can utilize the Cooklings community to promote their products. Targeted advertisement serves as one revenue stream to finance Cooklings and increase brand awareness.

Cooperation with grocery suppliers: Cooklings will cooperate with grocery suppliers to offer users the benefit of receiving all the necessary ingredients for a recipe directly through the app. This opens up another revenue stream by adding a commission on the orders made via the app.

Content monetization: Celebrity chefs and fine dining restaurants can choose to offer exclusive behind-the-scenes material such as recipes, tutorials, and discussion boards. This content can only be accessed with a pay-per-use pricing model. Cooklings charges a commission on transactions.

Trend identification: Cooklings can run advanced data analytics with a vast customer base. The user activity serves as a reliable indicator for culinary trends. Providing these insights for restaurant chains and grocery producers allows for additional revenue.

Gamification: Users can receive badges for streaks and unlock special content by sharing posts regularly. These gamification techniques increase user engagement. Users can also buy in-app currency to recover broken streaks. This offers an additional revenue opportunity for Cooklings.



Cost Structure

Initial Investments: Initially, to launch Cooklings, the main efforts will go into the development of the platform, requiring both human capital and technical equipment. As Cooklings is based on state-of-the-art technology, specialists in the field of NLP and qualified software engineers are required to develop the platform, ensuring the best possible experience for the customers. The main cost driver will thus be the salaries.

Fixed Costs: Cooklings bears costs that are independent of the number of customers. This mainly includes continuous research and development to refine the technology. Moreover, overhead costs, such as renting office space and work equipment, have to be covered. Another source of incurring costs is Cooklings' use of cloud-hosting services to run and maintain its IT infrastructure. Furthermore, Cooklings needs to provide excellent customer service and thus requires staff in the field of customer support, marketing as well as administration. Lastly, financing costs will stem from the initial investments.

Variable Costs: A major share of the variable costs are marketing costs - both in online and offline channels - to reach as many passionate cooks as possible. Major online channels are social media ads and influencer marketing on social networks. Offline channels consist of cooking magazines. As a software solution, Cooklings relies on little variable costs, allowing for an easily scalable product. Eventually, once Cooklings has built a reputation, word of mouth from satisfied users will become an essential source of marketing and user generation which will lower marketing costs even further.

Cooklings

💰 Eco-Social Costs

Energy demand: Since Cooklings is a pure software product, its overall resource consumption is low. However, Cooklings' unique speech-to-recipe technology still requires rather energy-intensive training of ML models. Additionally, the operation of the cloud-based platform and the added processes on the users' devices consume energy.

Digital dependency: The digitalization of former analog tasks comes with great benefits as well as risks. For example, increasing screen time can have negative effects on human physical and mental health. Cooklings aims for high user activity and implements gamification and engaging elements such as like-buttons. This may pose the risk of additional digital dependency.

Organizational use of resources: As with every corporate organization, Cooklings also creates a carbon footprint just by being in business. The operation of the company requires resources such as heating, water, and electricity. Furthermore, it also creates waste which needs to be dealt with.

🌱 Eco-Social Benefits

Human connections: Food is much more than just a nutritional necessity. It is about creativity, emotions, memories, and connections. Cooklings' users share recipes that matter to them and their loved ones. They interact with other users who share the same passion and create an amazing culinary journey. Cooklings brings people together and fosters meaningful human connections. The platform deepens these connections by encouraging interaction between users while keeping people in the loop about the culinary activities of their social circle. Furthermore, it allows users to expand their culinary horizon.

Healthy lifestyle: Arguably, cooking is healthier than ordering fast food. By lowering the entry barrier and encouraging participation on the platform, Cooklings supports users in their transition to a healthier lifestyle. It educates people about nutrition and their individual needs. This will lead to more cooking at home, and as a consequence, it will make Cooklings' users more proficient at cooking, initiating a virtuous circle. This goes beyond single users and could positively impact offline communities

Scenario Fit

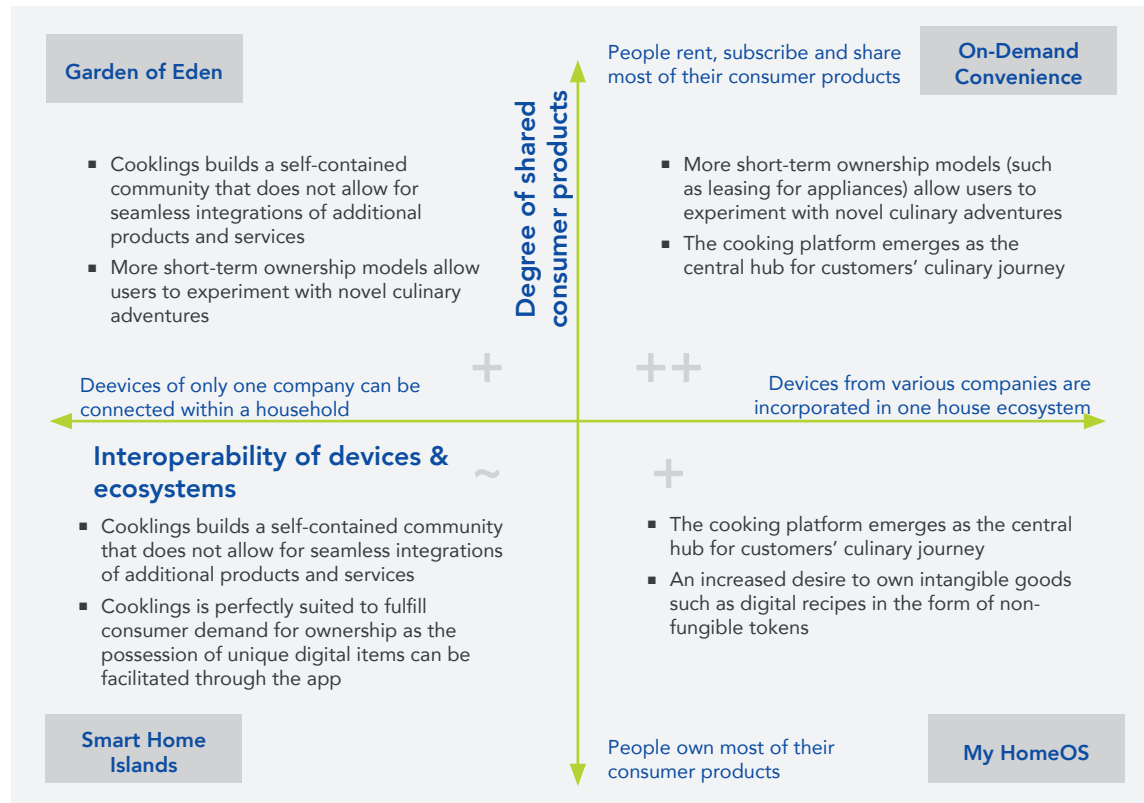
Garden of Eden: In this scenario, consumers exchange products mostly by sharing or subscribing to product-as-a-service platforms. Personal ownership is the exception. While device manufacturers focus on a smooth customer experience within their portfolio, interoperability across players remains scarce.

Cooklings can leverage this by enabling hobbyists and professionals alike to explore beyond their culinary horizon: users benefit from flexible ownership models, resulting in novel culinary adventures. The community can take short-term ownership of highly specialized tools (e.g., a dehydrator for

ingredient cultivation or a vacuum-sealer for low-temperature long-time cooking). This lowers the entry barrier for exceptional dishes, increasing culinary diversity among the community.

While Cooklings offers everything the community might require in a self-contained fashion, users cannot wander beyond the gates of the garden to experience the integration of additional products and services (such as grocery or other social media).

On-Demand Convenience: In this scenario, the smart devices of various players are seamlessly working together based



on high adoption rates of shared technology standards within the industry. This infrastructure allows Cooklings to vertically integrate with other players, like food delivery providers or appliance rental offerings. These additional integrations will bring significant value to users through a comprehensive customer experience within this rising go-to community platform. At the same time, this constellation improves the margin structure for Cooklings. Cooklings can at the same time leverage upon new approaches to accessing products and services, as personal ownership is the exception. Beneficial flexible ownership models enable novel culinary adventures with accessible equipment, as monetary barriers are relatively low. Furthermore, Cooklings could shift a number of basic features offered into its premium subscription as people are predominantly accustomed to these business models in the on-demand convenience scenario.

Smart Home Islands: The widespread adoption of privately-owned smart devices with a lack of common standards leads to a fragmented environment at home. In this scenario, Cooklings would need to focus on building an engaging community without vertical integration into a wider part of potential value chains related to the culinary space.

Ownership remains a highly relevant way of accessing consumer products, and Cooklings can easily adapt to this scenario. Cooklings will incorporate a different set of stimuli as part of advertising campaigns while focusing on attracting users to use the freely accessible community as a central go-to solution with regards to their culinary experience. Advertising will be the key monetization method in this scenario.

My HomeOS: Sharing and subscription-based services turn out to not be economically viable in this scenario. Society chooses to value individuality and ownership of consumer products over flexibility and short-term usage. At the same time, manufacturers specify and agree upon open standards allowing devices from various ecosystems to collaborate in a single, interconnected network.

Cooklings take full advantage of interconnectivity between ecosystems. In addition to the core features of the culinary community, users can seamlessly integrate further services, such as instant grocery delivery or producing analog books from their digital recipe collection. Here, Cooklings serves as the central hub for culinary experiences allowing users to enjoy a frictionless journey involving multiple stakeholders.

Challenges

- Difficult to gain traction, build a critical mass of users and differentiate from competitors.
- Platforms such as Instagram and Pinterest are heavily used to sharing all kinds of content. Cooklings needs to stand out and must convince users of its many advantages.
- It might be difficult to combine a clean and intuitive user experience with a variety of functionalities.
- It is hard to grow a relevant share of premium users who are willing to pay for additional features.
- Cooklings must provide an inclusive space without any hate speech while keeping a lean workforce.
- The community concept of Cooklings depends on an active community sharing its content. Especially in the early stages incentivizing content creation is a key activity.

Outlook

In the future, Cooklings plans to scale beyond Germany, first rolling out in the EU and eventually worldwide to address passionate chefs all around the world. As Cooklings grows, network effects will attract new users even faster. Word of mouth will become one of the most important channels. With the growing user base, data accumulates, allowing Cooklings to continuously improve the speech-to-recipe algorithm, especially in different languages. Moreover, vast amounts of data will allow Cooklings to tailor inspiration exactly to the customers' use and connect like-minded people even more easily.

Partnerships will be fostered and expanded. Synergy effects with partners will be exploited to add user value as well as to extend revenue streams. One example is a strategic partnership with grocery retailers to provide a seamless end-to-end culinary experience. Cooklings' users can add ingredients from a recipe into a grocery retailer's online shopping cart and complete the order within the Cooklings application.

In the long term, Cooklings aims to become a more comprehensive platform with additional culinary-related verticals. Cooklings will be the main go-to app for culinary experiences. Consequently, many more potential revenue streams will open up.



HELPING HAND

HelpingHand Automates Food Assembly and Distribution

HelpingHand has the long-term vision to offer an autonomous chef for everyone's home.

The team has to consider the technical feasibility of the product as well as its potential customer base. Thus, several expert interviews with professionals and researchers from TU Munich, Aitme, and Franka Emika were conducted. After intensive discussions among the expert partners and team members, HelpingHand had to make a significant decision on the future path of the product. While it is still envisioned to become an autonomous robotic assistant in the kitchen, the current state of robotics and customer demands did not align with a B2C model. The team has identified the current key strength of robotic arms, specifically within food handling and distribution. Those skills are particularly interesting for fast-food restaurants as well as for cafeterias.

The need for robotic assistance such as HelpingHand in the fast-food industry is very urgent. The employee turnover rate of fast-food restaurants is estimated to be about 120% per year, translating to the entire workforce being replaced on average 1.2 times each year. This selection, training, and recruitment of a new workforce comes at an economic cost. A study by the Center of Hospitality at Cornell University indicates a turnover cost per employee of about 5,800 USD [374]. HelpingHand will autonomously take over portions of the work and therefore decrease employee costs and the required personnel to operate a fast-food restaurant.

Based on those findings, HelpingHand is developed to be a stationary kitchen assistant robot for fast-food chains and cafeterias, tackling the pain points of fast-food restaurants. The HelpingHand robot can best leverage its core strengths of food handling behind the food distribution counters of caf-

eterias or in highly standardized kitchens in fast-food restaurants. Since the team acknowledges that kitchens are inherently built differently, the flexibility of the HelpingHand robot allows it to customize according to the customers' needs and products.

The following sections will guide the reader through the value proposition, product description, strategic positioning, and associated costs. This will shed light on how HelpingHand aims to enter the highly attractive and promising market of robotic kitchen assistance.





Key Partners

- Manufacturing partners: supplier of the robotic arm, manufacturer of grippers and extensions
- Sales partners: commercial kitchen/appliances sellers
- Strategic partners: kitchen appliance manufacturers
- After-sales partners: insurance partners, certified support partners



Key Resources

- Materials necessary for robotic development
- Key human resources necessary for research and development
- Intellectual property and research capabilities
- Digital infrastructure



Value Proposition

- Automation of food assembly into meals
- Automation of meal distribution to end consumers
- Pre-built modular use-cases including a suiting software and the corresponding gripper hardware
- Easy-to-use workflow builder for highly adaptable and personalized automation
- Holistic Solution Provider: installation, personalization, maintenance, upgrade, and disposal of the robotic arm



Customer Segments

- Fast-food restaurant kitchens have standardized processes which enable them to integrate HelpingHand.
- Food distribution counters in cafeterias have highly standardized processes, which allows them to integrate HelpingHand
- Global fast-food chains offer more possibilities to scale quickly, and corporate cafeterias are easier to target as first customers



Customer Relationships

- Longevity due to high quality, immediate customers support if problems occur, and long-term software updates
- Provision of installment assistance and educational material
- Customization according to customer's needs and sales of add-on products



Key Activities

- Design and production of robotic arm add-on hardware components
- Design and production of external hardware complementary products
- Development of use case



Revenue Streams

- Monthly subscription fee of 1,000 EUR
- Add-ons: specialized grippers and appliances
- Custom software: individualized solutions according to customer's



Channels

- Direct outreach to restaurant chains and cafeterias
- Trade shows
- Wholesalers and commercial kitchen dealers



Cost Structure

Initial Investment Costs

- Research & development of hardware (robotic arm, grippers) and software (platform)
- Launch costs

Fixed Costs

- Salaries
- Office rent and equipment
- Energy and water
- Marketing
- R&D

Variable Costs

- Development of custom software
- Additional service sales costs
- Hardware costs (supplier, production)



Eco-Social Costs

- Energy consumption of appliance production, supply, and usage
- Materials of hardware
- Potential replacement of human workers



Eco-Social Benefits

- Recycling and disposal of products
- Reduction of health risks of workers
- User-friendliness of product and provision of support
- Transparency about activities and co-determination

 Value Proposition

HelpingHand allows novel, reliable automation of sub-tasks in the food creation and distribution chain for various restaurants and fast-food companies. It enables entirely new business cases such as fully autonomous food stands. HelpingHand's robotic arm takes care of taking orders, combining pre-cooked ingredients to meals (e.g., sandwiches, salads, poke bowls, etc.), and handing out the meals to consumers.

Specifically, HelpingHand sources the robotic arm from external suppliers, such as Franka Emika - one of the leading companies in advanced robotics. HelpingHand then focuses on adding an entirely new software stack and a collection of different purpose-built grippers. To quickly achieve a broad market penetration among its business customers, HelpingHand focuses on two key goals: use-case specialization and high adaptability.

Firstly, HelpingHand focuses on providing human-level performance in a small array of impactful tasks in the domain of food assembly (e.g., creating a wrap out of pre-cooked food). Secondly, it focuses on meal distribution to end-consumers (e.g., taking orders, handing out meals). Finally, cooking is a highly individual process that depends mainly on the environment and the meal to be cooked. That is why HelpingHand focuses on building robust and compatible workflow components (Computer Vision, Control, Gripper), as well as best-in-class tools for Human-Machine-Interaction (e.g., a motion recording). The user can leverage these to very easily incorporate the robot into existing or new workflows.

Lastly, due to the technical and financial entry barriers to the usage of autonomous, robotic cooking aids, HelpingHand believes in providing a holistic service solution to its customers (more on the sales model in the "Revenue Stream" section). This solution begins with free-of-charge consulting and educational resources (whitepaper and workshops) to educate its customers on the benefits and pitfalls of using a robotic kitchen aid. Once a personalized plan has been co-created, the installation, maintenance, and support until the final disposal are centrally coordinated and monitored by HelpingHand. That leaves the customer with a single point of contact.

 Customer Segments

HelpingHand aims to become an integrated assistant in a wide range of private households in the long run. The team consulted with several industry experts, a lead engineer of a robotic startup, and a researcher at TU Munich. Their insights led to the decision that due to the current status of robotics technology and potential use cases, market entry through the B2B market segment is the most promising strategy. Due to its key strengths outlined in the Value Proposition section, the HelpingHand is particularly interesting for restaurants that deal with prefabricated or pre-cooked food.

Here, two industries are attractive for HelpingHand to target as primary customer groups. Fast-food burger and sandwich chain kitchens are characterized by standardized food-handling and customization tasks and represent an attractive customer base. Taking Subway as a prime example, one can observe that sandwiches are assembled in a pre-defined manner. Most ingredients are pre-cooked or processed. HelpingHand could here help to efficiently make the Subway sandwich and consider specific individual customer wishes. Targeting fast-food chains such as Subway also offers great potential for scaling. Once HelpingHand has proven to be effective, the concept could be expanded to many more franchise stores. The difficulty in convincing potential customers without a proven solution could be the most significant barrier to winning those global fast-food chains as first customers.

School and work cafeterias could be an attractive alternative first customer group. While the focus here also lies in handling and customizing pre-cooked food, those customers might be more realistic to convince without prominent references. A HelpingHand could not only be a very efficient cooking assistant, but it might also strengthen the public company image as well as attract students or employees.

 Customer Relationships

HelpingHand can be considered a high-end product for fast-food chains as well as cafeterias. Therefore, maintaining strong customer relationships and offering extraordinary customer support can be crucial factors for success. Specifically, close ties to customers might pay off within the B2B segment by potentially expanding alongside the customer's business or being introduced to potential new customers. Helping-

Hand's customer relationship management approach can be differentiated into two distinct categories.

The first cornerstone of HelpingHand's successful customer relationship management (CRM) is its strong customer support. On the one hand, this refers to continuous availability and service in case a customer experiences issues with his HelpingHand. On the other hand, strong customer management is also reflected in long-lasting hardware and frequent software updates, even for older versions of the robotic arm. This way, the company can ensure that the considerable adjustment of our customers' kitchen and processes to integrate HelpingHand has the chance to amortize over time. Further, the customer's relationship with HelpingHand can be strengthened through additional add-on products that extend the potential use cases of HelpingHand. Once bought, it also intensifies the customer's financial commitment to HelpingHand as its primary kitchen assistant.

Secondly, HelpingHand offers a full setup service included in the subscription of the robot. Also, the company provides individualization and customizations of the HelpingHand for businesses depending on their specific needs and products. The restaurant personnel or homeowners will also be educated on utilizing and controlling the robotic assistant and being provided with extensive educational material.

 Channels

Direct outreach to restaurant chains and cafeterias: HelpingHand's focus in the initial phase will be selling to restaurants and cafeterias. The ideal scenario would be to win a restaurant chain early on. The workflows would only need to be optimized once for several branches. Having HelpingHand installed in many branches would also increase visibility and benefit further sales. To win a restaurant chain, individual outreach and presentation of the HelpingHand solution and its use-cases will be necessary. But before a more prominent restaurant chain is open to deploying HelpingHands, the concept will need to be proven in some smaller cafeterias. To enter the market, HelpingHand will therefore focus on individual cafeterias or smaller restaurants that aim to benefit from the novelty of using a robotic hand for food assembly or distribution.

Trade shows: Trade shows can be another viable channel to reach the customer target group. Trade shows allow the

HelpingHand

demonstration of features and use-cases in a controlled environment and to a large audience. Trade show visitors are looking for novel technical solutions and can be potential early adopters.

Commercial kitchen dealers: HelpingHand will be an integral part of the kitchen it is installed in. The better the kitchen is optimized for the operation of a robotic arm, the more use-cases can be implemented and the higher the performance. At the same time, the purchase of a commercial kitchen is usually connected to high initial investment. At this point, the additional investment for a HelpingHand is less significant. Therefore, HelpingHand needs to partner with commercial kitchen dealers to be part of the early sales pro-

Key Activities

Design and production of robotic arm add-on hardware components: The restaurant industry needs assistance, especially in different food assembly tasks such as putting sandwiches together. To tackle the diverse challenges, HelpingHand comes with interchangeable hands (grippers) that the user can replace depending on the context. One example could be using thin fingers for grabbing bread and thick, firm fingers for grabbing tortillas. The HelpingHand team needs to develop different interchangeable grippers to add value in as many food assembly contexts.

Design and production of external hardware complementary products: HelpingHand needs to interact with different external tools, products, and components that are usually not homogeneous across use cases. These complementary products can be trays, sauce, and condiment dispensers, to name a few. To minimize errors and boost efficiency, the containers of these complementary products will be standardized and designed for HelpingHand. For example, a ketchup jar with a rectangular shape for easier grabbing and a QR code on top for faster recognition. Such a jar would be standardized and refillable so that restaurants can fill it up with their preferred condiment.

Development of use-case dependent software: In the same way a chef's apprentice learns, HelpingHand must learn how to assemble different types of food, and how these are assembled a specific restaurant. The HelpingHand team will program a base software for each food assembly scenario. The software will then be tailored according to the client's

setup and desired specifications. For example, all tacos will need tortillas, vegetables, and seasoning. Still, depending on the restaurant, the amount of each ingredient and the type will vary. HelpingHand will develop software that can assemble tacos. It will be tailored to make tacos the same way each different restaurant desires it.

Key Resources

Materials necessary for robotic development: Robotic arms are currently composed of controllers (chips), mechanical parts (motors), and sensors (cameras). These components are made up of plastics and metals, depending on the abundance of oil and raw metals. Given the current hype for robotic solutions, coupled with the explosion of IoT devices, some of the necessary resources to develop HelpingHand and its add-ons might be scarce.

Key Human resources necessary for R&D: Professionals necessary to make HelpingHand a reality are in high demand. Advanced knowledge of mechanical and electrical engineering as well as mechatronics will be required at all stages of development.

Intellectual property and research capabilities: Key intellectual property such as patents will be necessary to develop HelpingHand effectively. The infrastructure needed (labs) to experiment, build, and test HelpingHand prototypes is of equal importance.

Digital infrastructure: For HelpingHand to deliver value to customers, substantial software development must take place. As mentioned before, the development of use-case-dependent software is one of the essential key activities for HelpingHand. A large amount of software must be developed before HelpingHand can be sold. The HelpingHand software will come with large amounts of customer-dependent customization, constant improvement, and new features. The team aims to eventually open the software to third-party developers by providing an API to create and nurture a thriving developer community.

Key Partners

Manufacturing partners: For the initial product to enter the B2B market, HelpingHand will leverage an existing robotic



HelpingHand

arm from a leading supplier in the field. HelpingHand will focus on designing grippers and utensils optimized for specific food assembly and distribution cases. To produce these hardware extensions, HelpingHand will partner with experienced robotic arm manufacturers.

Sales partners: As HelpingHand's initial customer target groups are restaurants and cafeterias, suppliers of commercial kitchens belong to the key partners. While HelpingHand is highly adaptable to dynamic environments, it can unleash its full potential in a kitchen optimized for the operation of a robotic arm. By partnering with commercial kitchen suppliers, the commercial kitchen can be planned around HelpingHand already at the time of purchase.

Strategic partners: It is conceivable for restaurants to use HelpingHand to operate kitchen appliances. By partnering with kitchen appliance manufacturers, it can be ensured that the appliances are compatible with the arm. Appliances could even feature smart interfaces (e.g., for better integration for the temperature of a stove).

Aftersales partners: User safety is a number one priority for HelpingHand, but due to the nature of the product, the possibility of accidents should not be disregarded. Therefore, HelpingHand will partner with insurance companies to offer affordable insurance against potential accidents with the robotic arm. In addition, HelpingHand will partner with several certified support partners to provide best-in-class customer support and in-place repairs.

Revenue Streams

HelpingHand's business model has different income sources: a subscription fee for hardware and services, add-ons, and custom software.

Customers can lease the robotic arm for a monthly fee of 1,000 EUR and a minimum contract period of 24 months. This price covers hardware costs and includes additional services, such as setup, maintenance, support, and disposal of the product at the end of the contract. This monthly fee is easily comparable to an employee's salary. HelpingHand would not be able to automate all the tasks performed by an employee. However, it can cover multiple shifts without taking any vacations, covering a similar workload as an employ-

ee. Therefore, HelpingHand helps customers to modernize and standardize their business and cut personnel costs.

Optionally, customers can acquire multiple add-ons to complement the robotic arm and broaden the use cases of HelpingHand. For example, specialized grippers for specific tasks or other appliances designed to be operated by HelpingHand. One possible way to add value through such an appliance could be a microwave with a communication system to HelpingHand. It can be operated remotely without wasting energy or time pressing buttons or opening and closing the door. Furthermore, this would help building up an ecosystem around HelpingHand, which would benefit the product and increase switching costs to eventual competitors.

Cost Structure

Initial investment costs: To set up HelpingHand's business, a high initial investment is needed. The most important point to cover is partnerships with robotic arm manufacturers. Once a robotic manipulator is selected, a portion of the budget will go towards developing custom grippers to complement the hardware provided by the suppliers. Software development will also be a major cost driver. The platform needs to be extensible to third-party apps for future developments, which might initially slow down software development.

Fixed costs: Independent of the number of customers, HelpingHand needs to deal with fixed costs. These are derived mainly from employee salaries and financing costs, especially those associated with the initial investment. Besides, office rent and equipment, combined with energy and water consumption, make up a significant part of fixed costs. HelpingHand bears both marketing costs to attract new clients and research and development costs to improve the product.

Variable costs: The development of custom software and eventually complementary products constitute variable costs, as both depend on the customer's needs. Furthermore, there are costs derived from additional services provided by HelpingHand, which are consultation, installation, maintenance, support, and disposal of the hardware. Once a HelpingHand is uninstalled from a kitchen, a part of the hardware can be recycled, creating additional costs. Lastly, the acquisition and production of hardware account for the most significant share of variable costs since HelpingHand uses state-of-the-art and high-quality technology.

Eco-Social Costs

Carbon emission of appliance production, supply and usage: Although HelpingHand's hardware is sourced from an external supplier, the emissions generated during the hardware production cannot be disregarded. The hardware production leads to GHG emissions due to energy consumption, as energy in Germany is largely obtained from fossil fuels. Also, the transport and distribution of HelpingHand increase its ecological footprint. To use the HelpingHand, a continuous connection to an energy source must be ensured. Thus, the use of the HelpingHand also leads to an increase in energy consumption and, consequently, increased emissions.

Materials of hardware: The HelpingHand is a physical product that is made of various resources. The actual problem is related to the motor. Although there are currently various research projects dealing with the recycling of electric motors, there is still no satisfying solution.

Potential replacement of human workers: Initially, the HelpingHand will be used in fast-food restaurants and cafeterias. It might be possible that the use of the HelpingHand will reduce the workforce in the kitchen. However, it should be noted that the HelpingHand performs very specific activities such as food assembly and food distribution. A typical worker, however, pursues far more and diverse activities than these and is more flexible. Moreover, the HelpingHand creates additional jobs in different areas like software development and manufacturing of grippers. Whether the HelpingHand can lead to a replacement is uncertain.

Eco-Social Benefits

Recycling and disposal of products: Our business model, which is based on the assumption that the restaurants lease the HelpingHand for a minimum of two years, ensures that the product can be recycled and disposed of appropriately. Additionally, through our maintenance service, we ensure that the lifespan of the product is extended.

Reduction of health risks of workers: Over 87% of all workers in fast-food restaurants have been injured at least once in the last 12 months [375]. Also, the hourly wage is very low at 1680 EUR per month [376], and the average turnover rate of workers in fast-food restaurants is 120% [374]. Through Help-

ingHand, activities that are potentially threatening to workers can be reduced.

User-friendliness of product and provision of support: Through our seamless end-to-end solution, we offer consulting at the beginning of the HelpingHand usage, as well as an installation, so that the HelpingHand provides optimal support. We also provide maintenance, upgrades, repairs, and disposal. The customer gets the help needed to have an optimal customer experience.

Transparency about activities and co-determination: Transparency about the product and activities is vital to the HelpingHand team and considering the interests of both customers and partners. Therefore, in addition to HelpingHand's customer support, customers have the opportunity to impact HelpingHand's business and product actively. Through feedback, the goal is to improve the product and develop new features constantly. Customers should play an active part in the product development.

Scenario Fit

On-Demand Convenience: In this scenario, a strong societal and economic focus on sharing combined with HelpingHand's high adaptability to cooking workflows allows a swift market adoption. Specifically, the ability to easily create and store highly personalized cooking workflows greatly facilitates the shared usage of HelpingHand and lowers the financial entry barrier. Furthermore, the strong interoperability of diverse smart device ecosystems acts as a multiplier for adaptability and efficient sharing. This interoperability accelerates HelpingHand's vision of establishing a holistic, automated cooking platform in both the B2C and B2B sectors. The planned expansion of use-cases will significantly benefit from the exponential increase in smart devices in modern kitchens with which HelpingHand can communicate to achieve higher levels of robot autonomy and, consequently customer utility.

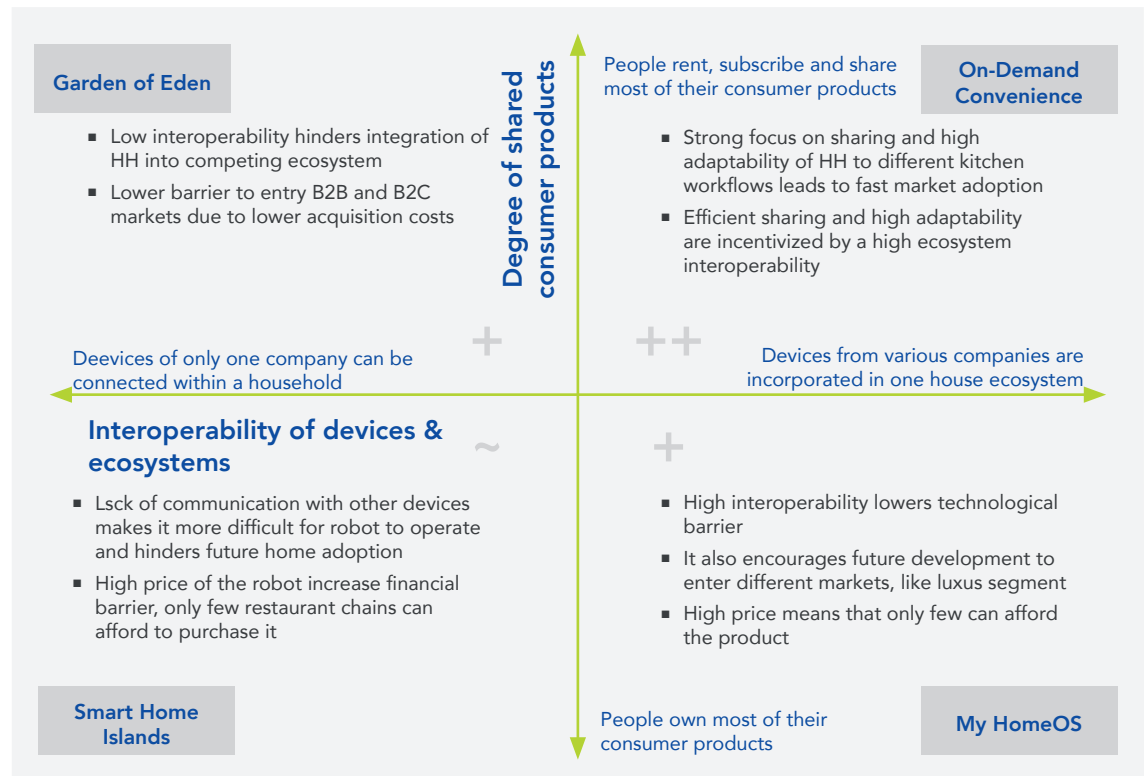
Smart Home Islands: There is almost no interoperability between different ecosystem devices in this scenario, and people choose to own their products. This means that only customers with a strong financial status can afford HelpingHand, which slows down market acceptance. The robot cannot communicate with third-party devices, making it more difficult for it to operate safely outside of familiar environments. With low customer market acceptance and

home kitchens posing such a technological challenge, HelpingHand targets the hotel and restaurant sector. Especially restaurant chains can benefit from HelpingHand's services.

My HomeOS: While there is high interoperability between devices from different brands, people still own their products. Therefore, only the wealthy and businesses can pay for HelpingHand. The ability to communicate with third-party devices enables home adoption of HelpingHand, as it allows it to adapt to individual kitchen settings. Thus, HelpingHand finds its niche in both the luxury and the B2B segments. To guarantee high-quality standards, HelpingHand puts special care to its additional services, such as insurance, installation,

buy-back, or maintenance services..

Garden of Eden: There is low interoperability between ecosystems and low ownership in this scenario, so most people rent or share their products. HelpingHand won't interact with devices from other companies as there are no shared standards across ecosystems. Because devices from different ecosystems cannot communicate with each other, integrating the HelpingHand into a competing ecosystem is limited or not possible at all. It could even lead to a reduced willingness to buy the product. However, the fact that people no longer own the products, but share or rent them, lowers the barrier to market entry for the B2B, but especially for the B2C market, since initial high acquisition costs are avoided.



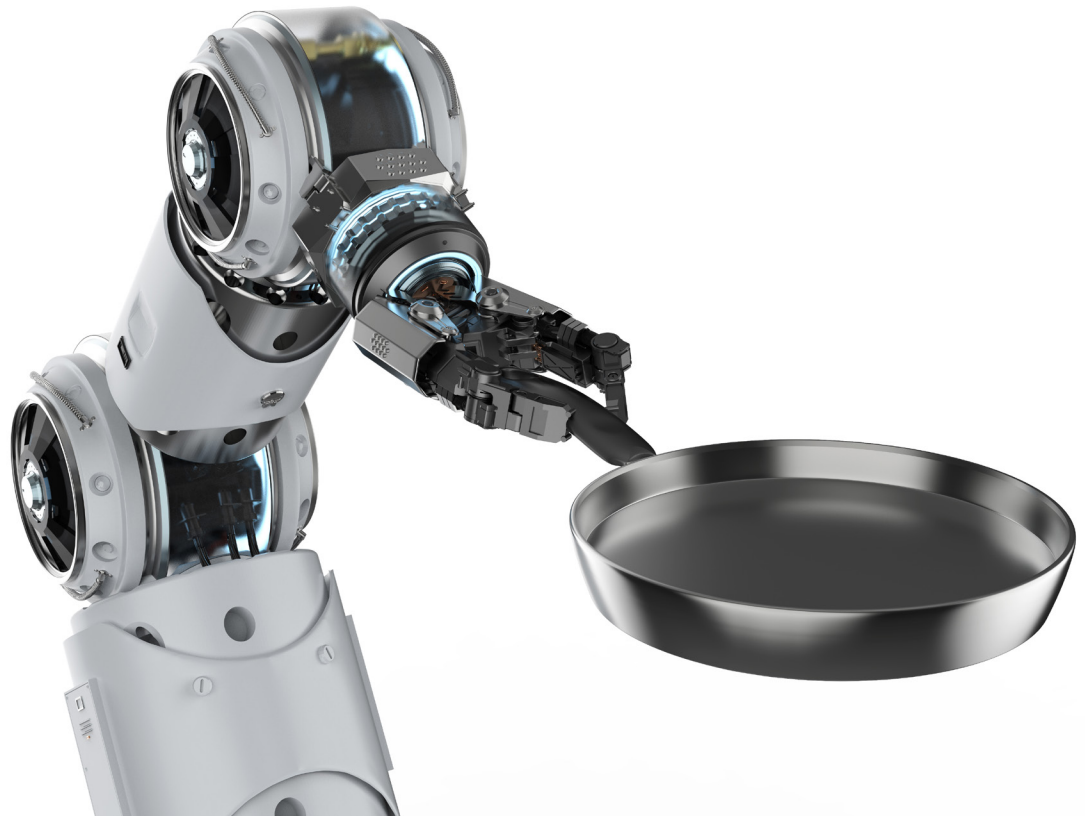
Challenges

- Even though HelpingHand is cheaper than a full-time employee on minimum wage, customers will still need to be convinced that HelpingHand will save money or increase the revenue to offset its costs.
- High costs of robotic arms are preventing entry into the mass consumer market for now.
- Entering the restaurant market will be hard without proof of work in the industry. The more restaurants use HelpingHand, the easier it will become to acquire new customers.
- Fine-grained, highly dynamic tasks (e.g., forming and stretching pizza dough) are much harder for robots than humans.
- More research is required before the goal of a fully autonomous chef can be realized.

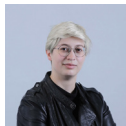
Outlook

In the twelve months after developing HelpingHand, the team will have its first prototype being tested live with rigorous safety requirements. The HelpingHand team will first focus on simple tasks such as food assembly (Subway sandwich). The development of new features and constant improvement will follow. HelpingHand will be open for third-party developers around three years after launch. At the same time, HelpingHand plans to develop a new robotic arm with a focus on affordability.

Within five years, HelpingHand will have a very diverse set of hardware and software programs that will allow it to deliver value in a multitude of scenarios in numerous restaurants. This development will enable HelpingHand to reach regular restaurants as well. At the same time, HelpingHand aims to reduce its base cost by at least 50%. Leveraging the already developed hardware, software, and price drop, HelpingHand will target the consumer market. With more use-cases and cheaper robots, HelpingHand can build a platform model with high modularity leveraging strong partnerships with kitchen appliances companies. HelpingHand's big hairy ambitious goal is to develop a fully autonomous chef for consumers' homes within the next ten years after being launched.



LIST OF CONTRIBUTORS



Ann-Christin Gah
Architecture



Florian Müller
Computer Science



Manuel Cardenas
Computer Science



Pranav Ragupathy
Data Science



Anna-Lena Zelder
Business Administration



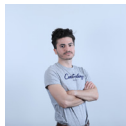
Frederic Martin
Management & Technology



Mariia Grebenshchikova
Management & Technology



Stefan Gerbes
Management & Technology



Berzan Yildiz
Computer Science



Gergana Lishkova
Medicine



Miriam Schmidt
Management & Technology



Tobias Schindler
Computer Science



Daniel Quiroga
Media, Management and Digital Technologies



Jan Krušnik
Information Systems



Nick Stracke
Data Science



Tom Böhnel
Electrical Engineering



Diego Martí Monsó
Electrical Engineering



Justus Maximilian Murke
Management & Technology



Nicolas Remerscheid
Data Engineering and Analytics



Xenia Bunk
Clinical Psychology & Cognitive Neuroscience



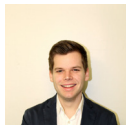
Elvira Yang
Economics



Laura Moll
Computer Science



Niklas Hölterhoff
Information Systems



Felix Rösner
Politics



Malte Wilhelm
Computer Science



Philipp Engel
Management & Technology

BOARD OF DIRECTORS



Prof. Dr. Albrecht Schmidt
Chair for Human-Centered Ubiquitous Media
Ludwigs-Maximilians-Universität



Prof. Dr. Alexander Pretschner
Chair of Software Engineering
Technische Universität München



Prof. Dr. Andreas Butz
Chair for Media Informatics
Ludwigs-Maximilians-Universität



Prof. Dr. Dres h.c. Arnold Picot †
Chair for Information, Organization
and Management
Ludwigs-Maximilians-Universität



Prof. Dr. Bernd Brügge
Chair for Applied Software
Engineering
Technische Universität München



Prof. Dr. Dieter Kranzlmüller
Chair for Communication Systems and Systems
Programming, Ludwigs-Maximilians-Universität,
Munich Network Management Team, Leibniz
Supercomputing Center



Prof. Dr. Dietmar Harhoff
Director at the Max Planck
Institute for Innovation and
Competition



Prof. Dr. Hana Milanov
Entrepreneurship Research Institute
Technische Universität München



Prof. Dr. Heinz-Gerd Hegering
Munich Network Management Team
Ludwigs-Maximilians-Universität



Prof. Dr. Helmut Krcmar
Chair for Information Systems
Technische Universität München



Prof. Dr. Isabell Welpé
Chair for Strategy and Organisation
Technische Universität München



Prof. Dr. Jelena Spanjol
Chair for Innovation Management
Ludwigs-Maximilians-Universität



Prof. Dr. Jörg Claussen
Chair for Strategy, Technology and Organization
Ludwigs-Maximilians-Universität



Prof. Dr. Jörg Eberspächer
Chair for Communication
Networks
Technische Universität München



Prof. Dr. Klaus Diepold
Chair for Data Processing
Technische Universität München



Prof. Dr. Dr. h.c. Manfred Broy
Chair for Software and Systems
Engineering
Technische Universität München



Prof. Dr. Martin Spann
Chair for Electronic Commerce and Digital
Markets
Ludwigs-Maximilians-Universität



Prof. Dr. Reiner Braun
Chair for Entrepreneurial Finance
Technische Universität München



Prof. Dr. Thomas Hess
Chair for Information Systems and New Media
Ludwigs-Maximilians-Universität



Prof. Dr. Tobias Kretschmer
Chair for Strategy, Technology and Organization
Ludwigs-Maximilians-Universität



Prof. Dr. Wolfgang Kellerer
Chair for Communication Networks
Technische Universität München

CDTM MANAGEMENT TEAM



Aaron Defort
M.Sc. Management



Philipp Hulm
M.Sc. Electrical and Computer Engineering



Anna-Sophie Liebender-Luc
M.A. Strategic Foresight



Theresa Doppstadt
M.A. Economics & Management



Carla Pregel Hoderlein
M.Sc. Electrical Engineering and Information Technology



Tom Schelo
M.Sc. Mechanical Engineering



Elizaveta Felsche
M.Sc. Physics



Amelie Pahl
M.Sc. Entrepreneurship & M.A. Management



Franz Xaver Waltenberger
M.A. Politics, Economics, Philosophy



Michael Fröhlich
M.Sc. Computer Science



Philipp Hofsummer
M.Sc. Business Administration

OTHER TREND REPORTS

Check www.cdtm.de/bookstore

2020



Independent Living for the Elderly
ISBN: 978-3-9822669-0-9
2020

2020



Public Administration in the digital Era
ISBN: 978-3-9818511-9-9
2020

2019



Parentech - The Future of Parenting
ISBN: 978-3-9818511-8-2
2019

2019



The Data Driven Future of the Dairy Industry
ISBN: 978-3-9818511-7-5
2019

2018



The Digital Future of the Construction Industry
ISBN: 978-3-9818511-5-1
2018

2018



Digital Companions in the Factory of the Future
ISBN: 978-3-9818511-4-4
2018

2017



Customer Interaction in the Telco Industry
ISBN: 978-3-9818511-3-7
2017

2017



Creating and Sustaining Healthy Habits
ISBN: 978-3-9818511-2-0
2017

2016



Digital Innovation in Diabetes Care
ISBN: 978-3-9818511-0-6
2016

SOURCES

- [1] A. Muhammad, "A Review of Smart Homes - Past, Present and Future," *IEEE Trans. Syst. Man Cybern. Part C*, 2012, [Online]. Available: https://www.researchgate.net/publication/262867986_A_Review_of_Smart_Homes_-_Past_Present_and_Future.
- [2] R. Bocksch, "100.000 Geräte unter Alexas Kontrolle," *Statista*, 2020, [Online]. Available: <https://de.statista.com/infografik/22376/anzahlder-smart-home-geraete-die-alexa-kontrollieren-kann/>.
- [3] J. Godenrath, "Expert Lecture at CDTM," 2021.
- [4] R. Knote, A. Janson, L. Eigenbrod, and M. Söllner, "The what and how of smart personal assistants: Principles and application domains for IS research," *MKWI 2018 - Multikonferenz Wirtschaftsinformatik*, vol. 2018-March, pp. 1083–1094, 2018, [Online]. Available: https://www.alexandria.unisg.ch/252796/1/JML_678.pdf.
- [5] L. Wood, "Global Smart Home Appliances Market (2020 to 2027)," *Businesswire*, 2020, [Online]. Available: <https://www.businesswire.com/news/home/20200911005283/en/Global-Smart-Home-Appliances-Market-2020-to-2027---Size-Share-Trends-Analysis-Report---ResearchAndMarkets.com>.
- [6] B. Rabe, "New survey finds 70% of consumers improved home during COVID-19, more than half used smart devices," 2021, [Online]. Available: <https://www.prnewswire.com/news-releases/new-survey-finds-70-of-consumers-improved-home-during-covid-19-more-than-half-used-smart-devices-301201817.html>.
- [7] K. Rupp, "40 Years of Microprocessor Trend Data," 2018, [Online]. Available: <https://www.karlsruher.net/2015/06/40-years-of-microprocessor-trend-data/>.
- [8] T. Cisco and A. Internet, "Cisco: 2020 CISO Benchmark Report," *Comput. Fraud Secur.*, vol. 2020, no. 3, p. 4, 2020, doi: 10.1016/s1361-3723(20)30026-9.
- [9] M. Boussard, "Future Spaces: Reinventing the Home Network for Better Security and Automation in the IoT Era," *Sensors*, vol. 18, no. 9, 2018, [Online]. Available: <https://www.mdpi.com/1424-8220/18/9/2986>.
- [10] R. Lackes, "The Acceptance of Intelligent Personal Assis," *Perspect. Bus. Informatics Res.*, pp. 204–218, 2019, [Online]. Available: https://www.researchgate.net/publication/335831970_Can_I_Help_You_-_The_Acceptance_of_Intelligent_Personal_Assistants.
- [11] F. Richter, "America's Smartphone Addiction," 2018, [Online]. Available: <https://statista.com/chart/12403/smartphone-addiction/>.
- [12] M. Kokholm, "The decline of the computer continues while newer devices are on the rise," *Audience Project*, 2020, [Online]. Available: <https://www.audienceproject.com/blog/key-insights/new-study-the-decline-of-the-computer-continues-while-newer-devices-are-on-the-rise/>.
- [13] E. Kopytug, "Reading books on e-readers, tablets and smartphones in Germany 2016–2020," 2020, [Online]. Available: <https://www.statista.com/statistics/382350/reading-books-on-electronic-devices-germany/>.
- [14] Bitkom, "Audio-Streaming bleibt auf Wachstumskurs," 2020, [Online]. Available: <https://www.bitkom.org/Presse/Presseinformation/Audio-Streaming-bleibt-auf-Wachstumskurs>.
- [15] T. Kupferschmitt, "Onlinevideo-Reichweite und Nutzungsfrequenz wachsen, Altersgefälle bleibt," *Media Perspekt.*, vol. 9, no. 6, pp. 427–437, 2018, [Online]. Available: https://www.ard-zdf-onlinestudie.de/files/2018/0918_Kupferschmitt.pdf.
- [16] Microsoft, "Hololens @ www.microsoft.com." 2015, [Online]. Available: <https://www.microsoft.com/microsoft-hololens/en-us>.
- [17] Google, "Google Glass." Google, 2021, [Online]. Available: <https://www.google.com/glass/start/>.
- [18] Oculus, "Oculus Quest 2 Glasses," 2021, [Online]. Available: <https://www.oculus.com/quest-2/>.
- [19] J. Rossignol, "Apple to Launch Mixed Reality Headset in Mid 2022," *MacRumors*, 2021, [Online]. Available: <https://www.macrumors.com/2021/03/07/kuo-apple-mixed-reality-headset-2022/>.
- [20] Apple Developer, "Dive into the world of augmented reality," 2021, [Online]. Available: <https://developer.apple.com/augmented-reality/>.
- [21] Neuralink, "Neuralink - Breakthrough Technology for our Brain." Neuralink, 2020, [Online]. Available: <https://neuralink.com/>.
- [22] T. Alsop, "Global mobile augmented reality (AR) users 2015-2023." *Statista*, 2021, [Online]. Available: <https://www.statista.com/statistics/1098630/global-mobile-augmented-reality-ar-users/>.
- [23] Lionel Sujay Vailshery, "Worldwide VR AR device shipments by product type", 2021, [Online]. Available: <https://www-statista-com.eaccess.ub.tum.de/statistics/1055434/worldwide-vr-ar-device-shipments-by-product-type/>.
- [24] B. Safaei, "Reliability side-effects in Internet of Things application layer protocols," 2017, [Online]. Available: <https://sci-hub-se/10.1109/ICSR5.2017.8272822>.
- [25] T. May, "CSS Insights survey shows users highly satisfied with VR devices," *CCS Insights*, 2019, [Online]. Available: <https://www.ccsinsight.com/press/company-news/virtual-and-augmented-reality-headset-shipments-ready-to-soar/>.
- [26] K. Kelly, "Hyper Vision," *Wired*, 2016, [Online]. Available: <https://www.wired.com/2016/04/magic-leap-vr/>.
- [27] J. A. D. E. Guzman, K. Thilakarathna, and A. Seneviratne, "Security and Privacy Approaches in Mixed Reality," vol. 0, no. 0, 2019, [Online]. Available: <https://arxiv.org/pdf/1802.05797.pdf>.
- [28] G. Small, "Brain Health Consequences of Digital Technology Use," *Dialogues Clin. Neurosci.*, vol. 22, no. 2, pp. 179–187, 2020, [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7366948/>.
- [29] Apple, "Use Screen Time on your Mac," 2021, [Online]. Available: <https://support.apple.com/en-us/HT210387>.
- [30] P. Musilek, "Energy Management for Smart Homes -State of the Art," *Appl. Sci.*, vol. 9, no. 17, 2019, [Online]. Available: https://www.researchgate.net/publication/335315940_Energy_Management_for_Smart_Homes-State_of_the_Art.
- [31] J. Kim, "HEMS (Home Energy Management System) Base on the IoT Smart Home," vol. 9, no. 1, pp. 21–28, 2016, [Online]. Available: <http://www.m-hikari.com/ces/ces2016/ces1-4-2016/p/kimjunyonCES1-4-2016.pdf>.
- [32] M. Daneshvar, "Transactive energy in future smart homes," *Energy Internet*, pp. 153–179, 2019, [Online]. Available: <https://www.sciencedirect.com/science/article/pii/B9780081022078000072>.
- [33] O. Ellabban, "Smart grid customers' acceptance and engagement: An overview," *Renew. Sustain. Energy Rev.*, vol. 65, pp. 1285–1298, 2016, [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S1364032116302441#bib2>.
- [34] Statista, "Energy Management," 2020, [Online]. Available: <https://www.statista.com/outlook/dmo/smart-home/energy-management/worldwide>.
- [35] J. Scully, "Europe's residential market installed 745MWh of battery storage in 2019," 2020, [Online]. Available: <https://www.energy-storage.news/news/europes-residential-market-installed-745mwh-of-battery-storage-in-2019-sola>.
- [36] E. P. Review, "Germany 2020," 2020, [Online]. Available: https://www.bmwi.de/Redaktion/DE/Downloads/G/germany-2020-energy-policy-review.pdf?__blob=publicationFile&v=4.
- [37] C. Wilson, "Benefits and risks of smart home technologies," *Energy Policy*, vol. 103, pp. 72–83, 2017, [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S030142151630711X>.
- [38] Bundesgesetz, "Gesetz zur Digitalisierung der Energiewende," 2016, [Online]. Available: <https://www.bmwi.de/Redaktion/DE/Downloads/Gesetz/gesetz-zur-digitalisierung-der-energiewende.html>.
- [39] J. Bugeja, A. Jacobsson, and P. Davidsson, "On Privacy and Security Challenges in Smart Connected Homes," 2016, doi: 10.1109/EISIC.2016.21.
- [40] R. Daziano, "Flexible customer willingness to pay for bundled smart home energy products and services," *Resour. Energy Econ.*, vol. 61, 2020, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0928765519303227?dgcid=rss_sd_all.
- [41] A. Voulodimos, N. Doulamis, A. Doulamis, and E. Protopapadakis, "Deep Learning for Computer Vision: A Brief Review," *Comput. Intell. Neurosci.*, vol. 2018, 2018, doi: 10.1155/2018/7068349.
- [42] P. A. Lasota, T. Fong, and J. A. Shah, "A Survey of Methods for Safe Human-Robot Interaction," *Found. Trends Robot.*, vol. 5, no. 3, pp. 261–349, 2017, doi: 10.1561/23000000052.

Sources

- [43] A. Billard and D. Kragic, "Trends and challenges in robot manipulation," *Science* (80-.), vol. 364, no. 6446, 2019, doi: 10.1126/science.aat8414.
- [44] M. Hägele, "Robots Conquer the World," *IEEE Robot. Autom. Mag.*, vol. 23, no. 1, pp. 1–3, 2016.
- [45] Irobot, "Roomba," 2021, [Online]. Available: <https://www.irobot.de/roomba/s-serie>.
- [46] Temi The Personal Robot, "Temi Robo," 2021, [Online]. Available: <https://www.robotemi.com>.
- [47] D. Leidner, "Cognition-enabled robotic wiping: Representation, planning, execution, and interpretation," *Rob. Auton. Syst.*, vol. 114, pp. 199–216, 2019, [Online]. Available: <https://www.sciencedirect.com/science/article/abs/pii/S09211889018303312>.
- [48] R. Kittmann, "Let me Introduce Myself: I am Care-O-bot 4, a Gentleman Robot," *Mensch und Comput.* 2015 – Tagungsband, 2015, [Online]. Available: <http://publica.fraunhofer.de/dokumente/N-421345.html>.
- [49] B. Bäuml et al., "Core Functionalities and Use Cases ©," 2021.
- [50] Research and Markets, "Households Robots Market - Growth, Trends, Covid-19 Impact and Forecasts (2021-2026)," 2021, [Online]. Available: <https://www.researchandmarkets.com/reports/4846017/household-robots-market-growth-trends-covid#>.
- [51] S. Pfahl, "Zeitaufwand für Hausarbeit," pp. 1–7, 2013, [Online]. Available: <https://media.boeckler.de/Sites/A/Online-Archiv/21276>.
- [52] J. M. Twenge, "A review of the empirical evidence on generational differences in work attitudes," *J. Bus. Psychol.*, vol. 25, no. 2, pp. 201–210, 2010, doi: 10.1007/s10869-010-9165-6.
- [53] C. A. Smarr et al., "Domestic Robots for Older Adults: Attitudes, Preferences, and Potential," *Int. J. Soc. Robot.*, vol. 6, no. 2, pp. 229–247, 2014, doi: 10.1007/s12369-013-0220-0.
- [54] N. Ezer, A. D. Fisk, and W. A. Rogers, "Attitudinal and intentional acceptance of domestic robots by younger and older adults," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 5615 LNCS, no. PART 2, pp. 39–48, 2009, doi: 10.1007/978-3-642-02710-9_5.
- [55] Statista, "Global Annual Investments in Robotics," 2021, [Online]. Available: <https://www.statista.com/statistics/911907/global-annual-investment-in-robotics/#:-:text=This statistic represents annual global,135 billion U.S. dollars worldwide>.
- [56] R. Bogue, "Domestic robots: Has their time finally come?," *Ind. Rob.*, vol. 44, no. 2, pp. 129–136, 2017, doi: 10.1108/IR-01-2017-0018.
- [57] M. Eleftheria, "Safety certification requirements for domestic robots," *Saf. Sci.*, vol. 50, no. 9, pp. 1888–1897, 2012, [Online]. Available: <https://www.sciencedirect.com/science/article/abs/pii/S0925753512001294>.
- [58] M. Satyanarayanan, "The emergence of edge computing," *Computer (Long Beach, Calif.)*, vol. 50, no. 1, pp. 30–39, 2017, doi: 10.1109/MC.2017.9.
- [59] Statista, "IoT connected Devices worldwide," 2021, [Online]. Available: <https://www.statista.com/statistics/802690/worldwide-connected-devices-by-access-technology/>.
- [60] Parks Associates, "35% of US broadband households experienced data security problems in the past 12 months," 2020, [Online]. Available: <https://www.parksassociates.com/blog/article/pr-11032020>.
- [61] Avast, "Two out of Five Digital Households Worldwide at Cyber Risk," 2019, [Online]. Available: <https://press.avast.com/two-out-of-five-digital-households-worldwide-at-cyber-risk-avast-reveals>.
- [62] EU Project, "GDPR," 2020, [Online]. Available: <https://gdpr.eu>.
- [63] I. Commissioner, "Information Commissioner's Annual Report and Financial Statements", 2019, [Online]. Available: <https://ico.org.uk/media/about-the-ico/documents/2618021/annual-report-2019-20-v83-certified.pdf>.
- [64] A. Dorri, S. S. Kanhere, and R. Jurdak, "Blockchain in Internet of Things : Challenges and Solutions," 2014, [Online]. Available: <https://arxiv.org/pdf/1608.05187.pdf>.
- [65] United Nations Department of Economic and Social Affairs, "World Population Ageing 2019," 2020, [Online]. Available: <https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Highlights.pdf>.
- [66] A. Tinker, "The Social Implications of an Ageing Population," *Mech. Ageing Dev.*, vol. 123, pp. 729–735, 2002.
- [67] Accenture, "Putting the Human First in The Future Home," 2018, [Online]. Available: https://www.accenture.com/_acnmedia/pdf-98/accenture-putting-human-first-future-home.pdf.
- [68] United Nations Economic Commission for Europe, "Older Persons as Consumers," 2009, [Online]. Available: https://unece.org/DAM/pau/_docs/age/2009/Policy_briefs/Policy-brief-Old_persons.pdf.
- [69] M. Roser, "Future Population Growth," 2014, [Online]. Available: <https://ourworldindata.org/future-population-growth>.
- [70] M. Roser, E. Ortiz-Ospina, and H. Ritchie, "Life Expectancy - Our World in Data," 2013, [Online]. Available: <https://ourworldindata.org/life-expectancy>.
- [71] J. P. Michel and F. Ecarnot, "The shortage of skilled workers in Europe: its impact on geriatric medicine," *European Geriatric Medicine*, vol. 11, no. 3. Springer, pp. 345–347, 01-Jun-2020.
- [72] WHO, "Global health workforce shortage to reach 12.9 million in coming decades," 2013, [Online]. Available: <https://apps.who.int/mediacentre/news/releases/2013/health-workforce-shortage/en/index.html>. accessed: 20-Apr-2021.
- [73] M. Roser, "Fertility Rate - Our World in Data," 2014, [Online]. Available: <https://ourworldindata.org/fertility-rate>. [Accessed: 09-Mar-2021].
- [74] Siemens Zukunftsinstitut, "Future Living: Moderne Lebenswelten für das 21. Jahrhundert," 2013, [Online]. Available: https://www.zukunftsinstitut.de/fileadmin/user_upload/Publikationen/Auftragsstudien/Future_Living_Zukunftsinstitut_Siemens_Future_Living.pdf. accessed: 09-Mar-2021.
- [75] S. Carreto et al., "Can Technology-based Services support Long-term Care Challenges in Home Care?," *Publications Office of the EU*, doi: 10.2791/43024.
- [76] C. D. Nugent, D. D. Finlay, P. Fiorini, Y. Tsumaki, E. Prassler, "Home automation as a means of independent living," *IEEE Trans. Autom. Sci. Eng.*, vol. 5, no. 1, pp. 1–8, Jan. 2008.
- [77] Institut der deutschen Wirtschaft (IwD), "Größer wohnen," 2020, [Online]. Available: <https://www.iwd.de/artikel/grosser-wohnen-489720/>. accessed: 09-Mar-2021.
- [78] P. Carnemolla, "Ageing in Place and the Internet of Things – How Smart Home Technologies, the Built Environment and Caregiving Intersect," *Vis. Eng.*, vol. 6, no. 1, p. 7, Dec. 2018.
- [79] Q. Lê, H. B. Nguyen, T. Barnett, "Smart Homes for Older People: Positive Aging in a Digital World," *Futur. Internet*, vol. 4, no. 2, pp. 607–617, 2012.
- [80] V. Quinio, G. Burgess, "Is Co-Living a Housing Solution for Vulnerable Older People?," Cambridge Center of Housing & Planning Research, 2019, [Online]. Available: http://www.nationwidefoundation.org.uk/wp-content/uploads/2019/11/Final-report-coliving_web-version.pdf, accessed on: 2021-05-30.
- [81] A. Clark and C. Coelho, "Elder Cohousing: The Future of Eldercare," 2020, [Online]. Available: <https://www.theseniorlist.com/cohousing/>. accessed: 09-Mar-2021.
- [82] L. N. Lee, M. J. Kim, "A Critical Review of Smart Residential Environments for Older Adults With a Focus on Pleasurable Experience," *Frontiers in Psychology*, vol. 10. Frontiers Media S.A., p. 3080, 24-Jan-2020.
- [83] OECD, "Doing better for families Germany", 2011, [Online]. Available: <https://www.oecd.org/els/family/47700996.pdf>. accessed on: 2021-05-30.
- [84] G. Doblhammer, J. Gumà, "A Demographic Perspective on Gender, Family and Health in Europe," Springer International Publishing, 2018.
- [85] Eurostat, "Household Composition Statistics," 2020, [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php/Household_composition_statistics#More_and_more_households_consisting_of_adults_living_alone.
- [86] R. Nijskens, M. Lohuis, P. Hilbers, W. Heeringa, "Hot Property - The Housing Market in Major Cities," 2019.
- [87] G. Berger, "Will This Year's College Grads Job-Hop More Than Previous Grads?," 2016, [Online]. Available: <https://blog.linkedin.com/2016/04/12/will-this-year-s-college-grads-job-hop-more-than-previous-grads>. accessed: 20-Apr-2021.
- [88] M. Lemli, "Temporary Living: Short-term, Small and Expensive?," 2019, [Online]. Available: https://en.savills.de/research_articles/259694/289919-0. accessed: 06-Mar-2021.
- [89] Statistisches Bundesamt, "Ehen im Wandel," 2021, [Online]. Available: <https://www.destatis.de/DE/Themen/Querschnitt/Demografischer-Wandel/Hintergruende-Auswirkungen/demografie-ehen.html>. accessed: 20-Apr-2021.
- [90] Eurostat, "Women's employment in the EU," 2020, [Online]. Available: <https://ec.europa.eu/eurostat/en/web/products-eurostat-news/-/edn-20200306-1>. accessed: 20-Apr-2021.
- [91] Corestate, "Micro Living Overview," 2019, [Online]. Available: https://corestate-capital.com/wp-content/uploads/2019/05/CORESTATE-Group_Microliving-Overview_072019.pdf. accessed on: 2021-05-30.

Sources

- [92] KPMG International, "Responding to Consumer Trends in the New Reality," n.d., [Online]. Available: <https://home.kpmg/xx/en/home/insights/2020/06/consumers-and-the-new-reality.html>, accessed on: 2021-05-30.
- [93] A. Scott, "Home Design is Adapting to the Pandemic, too," 2020, [Online]. Available: <https://www.marketplace.org/2020/08/17/homebuilders-construction-design-covid-19-work-space-quiet-space-safety-technology/>.
- [94] Anton & Irene and SPACE10, "How will we live in the year 2030?," 2020, [Online]. Available: <http://onesharedhouse2030.com/survey/>, accessed: 09-Mar-2021.
- [95] SPACE10 and Urgent.Agency, "IMAGINE Exploring the Brave New World of Shared Living," 2018, [Online]. Available: <https://issuu.com/hannah.wood/docs/imagine-issue2>, accessed: 09-Mar-2021.
- [96] CBRE EMEA Research Team, "Europe Co-Living Report", 2020, [Online]. Available: <http://cbre.vo.llnwd.net/grgservices/secure/42008116%20EMEA%20Co-Living%20FINAL.pdf?e=1622409899&h=8f83987882ce50513bf15f0b64fa3c7>, accessed on: 2021-05-30.
- [97] JLL, "European coliving index," 2019, [Online]. Available: <https://www.jll.de/content/dam/jll-com/documents/pdf/research/emea/jll-european-coliving-index-2019.pdf>, accessed: 09-Mar-2021.
- [98] A. Lafci, "We'll soon co-live in apartments in much the same way we co-work," 2018, [Online]. Available: <https://qz.com/1383669/well-soon-co-live-in-apartments-in-much-the-same-way-we-co-work/>, accessed: 09-Mar-2021.
- [99] L. Vanazzi, "URBAN CO-LIVING," 30-Jul-2019, [Online]. Available: https://issuu.com/lablogpublications/docs/2019_07_co-living_laura_vanazzi.
- [100] Fett, M. "Technology, Health and Health Care." Heal. Financ. Ser., vol. 5, 2000, p. 33., [www1.health.gov.au/internet/main/publishing.nsf/Content/DA8177ED1A80D332CA257BF0001B08EE/\\$File/ocpahfsv5.pdf](http://www1.health.gov.au/internet/main/publishing.nsf/Content/DA8177ED1A80D332CA257BF0001B08EE/$File/ocpahfsv5.pdf).
- [101] World Health Organization, "Global recommendations on physical activity for health," 2010.
- [102] World Health Organization, "Physical activity," 2020, [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/physical-activity>, accessed: 09-Mar-2020.
- [103] World Health Organization, "Healthy diet," 2020, [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/healthy-diet>, accessed: 09-Mar-2020.
- [104] World Health Organization, "Obesity and overweight," 2020, [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>, accessed: 09-Mar-2020.
- [105] World Health Organization, "Mental health," 2021, [Online]. Available: https://www.who.int/health-topics/mental-health#tab=tab_2, accessed: 20-Jan-2021.
- [106] L. Sbaffi and J. Rowley, "Trust and Credibility in Web-Based Health Information: A Review and Agenda for Future Research," J. Med. Internet Res., vol. 19, no. 6, pp. e218–e218, Jun. 2017.
- [107] Edenred, "Eighth FOOD barometer survey," 2019, [Online] Available: <https://www.edenred.com/en/medias/news-and-press-releases/8th-food-barometer-survey-european-employees-consult-more-online-dietary-information-and-want-more>.
- [108] J. Berardi, "What 10,000 people can teach you about health and fitness," 2021, [Online]. Available: <https://www.precisionnutrition.com/fitness-survey-results>, accessed on: 09-Mar-2020.
- [109] M. A. Stults-Kolehmainen and R. Sinha, "The effects of stress on physical activity and exercise," Sports Med., vol. 44, no. 1, pp. 81–121, Jan. 2014.
- [110] A. Drewnowski and W. J. Evans, "Nutrition, Physical Activity, and Quality of Life in Older Adults: Summary," Journals Gerontol. Ser. A, vol. 56, no. suppl_2, pp. 89–94, Oct. 2001.
- [111] R. Jefferson, "More Seniors Are Embracing Technology. But Can They Use It? UCSD Researchers Suggest Asking Them," 2019, [Online]. Available: <https://www.forbes.com/sites/robinseatonjefferson/2019/06/28/more-seniors-are-embracing-technology-but-can-they-use-it-ucsd-researchers-suggest-asking-them/>, accessed on: 09-Mar-2020.
- [112] V. Zimmermann, P. Gerber, K. Marky, L. Böck, and F. Kirchbuchner, "Assessing Users' Privacy and Security Concerns of Smart Home Technologies," i-com, vol. 18, no. 3, pp. 197–216, 2019.
- [113] B. Allen, "The Impact IoT Devices Can Have On Your Health," 2018, [Online]. Available: <https://infineegk.com/impact-iot-devices-have-on-health/>, accessed: 09-Mar-2020.
- [114] Design Partners, "Consumer Fitness Survey Reveals Key Insights to Better Connect with Shoppers," 2020, [Online]. Available: <http://www.globenewswire.com/fr/news-release/2020/08/17/2079107/0/en/Consumer-Fitness-Survey-Reveals-Key-Insights-to-Better-Connect-with-Shoppers.html>.
- [115] L. LaBerge, C. O'Toole, J. Schneider, and K. Smaje, "How COVID-19 has pushed companies over the technology tipping point—and transformed business forever," 2020, [Online]. Available: <https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever>.
- [116] M. Cramer and M. Zaveri, "What if You Don't Want to Go Back to the Office?," The New York Times, 2020, [Online]. Available: <https://www.nytimes.com/2020/05/05/business/pandemic-work-from-home-coronavirus.html>
- [117] S. Lund, A. Madgavkar, J. Manyika, and S. Smit, "What's next for remote work: An analysis of 2,000 tasks, 800 jobs, and nine countries," 23-Nov-2020, [Online]. Available: <https://www.mckinsey.com/featured-insights/future-of-work/whats-next-for-remote-work-an-analysis-of-2000-tasks-800-jobs-and-nine-countries>.
- [118] S. Lund et al., "The future of work after COVID-19," 2021, [Online]. Available: <https://www.mckinsey.com/featured-insights/future-of-work/the-future-of-work-after-covid-19>
- [119] A. Dua, C. Wan-Lae, S. Lund, A. De Smet, O. Robinson, and S. Sanghvi, "What 800 executives envision for the postpandemic workforce," 2020, [Online]. Available: <https://www.mckinsey.com/featured-insights/future-of-work/what-800-executives-envision-for-the-postpandemic-workforce>.
- [120] G. Poulton, "THE HOME OFFICE BECOMES THE NEW NORMAL," 2020, [Online]. Available: <https://www.rolandberger.com/en/Insights/Publications/The-home-office-becomes-the-new-normal.html>.
- [121] S. Holder, "The True Costs of Working From Home," 2021, [Online]. Available: <https://www.bloombergenews.com/news/articles/2021-02-26/why-remote-workers-spend-more-on-housing-and-rent>.
- [122] P. Choudhury, "Our Work-from-Anywhere Future," 2020, [Online]. Available: <https://hbr.org/2020/11/our-work-from-anywhere-future>.
- [123] R. Florida, "The Uncertain Future of Corporate HQs," 2020, [Online]. Available: <https://hbr.org/2020/09/the-uncertain-future-of-corporate-hqs>.
- [124] K. Lister, "The Business Case For Remote Work." pp. 6–27, 2021.
- [125] C. Westfall, "Mental Health And Remote Work: Survey Reveals 80% Of Workers Would Quit Their Jobs For This," 2020, [Online]. Available: <https://www.forbes.com/sites/chriswestfall/2020/10/08/mental-health-leadership-survey-reveals-80-of-remote-workers-would-quit-their-jobs-for-this/>.
- [126] M. Taylor, J. Watts, and J. Bartlett, "Climate crisis: 6 million people join latest wave of global protests | School climate strikes | The Guardian," The Guardian, 2019, [Online]. Available: <https://www.theguardian.com/environment/2019/sep/27/climate-crisis-6-million-people-join-latest-wave-of-worldwide-protests>, accessed: 09-Mar-2021.
- [127] World Economic Forum, "The Global Risks Report 2020," 2020, [Online] Available: [weforum.org/reports/the-global-risks-report-2020](https://www.weforum.org/reports/the-global-risks-report-2020).
- [128] Science Based Targets Initiative, "Companies taking action - Science Based Targets," 2020, [Online]. Available: <https://sciencebasedtargets.org/companies-taking-action>, accessed: 09-Mar-2021.
- [129] European Investment Bank, "2018-2019 EIB climate survey," 2019.
- [130] European Investment Bank, "2020-2021 EIB climate survey," 2021.
- [131] Ipsos, "Climate Change and Consumer Behavior," Jan. 2020, [Online] Available: https://www.ipsos.com/sites/default/files/ct/news/documents/2020-01/report-global-advisor-climate-change-consumer-behavior-final_2.pdf.
- [132] N. Kachaner, J. Nielsen, A. Portafaix, and F. Rodzko, "BCG Survey on COVID-19 and Environment," Jun. 2020, [Online] Available: <https://www.bcg.com/publications/2020/pandemic-is-heightening-environmental-awareness>.
- [133] M. Lampert, S. Metaal, S. Liu, and L. Gambarin, "Trend Report: Global Rise in Environmental Concern," 2019, [Online]. Available: <https://www.courthousenews.com/wp-content/uploads/2019/08/ClimateChangeGlobalities.pdf>.
- [134] M. Motyka, J. Thomson, K. Hardin, and S. Sanborn, "Deloitte Resources 2020 Study," 2020, [Online]. Available: https://www2.deloitte.com/content/dam/insights/us/articles/6655_Resources-study-2020/DL_Resources-study-2020.pdf.
- [135] "Overview of Climate Emergency Declarations," Cedamia, [Online]. Available: <https://www.cedamia.org/global/>, accessed: 09-Mar-2021.
- [136] M. K. Salamon, "Leading the Public into Emergency Mode," The Climate Mobilization, 2019, [Online]. Available: <https://www.theclimatemobilization.org/resources/whitepapers/leading-public-emergency-mode/>.

Sources

- [137] S. J. Thackeray et al., "Civil disobedience movements such as School Strike for the Climate are raising public awareness of the climate change emergency," *Glob. Chang. Biol.*, vol. 26, no. 3, pp. 1042–1044, Mar. 2020.
- [138] P. Giger, "COVID-19 could distract the world from even greater threats | World Economic Forum," *World Economic Forum*, 2020, [Online]. Available: <https://www.weforum.org/agenda/2020/10/covid-19-distract-world-greater-threats/>.
- [139] G. Cantwell, M. Nolan, and M. Corser, "Accenture Chemicals Global Consumer Sustainability Survey 2019," 2019, [Online]. Available: <https://www.slideshare.net/accenture/accenture-chemicals-global-consumer-sustainability-survey-2019>.
- [140] European Investment Bank, "2019-2020 EIB climate survey," 2020.
- [141] Statista, "Energy Management - Europe," Statista, Sep-2021, [Online]. Available: <https://www-statista-com.eaccess.ub.tum.de/outlook/dmo/smart-home/energy-management/europe>, accessed: 09-Mar-2021.
- [142] Wood Mackenzie and Statista, "Europe: Annual home battery installations 2013-2024," Statista, Aug-2019, [Online]. Available: <https://www-statista-com.eaccess.ub.tum.de/statistics/1036363/home-battery-installations-europe/>, accessed: 09-Mar-2021.
- [143] M. Schmela et al., "SolarPower Europe EU Market Outlook For Solar Power 2019-2023," 2019, [Online]. Available: <https://www.solarpowereurope.org/eu-market-outlook-for-solar-power-2019-2023/>.
- [144] European Commission, "Closing the loop - An EU Action Plan for the Circular Economy" , 2015, [Online]. Available: <http://www.w.xploit-eu.com/pdfs/Europe%202020%20Flagship%20Initiative%20INNOVATION.pdf>.
- [145] Ellen MacArthur Foundation, "The EU's Circular Economy Action Plan" , 2020, [Online]. Available: <https://www.ellenmacarthurfoundation.org/case-studies/the-eus-circular-economy-action-plan>.
- [146] CABUZEL, T. European Climate Law [Text]. "Klimapolitik - European Commission", 2020, [Online]. Available: https://ec.europa.eu/clima/policies/eu-climate-action/law_en.
- [147] European Commission, "The new ecodesign measures explained." 2019, [Online]. Available: https://ec.europa.eu/commission/presscorner/detail/en/QANDA_19_5889.
- [148] Hughes, O "Right to repair moves forward for your broken devices. But campaigners want to go much further." *TechRepublic*, 2021, [Online]. Available: <https://www.techrepublic.com/article/right-to-repair-moves-forward-for-your-broken-devices-but-campaigners-want-to-go-much-further/>.
- [149] WWF, "Living beyond nature's limits." 2019, [Online]. Available: <https://www.footprintnetwork.org/content/uploads/2019/05/WWF-GFN-EU-Overshoot-Day-report.pdf>.
- [150] Accenture Newsroom, "The Circular Economy Could Unlock \$4.5 trillion of Economic Growth, Finds New Book by Accenture," 2020, [Online]. Available: <https://newsroom.accenture.com/news/the-circular-economy-could-unlock-4-5-trillion-of-economic-growth-finds-new-book-by-accenture.htm>.
- [151] European Commission, "Impacts of circular economy policies on the labour market," 2018, [Online]. Available: https://circulareconomy.europa.eu/platform/sites/default/files/ec_2018_-_impacts_of_circular_economy_policies_on_the_labour_market.pdf
- [152] Eurobarometer, F. "Attitudes of Europeans towards waste management and resource efficiency." Report, Flash EB Series, 388, 2014.
- [153] ING Think, "The Circular Economy's Six 'C' Challenge." 2019, [Online]. Available: <https://think.ing.com/articles/the-circular-economys-six-c-challenge/>.
- [154] Veolia, "To develop a more circular economy, do the main challenges for Veolia lie in waste collection or in improving recycling technology? (n.d.)." [Online]. Available: <https://www.veolia.com/en/csr-natural-resources/to-develop-more-circular-economy-do-main-challenges-veolia-lie-waste-collection-or-improving>, accessed on: 9 March 2021.
- [155] World Resources Institute, "Here's What Could Go Wrong with the Circular Economy—And How to Keep it on Track" 2019, [Online]. Available: <https://www.wri.org/blog/2019/08/here-s-what-could-go-wrong-circular-economy-and-how-keep-it-track>.
- [156] European Commission, "Climate change consequences." 2016, [Online]. Available: https://ec.europa.eu/clima/change/consequences_en.
- [157] Bukow, S., "Europawahl in Deutschland 2019. Ergebnisse und Analysen. Böll," 2019.
- [158] Climate Action. (n.d.). [Online]. Available: <https://www.bundesregierung.de/breg-en/issues/climate-action>, accessed on: 9 March 2021.
- [159] vbw, "EU-Klimagesetz soll Klimaneutralität 2050 gesetzlich verankern", 2021, [Online]. Available: <https://www.vbw-bayern.de/vbw/Themen-und-Services/Energie-Klima/Klima/EU-Klimagesetz-vbw-EU-Gesetzgebungsradar.jsp>.
- [160] "BfEE - Europäische Energieeffizienzpolitik. (n.d.)." , [Online]. Available: https://www.bfee-online.de/BfEE/DE/Effizienzpolitik/EuropaeischeEnergieeffizienzpolitik/europaeischeenergieeffizienzpolitik_node.html, accessed on: 9 March 2021.
- [161] "BfEE - Nationale Energieeffizienzpolitik. (n.d.)." [Online]. Available: https://www.bfee-online.de/BfEE/DE/Effizienzpolitik/NationaleEnergieeffizienzpolitik/nationaleenergieeffizienzpolitik_node.html, accessed on: 9 March 2021.
- [162] Bundesregierung, "CO2-Bepreisung." 2019, [Online]. Available: <https://www.bundesregierung.de/breg-de/themen/klimaschutz/co2-bepreisung-1673008>.
- [163] "BMWi—Das neue EU-Energielabel. (n.d.)", [Online]. Available: <https://www.deutschland-machts-effizient.de/KAENEF/Redaktion/DE/Standardartikel/Dossier/A-label-uebersicht.html>.
- [164] World Economic Forum, "The Global Risks Report." 2021, [Online]. Available: <https://www.weforum.org/reports/the-global-risks-report-2021/>.
- [165] The Guardian, "A quiet revolution sweeps Europe as Greens become a political force." 2019, [Online]. Available: <http://www.theguardian.com/politics/2019/jun/02/european-parliament-election-green-parties-success>.
- [166] "Gastbeitrag: Warum die internationale Klimapolitik scheitert—WELT." 2018, [Online]. Available: https://www.welt.de/print/die_welt/wirtschaft/article185567126/Gastbeitrag-Warum-die-internationale-Klimapolitik-scheitert.html.
- [167] Ward, H., Steckel, J. C., & Jakob, M. "How global climate policy could affect competitiveness." *Energy Economics*, 84, 104549, 2019.
- [168] Greenpeace European Unit, "Report: Big Oil and gas buying influence in Brussels," Greenpeace European Unit, [Online]. Available: <https://www.greenpeace.org/eur-unit/issues/climate-energy/2238/big-oil-gas-buying-influence-brussels/>.
- [169] Bogazliyan, S. "Klimaschutz: CO2-Steuer – Alles was Sie wissen müssen." 2021, [Online]. Available: <https://www.wiwo.de/finanzen/steuern-recht/klimaschutz-co2-steuer-alles-was-sie-wissen-muessen/25533826.html>.
- [170] BMWi, "Nachhaltigkeit in der Wirtschaft. (n.d.)." [Online]. Available: <https://www.bmwi.de/Redaktion/DE/Dossier/nachhaltigkeit.html>.
- [171] Energieeffizienzstrategie 2050., "Energie, B. für W. und. (n.d.)." [Online]. Available: <https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/energieeffizienzstrategie-2050.html>.
- [172] BUNDESMINISTERIUM FÜR ARBEIT UND SOZIALES, "Weissbuch—Arbeiten 4.0," 2017, [Online]. Available: https://www.bmas.de/SharedDocs/Downloads/DE/Publikationen/a883-weissbuch.pdf?__blob=publicationFile&v=1.
- [173] J. Klier, J. Kirchner, B. Gumbmann, "New Work – die neue Realität der Arbeitswelt", McKinsey, 2020, [Online]. Available: <https://www.mckinsey.de/publikationen/2020-12-10-new-work>, accessed on 2021-05-30.
- [174] BMAS , "Digitalisierung im Arbeitsalltag von Beschäftigten: Konsequenzen für Tätigkeiten, Verhalten und Arbeitsbedingungen." 2020, [Online]. Available: <https://www.bmas.de/Service/Publikationen/Forschungsberichte/fb-555-digitalisierung-im-arbeitsalltag-von-beschaeftigten.html>.
- [175] Bonin, H., Eichhorst, W., Kaczynska, J., Kümmerling, A., Rinne, U., Scholten, A., & Steffes, S. "Verbreitung und Auswirkungen von mobiler Arbeit und Homeoffice." 2020.
- [176] BMAS , "Homeoffice: Welche Rechte und Pflichten bestehen?" 2021, [Online]. Available: <https://www.bmas.de/DE/Arbeit/Arbeitschutz/Gesundheit-am-Arbeitsplatz/homeoffice-was-bestehen-fuer-rechte-und-pflichten.html>.
- [177] FDP, "Arbeitsrecht: Wir brauchen moderne Gesetze für flexibles Arbeiten." 2021, [Online]. Available: https://www.fdp.de/_wir-brauchen-moderne-gesetze-fuer-flexibles-arbeiten.
- [178] BMAS , "Homeoffice." 2020, [Online]. Available: <https://www.bmas.de/DE/Arbeit/Arbeitsrecht/Teilzeit-flexible-Arbeitszeit/homeoffice.html>.
- [179] WELT, "Hubertus Heil für flexible Arbeitszeiten und Home-Office." 2020, [Online]. Available: <https://www.welt.de/politik/deutschland/article204947346/Hubertus-Heil-fuer-flexible-Arbeitszeiten-und-Home-Office.html>.

Sources

- [180] "Arbeit. (n.d.). BÜNDNIS 90/DIE GRÜNEN." [Online]. Available: <https://www.gruene.de/themen/arbeit>.
- [181] Työ- Ja Elinkeinoministeriö, "New Working Time Act in a nutshell— Ministry of Economic Affairs and Employment." 2019, [Online]. Available: <https://tem.fi/en/new-working-time-act-in-a-nutshell>.
- [182] CIPD, "Flexible Working Task Force.," [Online]. Available: <https://www.cipd.co.uk/news-views/policy-engagement/flexible-working>.
- [183] BMFSFJ, "Zweites Gesetz zur Änderung des Bundeselterngeld- und Elternzeitgesetzes.," 2021, [Online]. Available: <https://www.bmfsfj.de/bmfsfj/service/gesetze/zweites-gesetz-zur-aenderung-des-bundeselterngeld-und-elternzeitgesetzes-147674>.
- [184] Deutsche Gesetzliche Unfallversicherung e.V. (DGUV), "Arbeiten im Homeoffice – nicht nur in der Zeit der SARS-CoV-2-Epidemie.," 2021, [Online]. Available: <https://publikationen.dguv.de/widgets/pdf/download/article/3925>.
- [185] A. Holdampf-Wendel, B. Pauly, "Mehr als 10 Millionen arbeiten ausschließlich im Home Office," Bitkom, 2020, [Online]. Available: [https://www.bitkom.org/Presse/Presseinformation/Mehr-als-10-Millionen-arbeiten-ausschliesslich-im-Homeoffice#:~:text=Aktuell%20arbeitet%20jeder%20Vierte%20\(25,an%20allen%20Arbeitstagen%20pro%20Woche,accessed on: 2021-04-17](https://www.bitkom.org/Presse/Presseinformation/Mehr-als-10-Millionen-arbeiten-ausschliesslich-im-Homeoffice#:~:text=Aktuell%20arbeitet%20jeder%20Vierte%20(25,an%20allen%20Arbeitstagen%20pro%20Woche,accessed on: 2021-04-17).
- [186] S. Levi, "How upcoming smart home technology will influence remote working," TechRadar, 2020, [Online]. Available: <https://www.techradar.com/news/three-ways-upcoming-smart-home-technology-will-influence-remote-working>.
- [187] Broadband Europe, "Shaping Europe's Digital Future," European Commission, 2013, [Online]. Available: <https://ec.europa.eu/digital-single-market/en/broadband-europe>.
- [188] European Commission, "Mid-term review/revision of the multiannual financial framework 2014-2020 An EU budget focused on results," 2016, [Online]. Available: https://doi.org/10.1163/2210-7975_HRD-4679-0058.
- [189] European Commission, "Recovery and Resilience Facility," [Online]. Available: https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en,accessed on: 2021-03-09.
- [190] European Commission, "The 2021-2027 Multiannual Financial Framework: Digital shines through in the EU's long-term budget," 2020, [Online]. Available: <https://ec.europa.eu/digital-single-market/en/2021-2027-multiannual-financial-framework-digital-shines-through-eus-long-term-budget>.
- [191] European Commission, "Country information—Germany," 2020, [Online]. Available: <https://ec.europa.eu/digital-single-market/en/country-information-germany>.
- [192] Candelon, F., Bürkner, H.-P., M. Grebe, "As the COVID-19 Crisis Reveals, Europe Urgently Needs to Digitize Its Industry," BCG, 2020, [Online]. Available: <https://www.bcg.com/publications/2020/covid-crisis-reveals-europe-urgently-needs-industry-digitization>.
- [193] R. D. Atkinson, S. Ezell, "Promoting European Growth, Productivity, and Competitiveness by Taking Advantage of the Next Digital Technology Wave. Information Technology and Innovation Foundation.," 2019, [Online]. Available: <https://itif.org/publications/2019/03/26/promoting-european-growth-productivity-and-competitiveness-taking-advantage>.
- [194] European Commission, "Shaping the Digital Transformation in Europe," 2020, [Online]. Available: <https://digital-strategy.ec.europa.eu/en/news/commission-publishes-analysis-macro-economic-potential-digital-transformation-independent>.
- [195] E. Heymann, K. Koerner, "Digital infrastructure: Bottlenecks hamper Europe's progress," DBResearch, 2018, [Online]. Available: https://www.dbresearch.com/PROD/RPS_EN-PROD/PRODD000000000479443/Digital_infrastructure%3A_Bottlenecks_hamper_Europe%27.pdf,accessed on: 2021-05-30.
- [196] World Economic Forum, "The Challenge for Europe: Crafting a Digital Renaissance," [Online]. Available: <https://wef.ch/2Lb06p1,accessed on: 2021-03-09>.
- [197] P. Collela, "5G and IoT: Ushering in a new era," Ericsson, [Online]. Available: <https://www.ericsson.com/en/about-us/company-facts/ericsson-worldwide/india/authored-articles/5g-and-iot-ushering-in-a-new-era,accessed on: 2021-03-09>.
- [198] E. Fernandes, A. Rahmati, J. Jung, A. Prakash, "Security Implications of Permission Models in Smart-Home Application Frameworks," IEEE Security & Privacy, Volume: 15(2), 24–30, 2017, doi: <https://doi.org/10.1109/MSP.2017.43>.
- [199] T. Denning, T. Kohno, H. M. Levy, "Computer security and the modern home," Communications of the ACM, Volume: 56(1), 94–103, 2013, doi: <https://doi.org/10.1145/2398356.2398377>.
- [200] B. Schneier, "Click here to kill everybody: Security and survival in a hyper-connected world," WW Norton & Company, 2018.
- [201] European Data Protection Supervisor, "The History of the General Data Protection Regulation.," 2018, [Online]. Available: https://edps.europa.eu/data-protection/data-protection/legislation/history-general-data-protection-regulation_en.
- [202] European Commission, "The EU Cybersecurity Act at a glance," 2020, [Online]. Available: <https://ec.europa.eu/digital-single-market/en/news/eu-cybersecurity-act-glance>.
- [203] European Commission, "Proposal for an ePrivacy Regulation," 2017, [Online]. Available: <https://ec.europa.eu/digital-single-market/en/proposal-eprivacy-regulation>.
- [204] Consumers International, "The state of data protection rules around the world. A briefing for consumer organisation," [Online]. Available: <https://www.consumersinternational.org/media/155133/gdpr-briefing.pdf,accessed on: 2021-03-09>.
- [205] European Parliament, "Regulation (EU) 2016/679," 2016, [Online]. Available: <http://data.europa.eu/eli/reg/2016/679/oj,accessed on: 2019-05-30>.
- [206] DLA Piper, "GDPR fines and data breach survey: January 2021," 2021, [Online]. Available: <https://www.dlapiper.com/en/netherlands/insights/publications/2021/01/dla-piper-gdpr-fines-and-data-breach-survey-2021/>.
- [207] Home Appliance Europe, "By the numbers: The home appliance industry in Europe, 2018-2019," 2020, [Online]. Available: <https://www.applia-europe.eu/statistical-report-2018-2019/files/applia-statistical-report-2019.pdf>.
- [208] M. Humerick, "Taking AI personally: How the EU must learn to balance the interests of personal data privacy & artificial intelligence," Santa Clara High Tech. LJ, Volume: 34, 393, 2017.
- [209] Gartner, "Gartner Predicts for the Future of Privacy 2020," 2020, [Online]. Available: <https://www.gartner.com/smarterwithgartner/gartner-predicts-for-the-future-of-privacy-2020/>.
- [210] European Commission, "Europe investing in digital: The Digital Europe Programme," [Online]. Available: <https://ec.europa.eu/digital-single-market/en/europe-investing-digital-digital-europe-programme,accessed on: 2019-03-10>.
- [211] S. Chabinsky, "International Comparative Legal Guides (United Kingdom)," Global Legal Group, [Online]. Available: <https://iclg.com/practice-areas/data-protection-laws-and-regulations/usa,accessed on: 2019-03-10>.
- [212] A. Subramanian, "GDPR Cost and Implementation Concerns for Businesses," 2019, [Online]. Available: <https://medium.com/swlh/gdpr-cost-and-implementation-concerns-for-businesses-yumfog-6f72e68b0f6c>.
- [213] M. A. Mendoza, "Challenges and implications of cybersecurity legislation," 2017, [Online]. Available: <https://www.welivesecurity.com/2017/03/13/challenges-implications-cybersecurity-legislation/>.
- [214] D. Meyer, "Inside the ePrivacy Regulation's furious lobbying war," 2017, [Online]. Available: <https://iapp.org/news/a/inside-the-eprivacy-regulations-furious-lobbying-war/>.
- [215] M. Bayern, "How remote work rose by 400% in the past decade - TechRepublic," TechRepublic, 2020, [Online]. Available: <https://www.techrepublic.com/article/how-remote-work-rose-by-400-in-the-past-decade/>.
- [216] Clutch, "Remote work frequency before/after COVID-19," Statista, 2020, [Online]. Available: <https://www.statista.com/statistics/1122987/change-in-remote-work-trends-after-covid-in-usa/>.
- [217] D. Nevogt, "Are remote workers more productive? A data-backed answer," 2020, [Online]. Available: <https://blog.hubstaff.com/remote-workers-more-productive/>.
- [218] K. Lister, "Latest Work-at-Home/Telecommuting/Mobile Work/ Remote Work Statistics. Analytics, Global Workplace," 2020, [Online]. Available: <https://globalworkplaceanalytics.com/telecommuting-statistics>.
- [219] Capgemini, "From remote to hybrid," 2020, [Online]. Available: https://www.capgemini.com/research/the-future-of-work/?utm_source=pr&utm_medium=referral&utm_content=none_none_link_pressrelease_none&utm_campaign=other_hybrid_workforce.
- [220] DAK, "Nachteile von Homeoffice.," Statista, 2020, [Online]. Available: <https://de.statista.com/statistik/daten/studie/1135513/umfrage/nachteile-von-homeoffice-in-deutschland/>.
- [221] Hans Böckler Stiftung, "Studien zu Homeoffice und mobiler Arbeit," 2021, [Online]. Available: <https://www.boeckler.de/de/auf-einen-blick-17945-Auf-einen-Blick-Studien-zu-Homeoffice-und-mobiler-Arbeit-28040.html>.
- [222] PWC, "The costs and benefits of working from home," 2021, [Online]. Available: <https://www.pwc.nl/actueel-publicaties/assets/pdfs/pwc-the-costs-and-benefits-of-working-from-home.pdf>.
- [223] Capgemini, "Remote working productivity change by function," Statista, 2021, [Online]. Available: <https://www.statista.com/statistics/1196511/organizations-productivity-change-remote-working-by-function/>.

Sources

- [224] GitLab, "Remote work benefits to the employer," Statista, 2021, [Online]. Available: <https://www.statista.com/statistics/1111408/benefits-of-working-remote-to-the-employer/>.
- [225] K. Schneider, "Pendler-Statistik: Immer mehr Berufspendler in Deutschland," 2020, [Online]. Available: <https://wohnglueck.de/artikel/pendler-deutschland-statistik-29271>.
- [226] Getabstract, "National Survey: A Majority of US Employees Want Remote Work Arrangement to Stay," 2020, [Online]. Available: https://journal.getabstract.com/wp-content/uploads/2020/04/ga_remote_survey_2020_compressed.pdf.
- [227] CIPD, "Working From Home: What's driving the Rise in Remote Working," 2020, [Online]. Available: https://www.cipd.co.uk/Images/working-from-home-1_tcm18-74230.pdf.
- [228] Capgemini, "Employee disconnect when remote working by function," Statista, 2020, [Online]. Available: <https://www.statista.com/statistics/1196500/employee-disconnect-when-remote-working-by-function/>.
- [229] J. Dingel, B. Neiman, "How Many Jobs Can be Done at Home?," 2020.
- [230] Gartner, "Gartner CFO Survey Reveals 74% Intend to Shift Some Employees to Remote Work Permanently," 2020, [Online]. Available: <https://www.gartner.com/en/newsroom/press-releases/2020-04-03-gartner-cfo-survey-reveals-74-percent-of-organizations-to-shift-some-employees-to-remote-work-permanently2>.
- [231] BAIN & COMPANY, "Nachhaltige Finanzierungen werden für Banken zunehmend attraktiv," 2021, [Online]. Available: <https://www.bain.com/de/ueber-uns/presse/pressemitteilungen/germany/2021/nachhaltige-finanzierungen-werden-fuer-banken-zunehmend-attraktiv/>.
- [232] KPMG, "European Responsible Investing Fund market 2019," 2019, [Online]. Available: <https://assets.kpmg/content/dam/kpmg/lu/pdf/lu-en-European-Responsible-Investment-Fund-2019.pdf>.
- [233] BAIN & COMPANY, "Sustainability Efforts Accelerating Despite Covid-19 Disruption," 2020, [Online]. Available: <https://www.bain.com/insights/sustainability-efforts-accelerating-despite-covid-19-disruption-snap-chart/>.
- [234] G. Bressanelli, N. Sacconi, and M. Perona, "Towards Circular Economy in the Household Appliance Industry: An Overview of Cases," 2020, [Online]. Available: <https://doi.org/10.3390/resources9110128>.
- [235] Trivium Packaging, "New Report Finds Overwhelming Majority of Global Consumers Are Willing to Pay More for Sustainable Packaging," 2020, [Online]. Available: <https://triviumpackaging.com/news/150>.
- [236] European Commission, "New rules make household appliances more sustainable," 2019, [Online]. Available: https://ec.europa.eu/commission/presscorner/detail/en/IP_19_5895.
- [237] UNESCO, "UNESCO moving forward the 2030 Agenda for Sustainable Development," 2020, [Online]. Available: <http://en.unesco.org/sdgs>.
- [238] M. Lammi, M. Pantzar, "The data economy: How technological change has altered the role of the citizen-consumer," *Technology in Society*, Volume: 59, doi: 10.1157, 2019, [Online]. Available: <https://doi.org/10.1016/j.techsoc.2019.101157>.
- [239] BCG, "For Machinery Makers, Green Tech Creates Green Business," 2020, [Online]. Available: <https://www.bcg.com/publications/2020/for-machinery-makers-green-tech-creates-green-business>.
- [240] B. Conard, "Some challenges to sustainability," *Sustainability* (Switzerland), Volume: 5, no.8, 3368–3381, 2020, [Online]. Available: <https://doi.org/10.3390/su5083368>.
- [241] V. Herrera, "Reconciling global aspirations and local realities: Challenges facing the Sustainable Development Goals for water and sanitation," *World Development*, Volume: 118, 106–117, 2019.
- [242] D. Reinsel, J. Rydning, and J. F. Gantz, "Worldwide Global DataSphere Forecast, 2020–2024: The COVID-19 Data Bump and the Future of Data Growth," 2019, [Online]. Available: <https://www.idc.com/getdoc.jsp?containerId=US44797920>.
- [243] G. Cattaneo, G. Micheletti and M. Glennon, "Final Study Report: The European Data Market Monitoring Tool Key Facts & Figures, First Policy Conclusions, Data Landscape and Quantified Stories," 2019, [Online]. Available: <https://datalandscape.eu/study-reports/final-study-report-european-data-market-monitoring-tool-key-facts-figures-first-policy>.
- [244] European Commission, "Building a Data Economy," 2021, [Online]. Available: <https://ec.europa.eu/digital-single-market/en/news/building-data-economy-brochure>.
- [245] McKinsey Global Institute, "The Age of Analytics: Competing in a Data-Driven World," 2020, [Online]. Available: www.mckinsey.com/mgi.
- [246] IDC, "Total Data Volume Worldwide 2010-2024," 2020, [Online]. Available: <https://www.statista.com/statistics/871513/worldwide-data-created/>.
- [247] M Rathore, H. Son, and A. Ahmad, "Real-Time Big Data Stream Processing Using GPU with Spark Over Hadoop Ecosystem," *International Journal of Parallel Programming*, Volume: 46, no. 3, pp. 630–646., 2018 .
- [248] D. Ricardo, D. Barros, and S. Diederichs, "Performance and Capacity Implications for Big Data," 2014, [Online]. Available: <https://www.redbooks.ibm.com/redpapers/pdfs/redp5070.pdf>.
- [249] B. Chakravorti, B. Ajay, and C. Shankar, "Which Countries Are Leading the Data Economy?," 2019, [Online]. Available: <https://hbr.org/2019/01/which-countries-are-leading-the-data-economy>.
- [250] European Commission, "Proposal for a Regulation of the European Parliament and of the Council Establishing the Digital Europe Programme for the period 2021-2027," 2018, [Online]. Available: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A434%3AFIN>.
- [251] W. Lambrechts, C. Gelderman, J. Semeijn, and E. Verhoeven, "The role of individual sustainability competences in eco-design building projects," *Journal of Cleaner Production*, Volume: 208, 1631–16https://doi.org/10.1016/j.jclepro.2018.10.084.
- [252] V. Vitaliev, "Digital Security and Privacy," 2020, [Online]. Available: <https://www.oecd.org/going-digital/topics/digital-security-and-privacy/>.
- [253] B. Millettler, "Data Economy: Radical Transformation or Dystopia?," 2019, [Online]. Available: https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/FTQ_1_Jan_2019.pdf.
- [254] A. Opher, A. Chou, A. Onda, "The Rise of the Data Economy: Driving Value through Internet of Things Data Monetization A Perspective for Chief Digital Officers and Chief Technology Officers," 2016.
- [255] European Commission, "European legislation on open data and the re-use of public sector information," 2020, [Online]. Available: <https://ec.europa.eu/digital-single-market/en/european-legislation-reuse-public-sector-information>.
- [256] McKinsey Global Institute, "The Age of Analytics: Competing in a Data Driven World," 2016, [Online]. Available: <https://www.mckinsey.com/-/media/McKinsey/Industries/Public%20and%20Social%20Sector/Our%20Insights/The%20Age%20of%20analytics%20Competing%20in%20a%20data%20driven%20world/MGI-The-Age-of-Analytics-Full-report.pdf>, accessed on: 2021-03-09.
- [257] British Property Federation, "Micro Living Defined," 2018, [Online]. Available: https://bpf.org.uk/media/1076/compact_living_full_research_report.pdf.
- [258] A. K. Donati, "Node Raises Funds To Invest \$350 Million Into European Co-Living," *Forbes*, 2020, [Online]. Available: <https://www.forbes.com/sites/angelicakrystledonati/2020/09/22/node-raises-funds-to-invest-300-million-into-european-co-living/?sh=272e80d92b0d>.
- [259] Corestate, "The Living Circle A Case for Micro Living Real Estate Investments in Europe," 2019, [Online]. Available: <https://corestate-capital.com/en/research/>.
- [260] Eurostat, "Household composition statistics," 2020, [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php/Household_composition_statistics#More_and_more_households_consisting_of_adults_living_alone.
- [261] JLL, "Why investors are signing up for coliving," 2019, [Online]. Available: <https://www.jll.co.uk/en/trends-and-insights/investor/why-investors-are-signing-up-for-coliving>.
- [262] A. Azevedo, A. Cabrerizo & J. Colás, "Housing and Family Dynamics in Southern Europe," 2016, [Online]. Available: <https://www.tdx.cat/bitstream/handle/10803/400479/aba1de1.pdf?sequence=1>.
- [263] Funds Europe, "Real estate and Covid-19: Accelerating trends," 2021, [Online]. Available: <https://www.funds-europe.com/news/real-estate-and-covid-19-accelerating-trends>.
- [264] D. Bothun, M. Lieberman, "Unlocking a culture of convenience," 2017, [Online]. Available: <https://www.pwc.fr/fr/assets/files/pdf/2017/01/pwc-consumer-intelligence-series-iot-connected-home.pdf>.
- [265] Financial Times, "European city living gets less affordable," 2019, [Online]. Available: <https://www.ft.com/content/38f8c8e4-8227-11e9-9935-ad75b96c849>.
- [266] M. Mark, "What people say is the biggest benefit to communal living," *World Economic Forum*, 2019, [Online]. Available: <https://www.weforum.org/agenda/2021/03/co-living-communal-mental-health/>.

- [267] MSCI, "Post-Pandemic Reflections: Smart Cities," 2020, [Online]. Available: <https://www.msci.com/documents/1296102/18941732/ThematicIndex-SmartCities-Post-COVID-cbr-en.pdf/5b4df1b8-64d1-240c-eae3-f40eb36afbfb>.
- [268] J. Ford, & L. Gomez-Lanier, "Are Tiny Homes Here to Stay? A Review of Literature on the Tiny House Movement," 2017, [Online]. Available: <https://doi.org/10.1111/fcsr.12205>.
- [269] The Housmonk, "The Global Coliving Report," 2019, [Online]. Available: <http://52.77.103.130/global-coliving-report>.
- [270] J. U. Beriot, B. Arquitectos, "The Health Risks of Small Apartments Living in tiny spaces can cause psychological problems," 2021, [Online]. Available: <https://www.theatlantic.com/health/archive/2013/12/the-health-risks-of-small->
- [271] G. K. Deans, F. Kroeger, S. Zeisel, "The Consolidation Curve," Harvard Business Review, Volume: 12, 2002, [Online]. Available: <https://hbr.org/2002/12/the-consolidation-curve>.
- [272] Statista, "Smart Home - Worldwide," Statista Market Forecast, 2021, [Online]. Available: <https://www.statista.com/outlook/dmo/smart-home/worldwide>.
- [273] D.J. Lasquety-Reyes, "Smart Home Report 2020," Statista, [Online]. Available: <https://de.statista.com/statistik/studie/id/41155/dokument/smart-home-report/>.
- [274] Electrolux, "Electrolux Market Overview 2020," 2020.
- [275] S. Ali, Z. Yusuf, "Mapping The Smart-Home Market," 2018, [Online]. Available: <https://www.bcg.com/de-de/publications/2018/mapping-smart-home-market>.
- [276] S. Gibbs, "Amazon buys video doorbell firm Ring for over \$1bn," The Guardian, 2018, [Online]. Available: <https://www.theguardian.com/technology/2018/feb/28/amazon-buys-video-doorbell-ring-smart-home-delivery>.
- [277] M. Umair, M. Cheema, "Impact of COVID-19 on Adoption of IoT in Different Sectors," pp. 1–19, 2021, [Online]. Available: <http://arxiv.org/abs/2101.07196>.
- [278] Statista, "Number of connected devices worldwide 2030," 2019, [Online]. Available: <https://www.statista.com/statistics/802690/worldwide-connected-devices-by-access-technology/>.
- [279] Bundesministerium für Wirtschaft und Energie (BMWi), "Das Projekt GAIA-X," 2019, [Online]. Available: <https://www.bmwi.de/Redaktion/DE/Publikationen/Digitale-Welt/das-projekt-gaia-x.html>.
- [280] Bundesministerium für Wirtschaft und Energie (BMWi), "Smart Living in Germany," 2017, [Online]. Available: <https://www.smart-living-germany.de/SL/Navigation/DE/Home/home.html>.
- [281] Statista, "Global smart systems, services / IoT platform market size 2017-2023," 2018, [Online]. Available: <https://www.statista.com/statistics/805061/global-smart-systems-services-iot-platform-market-size-by-region/>.
- [282] Y. Zikria, Y. Bin, M. Afzal, "Internet of things (IoT) operating systems management: Opportunities, challenges, and solution," Sensors, Volume: 8, [Online]. Available: <https://doi.org/10.3390/s19081793>.
- [283] Connected Home IP, "Project Connected Home over IP," 2021, [Online]. Available: <https://www.connectedhomeip.com/>.
- [284] V. Bonneau, B. Copigneaux, L. Probst, & B. Pedersen, "Smart Home: Technologies with a standard battle," 2017, [Online]. Available: <https://smarthomeneed.com/inspirations/foundations/how-to-choose-a-smart-home-ecosystem/>.
- [285] P.D. Heimer, D. Köhler, M. Schidlack, D.H. Strese, "SmartLiving2Market 2020," 2020, [Online]. Available: https://www.smart-living-germany.de/SL/Redaktion/DE/Publikationen/2020_10_19_SmartLiving2Market2020_Studie.pdf?__blob=publicationFile&v=4.
- [286] BMI Lab, "Business Models – Definition and Reason," 2020, [Online]. Available: <https://bmlab.com/blog/2020/01/23/business-models-definition-and-reason>, accessed on 2021-03-08.
- [287] Castela, "The Transformative Business Model. Harvard Business Review," 2016, [Online]. Available: <https://hbr.org/2016/10/the-transformative-business-model>, accessed on 2021-03-02.
- [288] Z. Amit, "Creating Value Through Business Model Innovation," MIT Sloan Management Review, Volume: 53, 2012.
- [289] BCG, "Business Model Innovation Delivers Competitive Advantage," 2018, [Online]. Available: <https://www.bcg.com/capabilities/innovation-strategy-delivery/business-model-innovation>, accessed on 2021-03-08.
- [290] Economist Intelligence Unit, "Business 2010: Embracing the Challenge of Change," 2004.
- [291] BMI Lab, "Business Model Navigator," 2021, [Online]. Available: <https://businessmodelnavigator.com/explore>, accessed on: 2021-03-02.
- [292] PwC, "Sharing or paring? Growth of the Sharing Economy," 2015.
- [293] Tabcum, "The Sharing Economy is Still Growing, And Businesses Should Take Note. Forbes," 2019, [Online]. Available: <https://www.forbes.com/sites/forbeslacouncil/2019/03/04/the-sharing-economy-is-still-growing-and-businesses-should-take-note/?sh=299f583c4c33>, accessed on: 2021-03-02.
- [294] Kumar, Lahiri, Dogan, "A strategic framework for a profitable business model in the sharing economy," Industrial Marketing Management, Volume: 69, 2017.
- [295] M. Böcker, "Sharing for people, planet or profit? Analysing motivations for intended sharing economy participation," Environmental Innovation and Societal Transitions, Volume: 23, 2017.
- [296] M. Curtis, "Sharing Economy Business Models for Sustainability," Journal of Cleaner Production, Volume: 266, 2020.
- [297] R. Botsman, "Beyond Zipcar: Collaborative Consumption," Harvard Business Review, 2010, [Online]. Available: <https://hbr.org/2010/10/beyond-zipcar-collaborative-consumption>, accessed on: 2021-03-05.
- [298] Deloitte, "The Deloitte Global Millennial Survey," 2020.
- [299] F. Zhu, M. Iansiti, "Why Some Platforms Thrive and Others Don't," Harvard Business Review, 2019, [Online]. Available: <https://hbr.org/2019/01/why-some-platforms-thrive-and-others-dont>, accessed on: 2021-03-03.
- [300] United Nations, "Goal 12: Ensure sustainable consumption and production patterns," 2019, [Online]. Available: <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>, accessed on: 21-03-02.
- [301] EU Recycling, "360-Grad-Lösungen gesucht: Geschäftsmodelle für die Kreislaufwirtschaft," 2020, [Online]. Available: <https://eu-recycling.com/Archive/29684>, accessed on: 2021-03-02.
- [302] Hamari, Sjöklint, Ukkonen, "The Sharing Economy: Why People Participate in Collaborative Consumption," Journal of the Association for Information Science and Technology, Volume: 67, 2016.
- [303] S. Frenken, "Putting the Sharing Economy into Perspective," Environmental Innovation and Societal Transitions, Volume: 23, pp 3-10, 2017.
- [304] T. Evans, Schmalensee, "Failure to Launch: Critical Mass in Platform Businesses," Review of Network Economics, Volume: 9, 2010.
- [305] Grover, [Online]. Available: <https://www.grover.com/de-en>, accessed on: 2021-03-09.
- [306] Vinted, [Online]. Available: <https://www.vinted.com/>, accessed on: 2021-03-09.
- [307] Taskrabbitt, [Online]. Available: <https://www.taskrabbitt.com/>, accessed on: 2021-03-09.
- [308] A. Toffler, "The Third Wave," New York: Morrow, Volume: 544, 1980.
- [309] P. Kotler, "The Prosumer Movement," Prosumer Revisited, pp. 51–60, 2010.
- [310] G. Ritzer, P. Dean, & N. Jurgenson, "The Coming of Age of the Prosumer," American Behavioral Scientist, Volume: 56, pp. 379–398, 2012.
- [311] M. Wu & Y. Lin, "Open source software development: an overview," Computer, Volume: 34, pp. 33–38, 2001.
- [312] Infarm, "Infarm raises \$170M during pandemic to grow largest urban vertical farming network in the world," 2020, [Online]. Available: <https://www.infarm.com/en/articles/infarm-raises-170m-during-pandemic>.
- [313] R. Zafar, A. Mahmood, S. Razzaq and W. Ali, "Prosumer based energy management and sharing in smart grid," Renewable and Sustainable Energy Reviews, Volume: 82, pp. 1675–1684, 2018.
- [314] T. Ryna, L. Strukova, "From rapid prototyping to home fabrication: How 3D printing is changing business model innovation," Technological Forecasting and Social Change, Volume: 102, pp. 214–224, 2016.
- [315] Zukunftsinstitut, "Die Zukunft ist ein Garten," [Online]. Available: <https://www.zukunftsinstitut.de/artikel/wohnen/die-zukunft-ist-ein-garten/>, 2020, accessed on: 2021-03-02.
- [316] S. Phade, "What's a Prosumer and Are You One?," Futures Platform, 2018, [Online]. Available: <https://www.futuresplatform.com/blog/whats-prosumer-and-are-you-one>.
- [317] Federal Ministry of Education and Research. "Climate Change as a Societal Challenge," BMBF, [Online]. Available: <https://www.bmbf.de/en/climate-change-as-a-societal-challenge-2135.html>, 2019, accessed on: 2021-03-07.
- [318] Statista, "Global digital population as of January 2021," 2020, [Online]. Available: <https://www.statista.com/statistics/617136/digital-population-worldwide/>, accessed on: 2021-03-08.

Sources

- [319] Bundesverband Solarwirtschaft, "Zweimillionste Solarstromanlage in Betrieb," 2020, [Online]. Available: <https://www.solarwirtschaft.de/2020/12/03/zweimillionste-solarstromanlage-in-betrieb/>, accessed on: 2021-03-08.
- [320] Bundesverband Solarwirtschaft, "Solarboom auf privaten Dächern," 2021, [Online]. Available: <https://www.solarwirtschaft.de/2021/02/02/solarboom-auf-privaten-daechern/>, accessed on: 2021-03-08.
- [321] Statista, "Global 3D printing products and services market size from 2020 to 2024," [Online]. Available: <https://www.statista.com/statistics/315386/global-market-for-3d-printers/>, 2020, accessed on: 2021-03-07.
- [322] L. Holzki, "Ensure sustainable consumption and production patterns. Handelsblatt," 2021, [Online]. Available: <https://www.handelsblatt.com/technik/it-internet/lin-kayser-evolution-im-3d-drucker-hyperganic-will-eines-tages-die-natur-nachdrucken/26919202.html>, accessed on: 2021-03-07.
- [323] A. Vikram, "Ensure sustainable consumption and production patterns," 2016, [Online]. Available: <https://medium.com/@aditya.vikram/the-rise-of-prosumers-and-what-it-means-for-consumer-companies-26d408325934>, accessed on: 2021-03-08.
- [324] T. Kollmann, "Mass Customization," Gabler Wirtschaftslexikon, 2020, [Online]. Available: <https://wirtschaftslexikon.gabler.de/definition/mass-customization-41769>, accessed on: 2021-03-08.
- [325] United Nations Department of Economic and Social Affairs, "Ensure sustainable consumption and production patterns," 2019, [Online]. Available: <https://sdgs.un.org/goals/goal12>, accessed on: 2021-03-07.
- [326] M. Lund, & C. Nielsen, "Building Scalable Business Models," MIT Sloan Management Review, 2017, [Online]. Available: <https://sloanreview.mit.edu/article/building-scalable-business-models/>, accessed on: 2021-03-08.
- [327] F. Zhu, M. Iansiti, "Why Some Platforms Thrive and Others Don't," Harvard Business Review, 2019, [Online]. Available: <https://hbr.org/2019/01/why-some-platforms-thrive-and-others-dont>, accessed on: 2021-04-20.
- [328] C. Inès, P. Guilherme, M. Esther, "Regulatory challenges and opportunities for collective renewable energy prosumers in the EU," Energy Policy, Volume: 138, no. 111212, 2020.
- [329] European Economic and Social Committee, "Prosumer Energy: opportunities and challenges for the EU," 2016, [Online]. Available: <https://www.eesc.europa.eu/en/news-media/news/prosumer-energy-opportunities-and-challenges-eu>, accessed on: 2021-03-08.
- [330] W. Heising, T. Krüger, D. Küpper, "Additive Manufacturing Needs a Business Ecosystem," 2020, [Online]. Available: Boston Consulting Group. <https://www.bcg.com/de-de/publications/2020/additive-manufacturing-needs-to-adopt-a-managed-business-ecosystem> accessed on: 2021-03-08.
- [331] Enpal, "Die Zukunft grüner Energie heißt Enpal," 2020, [Online]. Available: <https://www.enpal.de/> accessed on: 2021-03-08.
- [332] A. Metz, M. Priebe, "Welcome to the Club(house)," Frankfurter Allgemeine Zeitung, 2021, [Online]. Available: <https://www.faz.net/aktuell/stil/trends-nischen/hype-um-clubhouse-was-kann-die-neue-app-17153745.html>, accessed on: 2021-03-08.
- [333] HP, "3D-DRUCKLÖSUNGEN. LASSEN SIE UNS MÖGLICHKEITEN SCHAFFEN," 2020, [Online]. Available: <https://www8.hp.com/de/de/printers/3d-printers.html>, accessed on: 2021-03-08.
- [334] Pew Research Center, "Psychological Stress In Social Media Use," 2015, [Online]. Available: <https://www.pewresearch.org/internet/2015/01/15/psychological-stress-and-social-media-use-2/>, accessed on: 2021-03-09.
- [335] P. Hemp, "Death by Information Overload," Harvard Business Review, 2009, [Online]. Available: <https://hbr.org/2009/09/death-by-information-overload>, accessed on: 2021-03-09.
- [336] Accenture, "Pulse Survey Accenture," 2018, [Online]. Available: https://www.accenture.com/_acnmedia/PDF-77/Accenture-Pulse-Survey.pdf.
- [337] Forbes, "The Path To Personalization," 2019, [Online]. Available: <https://www.forbes.com/sites/insights-treasuredata/2019/05/01/the-path-to-personalization/>, accessed on: 2021-03-02.
- [338] M. Day, "Your Smart Light Can Tell Amazon And Google When You Go To Bed," Bloomberg, 2019, [Online]. Available: <https://www.bloomberg.com/news/articles/2019-02-12/your-smart-light-can-tell-amazon-and-google-when-you-go-to-bed>, accessed on: 2021-03-09.
- [339] S. Flavin, "A Technology Blueprint For Personalization At Scale," McKinsey, 2019, [Online]. Available: <https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/a-technology-blueprint-for-personalization-at-scale> accessed on: 2021-03-09.
- [340] Segment, "Personalization Report," 2017, [Online]. Available: <http://grow.segment.com/Segment-2017-Personalization-Report.pdf>, accessed on: 2021-03-09.
- [341] A. Mintzer, "Paying Attention to the Attention Economy," Berkeley Economic Review, 2020, [Online]. Available: <https://econreview.berkeley.edu/paying-attention-the-attention-economy/>, accessed on: 2021-03-09.
- [342] L. F. Bright, "Consumer control and customization in online environments : an investigation into the psychology of consumer choice and its impact on media enjoyment, attitude, and behavioral intention," University of Texas, 2008.
- [343] Gartner, "Personalization 2Q19 Executive Guidance," 2019, [Online]. Available: <https://www.gartner.com/en/executive-guidance/personalization>, accessed on: 2021-03-09.
- [344] Cisco, "2020 Consumer privacy survey," 2020, [Online]. Available: https://www.cisco.com/c/dam/en_us/about/doing_business/trust-center/docs/cisco-consumer-privacy-infographic-2020.pdf, accessed on: 2021-03-09.
- [345] PWC, "Top policy trends 2020: Data privacy," 2020, [Online]. Available: <https://www.pwc.com/us/en/services/consulting/risk-regulatory/library/top-policy-trends/data-privacy.html>, accessed on: 2021-03-09.
- [346] C. Pettey, "Bridging the Customer Engagement Gap," Gartner, 2019, [Online]. Available: <https://www.gartner.com/smarterwithgartner/bridging-the-customer-engagement-gap/>, accessed on: 2021-04-16.
- [347] J. Sadowski, "Too smart. How Digital Capitalism is Extracting Data, Controlling Our Lives, and Taking Over the World," MIT Press, 2020.
- [348] National Retail Federation, "Consumer View Winter 2020," 2020, [Online]. Available: <https://nrf.com/research/consumer-view-winter-2020>, accessed on 2021-03-0.
- [349] Statista, "Market revenue of smart home subscription services worldwide from 2016 to 2022," 2019, [Online]. Available: <https://www.statista.com/statistics/935874/worldwide-smart-home-subscription-services-market-revenue/>, accessed on: 2021-03-05.
- [350] Paysafe, "COVID-19 and the future of subscriptions payments," 2020, [Online]. Available: <https://www.paysafe.com/en/blog/it-covid-19-and-the-future-of-subscription-payments/>, accessed on: 2021-03-02.
- [351] I. Amed, "Immediacy and the retail customer journey. McKinsey," 2019, [Online]. Available: <https://www.mckinsey.com/industries/retail/our-insights/now-or-never-immediacy-and-customer-experience-in-fashion-retail>, accessed on: 2021-03-09.
- [352] T. Chen, "Trends and opportunities in the subscription e-commerce market. McKinsey," 2018, [Online]. Available: <https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/thinking-inside-the-subscription-box-new-research-on-ecommerce-consumers#0>, accessed on: 2021-03-05.
- [353] Deloitte, "Price Hikes, Subscription Fatigue, and Password Sharing," 2019, [Online]. Available: <https://www2.deloitte.com/us/en/pages/technology-media-and-telecommunications/articles/password-sharing-streaming-wars.html>, accessed on: 2021-03-05.
- [354] Amazon, "Amazon Alexa Business Resources," 2020, [Online]. Available: <https://developer.amazon.com/en-US/alexa/devices/alexa-built-in/business-resources>, accessed on: 2021-03-07.
- [355] Statista, "Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025," 2020, [Online]. Available: <https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/>, accessed on: 2021-03-09.
- [356] Bosch, "Master your home with connected appliances," 2020, [Online]. Available: <https://www.bosch-home.com/us/experience-bosch/home-connect>, accessed on: 2021-03-09.
- [357] IoT For All, "Smart Home in the Spotlight," 2021, [Online]. Available: <https://www.iotforall.com/ces-smart-home>, accessed on: 2021-03-02.
- [358] G. Cuofaro, "What Is A B2B2C Business Model? B2B2C Business Model In A Nutshell. FourWeekMBA.," 2020, [Online]. Available: <https://fourweekmba.com/b2b2c/>, accessed on: 2021-03-02.
- [359] CommScope, "Smart Media Devices," 2020, [Online]. Available: <https://www.commscope.com/product-type/broadband-video-devices/video-devices/smart-media-devices/>, accessed on: 2021-03-02.
- [360] Alexa on Sonos, "Sonos," 2021, [Online]. Available: <https://www.sonos.com/de-de/alexa-on-sonos>, accessed on: 2021-03-07.
- [361] BCG, "Mapping the Smart-Home Market," 2021, [Online]. Available: <https://www.bcg.com/en-us/publications/2018/mapping-smart-home-market>, accessed on: 2021-03-07.
- [362] J. Knott, "Smart Home Market Set to Grow 4% in 2020. CEPro," 2020, [Online]. Available: <https://www.cepro.com/business-support/research/abi-research-smart-home-market-2020/>, accessed on: 2021-03-09.

Sources

- [363] J. Newman, "Amazon's three-pronged plan for taking over your home. Fast Company," 2018, [Online]. Available: <https://www.fastcompany.com/90284070/amazons-three-prong-plan-for-taking-over-your-home>, accessed on: 2021-03-07.
- [364] C. Beck, "Expert Lecture at CDTM," 2021.
- [365] J. Rodig, "Expert Lecture at CDTM," 2021.
- [366] V. Thirani, "The value of data. World Economic Forum," 2017, [Online]. Available: <https://www.weforum.org/agenda/2017/09/the-value-of-data/>, accessed on: 2021-03-09.
- [367] C. Kang, "U.S. and States Say Facebook Illegally Crushed Competition. The New York Time," 2020, [Online]. Available: <https://www.nytimes.com/2020/12/09/technology/facebook-antitrust-monopoly.html>, accessed on: 2021-03-09.
- [368] Amazon Alexa Fund, "Amazon developer," 2021, [Online]. Available: <https://developer.amazon.com/en-US/alexa/alexa-startups/alexa-fund>, accessed on: 2021-03-07.
- [369] Simply Kitchen, "10 Food & Kitchen Facts You May Not Know", 2017, [Online]. Available: <http://simplykitchensuk.com/blogs/10-food-kitchen-facts-may-not-know/>, accessed on: 2021-04-08.
- [370] Küchen & Design Magazin, "Checkliste zur Küchenplanung," [Online]. Available: <https://kuechen-design-magazin.de/wp-content/uploads/2020/11/30-punkte-Checkliste-zur-Kuechenplanung.pdf>, accessed at: 2021-04-08.
- [371] Immowelt, "Keine Corona-Atempause für Mieter: Angebotspreise steigen im 1. Halbjahr in drei Viertel der Großstädte weiter," 2020, [Online]. Available: <https://www.immowelt-group.com/presse/pressemitteilungenkontakt/immoweltde/2020/keine-corona-atempause-fuer-mieter-angebotspreise-steigen-im-1-halbjahr-in-drei-viertel-der-grossstaedte-weiter/>, accessed on: 2021-05-30.
- [372] Eurostat, "Waste statistics", 2018, [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics. [Accessed: 16-Apr-2021].
- [373] K. Sief, "The world is drowning in ever-growing mounds of garbage," The Washington Post, 2017, [Online]. Available: https://www.washingtonpost.com/world/africa/the-world-is-drowning-in-ever-growing-mounds-of-garbage/2017/11/21/cf22e4bd-17a4-473c-89f8-873d48f968cd_story.html, accessed: 08.04.2021.
- [374] C. Sha, "Center for Hospitality Research," [Online]. Available: <https://sha.cornell.edu/faculty-research/centers-institutes/chr/>, accessed on: 2021-04-08.
- [375] K. Taylor, "Workers at chains like Starbucks and McDonald's face violence and injuries on the job — and they're starting to speak out," Business Insider, 2019, [Online]. Available: <https://www.businessinsider.com/fast-food-industry-burdens-fall-on-workers-2019-1?r=DE&IR=T>.
- [376] AFP, "Stundenlohn in Fastfood-Restaurants steigt Ende 2023 auf zwölf Euro," FAZ, 2019, [Online]. Available: <https://www.faz.net/aktuell/wirtschaft/stundenlohn-in-fastfood-restaurants-steigt-ende-2023-auf-zwoelf-euro-16661592.html#:~:text=Laut%20Tarifabschluss%20steigt%20er%20nun,in%20Deutschland%20rund%20120.000%20Besch%C3%A4ftigte>.

Publisher	Center for Digital Technology and Management Arcisstr. 21 80333 Munich, Germany Phone: +49 89 289 – 28471 Fax: +49 89 289 – 28459 E-Mail: info@cdtm.de www.cdtm.de
Editors	Philipp Hofsommer, Franz Xaver Waltenberger
Team Heads	Anna-Lena Zelder (Layout), Frederic Martin (Editing), Philipp Engel (Q&A) with support from the entire Class Spring 2021
Printed Copies	80
Printing Company	printworld.com GmbH Weststraße 60 09603 Großschirma
Photos	All photos: http://www.pexels.com/ http://www.unsplash.com/ http://www.istockphoto.com/
Picture Manager	Felix Rösner
Illustrations	Florian Müller
Year of Publication	2021

SMART LIVING OF THE FUTURE

Digital technologies are constantly pushing us towards an ever more connected world and have a significant impact on our daily private and business lives. Smart living devices and services have introduced a whole new universe of individual interaction and customization to our homes, while data privacy concerns still limit the consumer adoption of promising appliances and applications.

Smart living holds promising opportunities in accommodating our changing housing needs. While the aim for a safe personal home has never changed, our daily lives inside and outside our living spaces have significantly changed. With an increasingly complex social environment, new technologies provide an ideal starting point to enable

a true change in the ways smart devices facilitate the way we interact with our homes.

How will we live in the future and spend time at home? Which activities will we pursue at home, and which not? How will environmental changes influence our habits in our everyday lives? What will be the long-lasting effects of Covid-19, remote work, and changing family models? Which drivers will particularly impact our living spaces in the future? Who will use and own the data? In a nutshell: What will the future of smart living look like in 2041, twenty years from today?

This report identifies current trends (political, economic, social, technological, environmental, and legal) that affect the future of smart living. It derives four future scenarios, as well as five related business ideas. The generated business concepts range from a smart chair, a resourceful cooking app, a flexible kitchen, a robotic arm, to a smart trash can.



The Center for Digital Technology and Management (CDTM) is a joint interdisciplinary institution of education, research, and entrepreneurship of the Ludwig-Maximilians-University (LMU) and the Technical University of Munich (TUM).

CDTM offers the interdisciplinary add-on study program „Technology Management“, which is part of the Elite Network of Bavaria. Students from various study backgrounds with creative ideas, great motivation and an entrepreneurial mindset are offered the tools to put their ideas into practice. As a research institution, CDTM closely cooperates with the industry, start-ups and public sector concentrating on topics at the intersection of technology, innovation, and entrepreneurship.

E-mail info@cdtm.de

Internet www.cdtm.de

Philipp Hofsommer · Franz Xavier Waltenberger

